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Arizona Ranchers' Management Guide

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2001

Arizona Ranchers' Management Guide

Introduction

Rangeland Management

Genetics and Reproduction

Production and Management Decisions

Animal Care and Health Maintenance

Range Cattle Nutrition

Ranch Business Management

Policy Issues

Introduction

This Guide is designed to be a comprehensive information resource with articles that focus on Arizona's ranching environment. Information on rangeland management, nutrition, genetics, animal heath, policy, and economic issues are included. This 2001 set of articles is the 3rd supplement to the initial publication that started the *Arizona Ranchers' Management Guide* in 1993. As you will note, some of the earlier articles have been superseded by more current information. Future supplements will be available on-line at http://ag.arizona.edu/arec/pubs/rmg/ranchers.html. A "hard copy" version of future supplements and the entire Guide will be available for purchase from the College of Agriculture and Life Sciences online ordering system (http://ag.arizona.edu/pubs/) or the following:

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Arizona IRM

Change is one of the certainties in life and The University of Arizona's Integrated Resource Management (IRM) programs continue to change and evolve as technologies, personnel, funding, and issues change. Since the first *Arizona Ranchers' Management Guide* publication in 1993, the College of Agriculture and Life Sciences has acquired the V Bar V Ranch through a gift-purchase agreement in 1995. This ranch is a 550-head working cattle ranch with a 57-pasture grazing allotment that runs about 30 miles east from Camp Verde along the Mogollon Rim and extends from 4 to 5 miles in width. The elevation varies from 3,200 to 7,000 feet and offers a diverse laboratory setting for studying livestock, range, and wildlife activities and interactions. Specific studies on the ranch range from range monitoring to animal health and the influence of animal genetics on carcass value.

Arizona ranchers are also welcome to see how their livestock perform on the grid by entering their cattle in the "Ranch to Rail" program. While individual ranchers retain ownership of their own cattle in the feedlot, the program provides feedlot and carcass performance information that has been used by ranchers to help market their cattle in subsequent years and improve their genetics. Ongoing rangeland monitoring programs are available to help validate stewardship that ranchers may be implementing on the range through their stocking and management programs. The economics of ranching and the impact of alternative management strategies can be evaluated through a hands-on computer-oriented "Ranching for Profit" curriculum.

Even though programs and personnel will continue to evolve and change, one constant is that your local county extension office is likely to be a good starting point for locating information or individuals that can address your problem or question. We also hope that this Guide will become a familiar source for you in identifying pertinent information for your ranch management decisions.

Other Information Sources

While this Guide focuses on range environment, management and policy issues, and animal health issues that are most germane for Arizona, other information sources are available for western cow-calf production. Another excellent resource is *The Cow-Calf Management Guide & Cattle Producer's Library* published by the University of Idaho. This Guide contains over 880 pages of articles written by numerous specialists, county agents, and ranchers. Included are sections on nutrition, reproduction, marketing, quality assurance, management, finance, genetics, and drought. Ordering information is available by contacting Agricultural Publications, University of Idaho, Moscow, ID 83844 (208-885-7982, phone), or online at http://info.ag.uidaho.edu/westbeef/.

In addition, a number of web sites have current and up-to-date information for cattle producers. Everything from market outlook to government regulations and animal health issues can be found by accessing the Internet sites listed below. A short description of each site is provided, although most sites usually cover many more subject areas and issues than those mentioned.

Agricultural Software Downloads
http://www.agdownload.com/
This site contains links to shareware and freeware programs. Topics include software for Children, Crops, Farm Management, GIS, Irrigation, Livestock, Office, Soils, and other related desktop software programs.

AgriSurf
http://www.agrisurf.com/agrisurfscripts/agrisurf.asp?index=_25
AgriSurf is a search engine for agriculture. Direct links are also provided and grouped by categories. Some of the categories included are farm management, software, agri-tourism, forestry, research and education, extension, and technology.

Agricultural Marketing Service USDA
http://www.ams.usda.gov/
The Agricultural Marketing Service includes the six commodity divisions of Cotton, Dairy, Fruit and Vegetable, Livestock and Seed, Poultry, and Tobacco. Depending on the market and location, daily, bi-weekly, weekly, or monthly price information is available. These divisions also employ specialists who provide standardization, grading, and market news services for those commodities. They enforce Federal Laws such as the Perishable Agricultural Commodities Act, the Federal Seed Act, and several other acts.

British Columbia Human Resource Management
http://farmcentre.com/bc/human.htm
This site covers a range of topics that include labor, communications, supervision, regulation, family business management, meeting protocol, and multigenerational family management of a business.

Cattle Industry's Link to the Future
http://www.cattlehome.com/
This site provides a source of information and services for the cattle industry. Direct links are grouped by categories including farm management, software, research and education, extension and technology.

Cattle Pages
http://www.cattlepages.com/
This is a commercial site that acts as source of information and services for the cattle industry. There are direct links grouped by categories including, but not limited to, cattle equipment, cattle supplies, cattle services, breeder's directory, breed associations, and market and weather information.

Center for Farm Financial Management
http://www.cffm.umn.edu/
The Center for Farm Financial Management is a unit in the Department of Applied Economics at the University of Minnesota. Its primary purpose is to develop educational tools for farmers, agricultural lenders, and educators to apply the principles and concepts of farm planning, financing, and analysis in a practical manner.

Direct Agricultural Marketing
http://www.directAg.com/directag/index.jhtml
DirectAg is a commercial site offering a way to purchase ag related products and access information for the farm. This site provides e-business to research ag brands, obtain immediate financing, and buy directly over the Internet.

Farmer's Guide to the Internet
http://www.rural.org/favorites.html
The University of Kentucky (UK) Rural Studies program developed this Farmer's Guide to the Internet and compiled nearly 2,000 different links to useful sites everywhere.

Livestock Marketing Information Center
http://lmic1.co.nrcs.usda.gov/
The LMIC is a cooperative effort between state university extension specialists, USDA economists, industry cooperators, and Center staff. LMIC provides market outlook information for feeder and fed cattle. Data and some links are limited to states that are members. Through cooperative efforts and programs, duplication of effort is greatly reduced while enhancing the overall quality and quantity of livestock market information for producers and other decision makers.

My Cattle Website
http://www.mycattle.com/
My Cattle is a commercial site designed as an Internet source of information and services for the cattle industry. Direct links are also provided and grouped by categories. Categories included are cattle equipment, cattle supplies, cattle services, breeder's directory, breed associations, and market and weather information.

National Cattleman's Beef Association
http://www.beef.org/
While much of the site is targeted at consumers, ranchers will also be interested. Current news is provided on the site with the latest research and findings related to beef always highlighted. Other sections on this site include nutrition, kitchen recipes, business, policy, and email discussion groups.

Net Vet
http://netvet.wustl.edu/
Numerous veterinary medical and animal health topics are considered on this site. Extensive links are provided to animals and pets by category, veterinary specialties, educational institutions, governmental and legal resources, publications and references, and other topics related to veterinarian activities.

OK State University Cow/Calf Corner
http://www.ansi.okstate.edu/exten/cc-corner/indext.htm
"Cow-calf Corner" is a weekly television presentation of management tips for Oklahoma beef cow producers. You can view and hear the most recent presentation by clicking on the "movie" link at the top of the "This Week" document. Click on Library for a wide variety of topics already covered.

Texas A&M University
http://ruralbusiness.tamu.edu/
Rural business development information and initiatives are featured on this site. Links are provided to livestock and crop budgets for Texas. Publications can be found that relate to risk management, rural entrepreneurship, beef, exotic wildlife, aquaculture, dairy, and forages.

University of Arizona AgNIC resources
http://ag.arizona.edu/OALS/agnic/toolkit/toolkit.html
AgNIC provides access to a wide scope of information on rangelands and rangeland management. It is geared towards users of all knowledge levels.

University of Arizona, AREC
http://ag.arizona.edu/AREC/ext/exthome.html
Publications and tools accessible from this site include the *Arizona Ranchers' Management Guide, Cost and Return Estimates for Cow/Calf Ranches in Five Regions of Arizona, Range Cow Culling Decisions, Managing for Today's Cattle Market and Beyond, Field and Vegetable Crop Budgets,* and other research information and links related to Arizona's agriculture.

Western Regional Sustainable Agriculture Research and Education (SARE)
http://wsare.usu.edu/
SARE's mission is to expand knowledge and adoption of sustainable agriculture practices that are economically viable, environmentally sound, and socially acceptable. Small grants are made available to ranches and farms to increase our knowledge of the integration of plant and animal production practices. Grantees need to demonstrate that they will help satisfy human food and fiber needs, enhance our environmental quality of life, make the most efficient use of nonrenewable resources, sustain the economic viability of farm operations and their communities, and enhance the quality of life for farmers and society as a whole.

FROM:

Arizona Ranchers' Management Guide
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WHAT IS AN A.U.M.?

George Ruyle and Phil Ogden[1]

Livestock grazing is one of the most widespread and important uses of Arizona rangelands. Ruminant animals provide food and fiber from renewable plant resources. This method of harvesting solar energy requires relatively low inputs of petroleum products for agricultural production. But range livestock must be managed properly to insure the long-term sustainability of the resource base. Proper grazing management depends in part on determining correct livestock numbers per area of land, known as the stocking rate. Stocking rate is often expressed as animal units per section or animal unit months per acre.

Federal and state livestock grazing permits generally are expressed in terms of animal units per area or total animal unit months (AUMs). One AUM is the amount of forage required by an animal unit (AU) for one month, or the tenure of one AU for a one-month period. If one AU grazes on an area of rangeland for six months, that tenure is equal to six AUs for one month or six AUMs. In general, the number of animal units, multiplied by the number of months they are on the range equals the number of AUMs used.

But how much forage is in one animal unit month? An animal unit is defined as a mature (1,000-pound) cow or the equivalent, based on an average consumption rate of 26 pounds of forage dry matter per day (Society for Range Management Glossary). That makes an AUM equal to 31 days x 26 pounds per day or about 800 pounds of air-dried forage. More conservative or liberal values are also used, for example 600 to 1,000 pounds of forage per AUM are common values.

Flexible management plans often allow for changes in the kind and class of livestock to be grazed on a particular area. To convert cow/calf AUMs to yearling, sheep or some other category, animal unit conversion factors are used. Animal unit conversion factors are numerical figures expressing the forage requirements of particular kinds or classes of animals relative to the standard animal unit, described above. They can be calculated by dividing the new animal's daily or monthly forage requirements by the standard animal unit value. However, these forage requirement values are variable and often unknown.

Another way to calculate the AU conversion factor is on the basis of metabolic body size (MBS), a relationship between animal weight and surface area. Metabolic body size is an expression relating energy metabolism to body weight, which has a relationship to body surface. The numerical expression for metabolic body size is $Wkg^{.75}$ where Wkg equals the weight of the animal in kilograms (1 kilogram = 2.2 pounds) and the exponent .75 has been derived through research. Metabolic body size conversions can be used when changing kind or class of livestock simply by dividing the average MBS of the current livestock by the average MBS of the new livestock. Then multiply that fraction by the current stocking rate for the adjustment.

For example, if you are now grazing five hundred 1,000-pound cows on an area and want to convert to 600-pound steers, completing the following steps will calculate the conversion factor and the number of steers you should run.

1. convert pounds to kilograms

   1,000 lbs x 0.45 kg/lbs = 450 kg
   600 lbs x 0.45 kg/lbs = 270 kg

2. take these values to the .75 power

   $450^{.75} = 98$

   $270^{.75} = 67$

3. divide the current (cow) weights by the new (steer) weights 98/67 = 1.5 = the conversion factor

4. multiply the cow herd size by the conversion factor 500 cows x 1.5 = 750 steers

To simplify matters, many people prefer the straight conversion by weight alone. In the above example, this would be 1,000/600 = 1.67. So the conversion would be 500 x 1.67 or 835 steers for 500 cows. On large-scale rangeland operations, weight conversions are usually adequate. Common conversion factors, based on metabolic body sizes are listed in Table 1.

CAUTION! Forage requirement values and conversion factors should only be used as a starting point when calculating and/or adjusting stocking rates. There are many variables that alter the animal unit requirement and change these basic relationships.

Standard conversion ratios should be modified locally to account for the type of range. For example, a proportionally larger number of sheep or yearling steers can be grazed on rough, poorly watered rangeland than standard conversion ratios would indicate. The vegetation mix may also alter this relationship.

Forage quality differences should also be considered. Seasonal changes in forage quality may increase or decrease the amount of forage animals must consume to meet maintenance

Table 1. Approximate Numbers of Individual Animals (Conversion Factor) per Standard Animal Unit Calculated by Using the Ratio of Metabolic Weights (wt. kg 0.75).

Species	Average lb.	Weight kg.	0.75 kg.	Ratio	Conversion Factor
Cow	1,000	450	98	1.00	1.0
Horse	1,100	495	105	0.93	0.9
Elk	600	270	67	1.46	1.5
Mule Deer	125	56	21	4.67	4.5
Sheep	120	54	20	4.90	5.0
Pronghorn Antelope	90	41	16	6.13	6.0

requirements. Animal needs also change over the year. Animal demands are much greater during lactation, a rule of thumb is a 33% increase in protein and a 50% increase in energy requirements.

Forage requirements are not uniform over various sized animals. Small animals consume more per unit of weight than larger animals. Metabolic weight conversions can be used where necessary to reduce this error.

Finally, there is little or no research information on forage wastage whether by trampling, covering with feces or by other means. However, there does appear to be a positive relationship between grazing pressure (the animal-to-forage ratio) and efficiency of forage harvesting by the grazing livestock.

In general, a value of 26 pounds of forage per day per animal unit seems to be a reasonable starting point for management purposes. Local values may be modified by the U.S. Forest Service, Bureau of Land Management or Soil Conservation Service procedures. But these values should be used only as a guide. Stocking rates should be continually monitored through range trend analysis.

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FROM:

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POISONOUS PLANTS ON ARIZONA RANGELANDS

George Ruyle[1]

Poisonous plants can be grouped according to their primary type of poison. The better understood types of poisoning include:

1. alkaloids;
2. glycosides
3. organic acids;
4. resins;
5. phytotoxins; and
6. various minerals.

Additionally, poisonous plants are lumped into a miscellaneous category attributed to unknown poisons.

ALKALOIDS

Alkaloids are complex compounds containing Nitrogen (N) that form salts with acids. In most cases poisonous alkaloids produce a strong physiological reaction in animals, primarily through the nervous system. These poisons may produce violent acute or chronic reactions. Alkaloids are found in a wide variety of plants, including ***desert tobacco***. Nicotine is the poisonous principle in this plant and although it is unpalatable to livestock a lethal dose is about 2% of the animal's weight and poisonings do occur.

Astragalus or ***locoweed*** is another plant containing poisonous alkaloids which cause the typical loco poisoning. This is a complex genera; nearly 100 different species occur in Arizona.

Locos are toxic in all stages of growth, even when dry. Consumption of loco by cattle, depending on the species, can cause immediate death or chronic poisoning leading to general unthriftyness and eventual death.

Senecio or ***threadleaf groundsel*** also poisons animals with a number of alkaloids. Cattle and horses are sensitive to senecio poisoning while sheep and goats are not. Often, a vitamin A-fortified supplement will cut down consumption of the plant.

GLYCOSIDES

Toxic glycosides yield a number of compounds. Hydrocyanic acid is the most common. Animals poisoned by HCN die of asphyxiation because HCN blocks the release of oxygen from red blood cells to tissue cells. Cattle are most susceptible and upon absorption of toxic amounts of HCN death follows in a few minutes to an hour or so.

Important hydrocyanic-acid producing plants in Arizona include ***Johnsongrass***. Danger from HCN poisoning in Johnsongrass is greatest when plants have been exposed to drought or have been frosted. Periods of rapid plant growth can also cause problems.

ORGANIC ACIDS

Oxalic acid is the most common poison in the organic acid group. This acid often produces colic, depression, coma and eventually death due to kidney failure. High calcium diets seems to prevent oxalic acid poisoning. ***Greasewood*** and ***Russian thistle*** contain oxalic acid. Losses are greatest in sheep and problems occur mainly when the diet is almost exclusively made up of these plants.

Many of the oaks including ***Gambel oak*** contain a related organic acid—

tannic acid which is also poisonous, but probably creates the most economic losses through reducing general herd productivity.

RESINS

Resins and resinoids affect both nerve and muscular tissues. The symptoms of resin poisoning are varied. The ***milkweeds*** are good examples of poisonous plants containing toxic resins.

Whorled milkweed contains toxic glycosides and resins which are partially retained in the plant after it is dry. This makes milkweed poisonous at all stages of growth, even after maturity, and when put up in hay. Whorled milkweed leaves are long and narrow and occur in whorls around the stem.

MINERALS

A number of minerals cause poisoning in livestock through plant consumption. In Arizona, probably only nitrogen and selenium are of real concern.

NITRATES

High nitrate levels in plants commonly poison livestock on both range and cropland. Losses most frequently occur during drought, after heavy application of N fertilizer and on soils high in N. Horses are less likely than ruminants to be poisoned by plants high in nitrate. Cattle are more frequently poisoned than other animals. Death is relatively rapid once enough plant material with high nitrate content is consumed.

Species that may accumulate toxic concentrations of nitrate are numerous and include ***carelessweed*** or ***pigweed***, and ***Russian thistle***. ***Filaree***, which is a valuable forage plant, occasionally develops high concentration of nitrates during the flush period of growth.

SELENIUM

Plants growing on soils containing over 2 ppm of selenium may accumulate toxic levels of this element. Consumption of these plants by livestock can produce either acute or chronic poisoning.

Plants that accumulate selenium are of two type-species Obligate species are those plants which require selenium for growth and therefore are indicators of selenium-bearing soils. Facultative selenium absorbers are plants that will accumulate selenium but are not limited to growing in soils containing selenium..

Some species of ***locoweed*** are obligate indicator plants meaning they require soils high in selenium. Secondary selenium absorbers include the ***asters*** and the ***saltbushes***.

Again, consumption of plants containing toxic amounts of selenium produce either acute or chronic poisoning. The acute form is rare however.

Chronic selenium intoxication occurs in one or two forms, blind staggers or alkalai disease. Blind staggers is caused by selenium consumption while grazing plants containing less than 200 ppm of selenium for one or two weeks. Alkalai disease develops after consumption of usually cultivated plants containing 5 to 40 ppm of selenium for periods of up to a month or longer.

MISCELLANEOUS POISONOUS PRINCIPLES

Numerous other toxic substances have been and are being discovered in plants. Tremetol, an alcohol found in

burroweed is an example of a miscellaneous poison. All parts of the burroweed plant is poisonous. These plants may also cause milk sickness in humans and calves from drinking the milk of cows grazing them.

GRASS TETANY

Grass tetany or grass staggers is a nutritional disease resulting from low blood magnesium levels and can be an important cause of losses among grazing cattle and sheep. The most common occurrence is during the first two weeks of spring green-up. Grass tetany generally affects the mature cow and is most common in the ten-week period after calving.

The immediate cause of grass tetany in animals on spring pasture is the rapid decrease in serum magnesium (MG), although the reasons for this decline are not clearly understood. Tetany can be prevented by providing additional magnesium like dolomitic limestone or magnesium oxide. Treatment of affected animals by injection of magnesium salts can prevent death loss.

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GRAZING CELL MANAGEMENT

Russell Gum[1] and George Ruyle[2]

INTRODUCTION

Management of a grazing cell requires careful planning and continuous monitoring. Both the planning and monitoring activities can be made easier by the use of computer spreadsheets to assist in calculations and data organization. Two useful spreadsheets are the growing season planning spreadsheet and the dormant season planning spreadsheet. The use of both of these spreadsheets are described below.

GROWING SEASON PLANNING

The growing season planning spreadsheet (see Table 1) assists in making the calculations to determine to the guidelines for rotation of animals through a cell during the season the forage is growing. To use the spreadsheet simply fill in the items in the spreadsheet, which are displayed in the gray cells. Each of these items is discussed below.

NUMBER OF PADDOCKS 14

If you have a different number of paddocks than the example program you will have to modify the spreadsheet by adding or deleting rows. If you do this you must change the formulas in D26 and D27 to reflect the correct number of paddocks. If you insert rows be sure to copy the formulas in row 24 to the new rows.

MINIMUM REST DESIRED 30
MAXIMUM REST DESIRED 45

Minimum rest desired is the least number of days you must rest a paddock when the plants are growing rapidly. Maximum rest desired is the most number of days you should rest a paddock when the plants are growing rapidly. Thirty and 45 days are reasonable values for many southwestern ranches. If plant growth is extremely rapid 20 to 50 days might be more reasonable. Since the spreadsheet assumes that you start in paddock 1 and proceed in numerical order, be sure to enter the paddock data accordingly.

<u>RELATIVE QUALITY</u>

The next step is to make an assessment of the forage available per acre in each paddock relative to one another. For new cells a simple procedure is to assume an equal quality of one for each paddock. If you have information about differences in production per acre among paddocks relative quality values can be assigned. This information is normally collected and refined as you operate a cell and keep records on its performance. To calculate the total forage available in a paddock the size of the paddock in acres is required by the spreadsheet. The following table might represent the data input for a typical cell.

PADDOCK	SIZE ACRES	RELATIVE QUALITY
1	500	0.5
2	300	2
3	200	1.2
4	300	2
5	500	0.3
6	600	0.7
7	500	1
8	200	0.3
9	300	3
10	400	1.5
11	500	0.6
12	200	0.8
13	300	1
14	500	2

At this point all of the required data has been entered into the spreadsheet and the results should appear as in the Table 1.

Use the minimum and maximum grazing periods for each paddock in the cell as guidelines for animal rotation. Continue this procedure throughout the growing season. Modifications may need to be made in the relative quality ratings of the paddocks based on observations of forage availability immediately after the animals are removed from a paddock. As modifications are made new guidelines will be calculated by the spreadsheet and should be used in determining animal rotations.

DORMANT SEASON PLANNING

The dormant season planning spreadsheet (see Table 2 and 3) assists in making the calculations to determine to guidelines for rotation of animals through a cell during the season the forage is not growing. To use the spreadsheet simply fill in the items in the spreadsheet, which are displayed in the gray cells. Each of these items is discussed below.

STARTING DATE 10/1/88

The starting date is simply the beginning date for the dormant season.

NUMBER OF PADDOCKS 14

Table 1

	A	B	C	D	E	F
1	ACTIVE GROWING SEASON					
2						
3						
4	NUMBER OF PADDOCKS		**14**			
5	MINIMUM REST DESIRED		**20**			
6	MAXIMUM REST DESIRED		**30**			
7						
8				STANDARD	MIMIMUM	MAXIMUM
9	PADDOCK	SIZE	RELATIVE	ACRES OF	GRAZING	GRAZING
10		ACRES	QUALITY	FORAGE	PERIOD	PERIOD
11	**1**	**500**	**0.5**	250	0.9	1.3
12	**2**	**300**	**2**	600	2.1	3.2
13	**3**	**200**	**1.2**	240	0.9	1.3
14	**4**	**300**	**2**	600	2.1	3.2
15	**5**	**500**	**0.3**	150	0.5	0.8
16	**6**	**600**	**0.7**	420	1.5	2.2
17	**7**	**500**	**1**	500	1.8	2.7
18	**8**	**200**	**0.3**	60	0.2	0.3
19	**9**	**300**	**3**	900	3.2	4.8
20	**10**	**400**	**1.5**	600	2.1	3.2
21	**11**	**500**	**0.6**	300	1.1	1.6
22	**12**	**200**	**0.8**	160	0.6	0.9
23	**13**	**300**	**1**	300	1.1	1.6
24	**14**	**500**	**2**	1000	3.5	5.3
25						
26	TOTAL FORAGE AVAILABLE (STANDARD ACRES)			6080		
27	AVERAGE PADDOCK RATING (STANDARD ACRES)			434		
28	AVERAGE MINIMUM GRAZING PERIOD			1.54		
29	AVERAGE MAXIMUM GRAZING PERIOD			2.31		

Table 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	DORMANT SEASON													
2														
3														
4	NUMBER OF PADDOCKS			14										
5	MINIMUM REST DESIRED			90										
6	MAXIMUM REST DESIRED			120	Rotation Guidelines									
7	ADA FOR RELATIVE QUALITY = 1			20.00										
8					MIMIMUM	MAXIMUM		MAX.				MAX.		
9	PADDOCK	SIZE	RELATIVE	INITIAL AD	GRAZING	GRAZING	STARTING	DAYS	NUMBER	AD	STARTING	DAYS	NUMBER	AD
10		ACRES	QUALITY	AVAILABLE	PERIOD	PERIOD	DATE	GRAZED	OF AD	REMAINING	DATE	GRAZED	OF AD	REMAINING
11	1	500	0.5	5000	3.99	5.31	1/1/88	5	1674	67%	5/9/88	5	2491	17%
12	2	300	2	12000	9.56	12.75	1/6/88	13	4018	67%	5/14/88	13	5979	17%
13	3	200	1.2	4800	3.83	5.10	1/19/88	5	1607	67%	5/27/88	5	2391	17%
14	4	300	2	12000	9.56	12.75	1/24/88	13	4018	67%	6/1/88	13	5979	17%
15	5	500	0.3	3000	2.39	3.19	2/5/88	3	1178	61%	6/14/88	3	1495	11%
16	6	600	0.7	8400	6.70	8.93	2/9/88	9	3299	61%	6/17/88	9	4185	11%
17	7	500	1	10000	7.97	10.63	2/18/88	11	3928	61%	6/26/88	11	4982	11%
18	8	200	0.3	1200	0.96	1.28	2/28/88	1	471	61%	7/6/88	1	632	8%
19	9	300	3	18000	14.35	19.13	2/29/88	19	7070	61%	7/8/88	19	9484	8%
20	10	400	1.5	12000	9.56	12.75	3/20/88	13	4714	61%	7/27/88	13	6323	8%
21	11	500	0.6	6000	4.78	6.38	4/1/88	6	2989	50%	8/9/88	6	1961	17%
22	12	200	0.8	3200	2.55	3.40	4/8/88	3	1594	50%	8/15/88	3	1046	17%
23	13	300	1	6000	4.78	6.38	4/11/88	6	2989	50%	8/18/88	6	1961	17%
24	14	500	2	20000	15.94	21.26	4/17/88	21	9964	50%	8/25/88	21	6538	17%
25														
26	TOTAL FORAGE AVAILABLE			121600	ADS									
27	AVERAGE PADDOCK RATING			8686	ADS									
28	AVERAGE MINIMUM GRAZING PERIOD			6.92	days									
29	AVERAGE MAXIMUM GRAZING PERIOD			9.23	days									

TABLE 3

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
30	STOCK TABLE													
31			JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
32	YEARLINGS													
33		STEERS												
34		HEIFERS	60	60	60	60	60	60	60	60	60	60	60	60
35														
36	COWS													
37		BRED HEIFERS	40	40	40	40	40	40	40	40	40	40	40	40
38		COWS	200	200	200	200	200	200	200	200	200	200	200	200
39														
40	BULLS								15					
41														
42	NUTRIENT REQUIREMENTS PER COW													
43	CALVE IN		IN											
44		%	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
45	JAN	0	1.60	1.60	1.60	1.60	0.95	0.95	0.95	0.98	0.98	0.98	1.20	1.20
46	FEB	0	1.20	1.60	1.60	1.60	1.60	0.95	0.95	0.95	0.98	0.98	0.98	1.20
47	MAR	0	1.20	1.20	1.60	1.60	1.60	1.60	0.95	0.95	0.95	0.98	0.98	0.98
48	APRIL	100	0.98	1.20	1.20	1.60	1.60	1.60	1.60	0.95	0.95	0.95	0.98	0.98
49	MAY	0	0.98	0.98	1.20	1.20	1.60	1.60	1.60	1.60	0.95	0.95	0.95	0.98
50	JUNE	0	0.98	0.98	0.98	1.20	1.20	1.60	1.60	1.60	1.60	0.95	0.95	0.95
51	JULY	0	0.95	0.98	0.98	0.98	1.20	1.20	1.60	1.60	1.60	1.60	0.95	0.95
52	AUG	0	0.95	0.95	0.98	0.98	0.98	1.20	1.20	1.60	1.60	1.60	1.60	0.95
53	SEPT	0	0.95	0.95	0.95	0.98	0.98	0.98	1.20	1.20	1.60	1.60	1.60	1.60
54	OCT	0	1.60	0.95	0.95	0.95	0.98	0.98	0.98	1.20	1.20	1.60	1.60	1.60
55	NOV	0	1.60	1.60	0.95	0.95	0.95	0.98	0.98	0.98	1.20	1.20	1.60	1.60
56	DEC	0	1.60	1.60	1.60	0.95	0.95	0.95	0.98	0.98	0.98	1.20	1.20	1.60
57														
58	AD YEARLINGS													
59		STEERS	0	0	0	0	0	0	0	0	0	0	0	0
60		HEIFERS	72	72	72	72	72	72	72	72	72	72	72	72
61	AD COWS													
62		BRED HEIFERS	47	58	58	77	77	77	77	46	46	46	47	47
63		COWS	196	240	240	320	320	320	320	190	190	190	196	196
64														
65	AD BULLS		0	0	0	0	0	0	27	0	0	0	0	0
66	TOTAL		315	370	370	469	469	469	496	308	308	308	315	315

If you have a different number of paddocks than the example program you will have to modify the spreadsheet by adding or deleting rows. If you do this, you must change the formulas in D26 and D27 to reflect the correct number of paddocks. If you insert rows be sure to copy the formulas in row 24 to the new rows.

MINIMUM REST DESIRED 90
MAXIMUM REST DESIRED 120

Minimum rest desired is the minimum number of days you must rest a paddock during the dormant season when forage plants are growing slowly or growth has halted. Maximum rest desired is the maximum you would want to rest a paddock during the dormant season. Values of 90 and 120 days are reasonable for many southwestern ranches.

ADA FOR RELATIVE QUALITY = 120.00

ADA is animal days per acre and refers to the quantity of forage that can be harvested by an animal from one acre of a paddock. If there is enough forage in a paddock for 20 animals to eat for a day on one acre or for 1 animal to eat for 20 days on one acre then the ADA for that paddock is equal to 20. We recommend the following procedure to estimate ADA's.

Select the paddock which is average for your cell. This paddock will become a standard and be assigned a relative quality value of 1.

Estimate how many square yards it would take to feed one cow for one day in this paddock. This would require about 20 pounds of edible forage on a dry weight basis. Then convert the square yard value into acre units by dividing it into 4840 (the number of square yards in an acre). For example, you might estimate that it would take an area 25 yards by 25 yards or 625 square yards to provide enough forage for one cow to eat for one day. Dividing 4840 by 625 results in an ADA value of 7.74. An average value for southeastern Arizona ranches would be around 10 to 12.

<u>*RELATIVE QUALITY*</u>

The next step is to make an assessment of the forage available per acre in each paddock relative to one another. Since the spreadsheet assumes that you start in paddock 1 and proceed in numerical order be sure to enter the paddock data accordingly. Rate each other paddock compared to the standard. For example a paddock with twice as much forage per acre (one which would only require 312.5 square yards i.e., about 18 by 18 yards to feed one cow for a day) would be rated as having a relative quality of 2. Table 2 shows what a typical rating might look like.

To calculate the total forage available in a paddock the size of the paddock in acres is required by the spreadsheet. Again, Table 2 might represent the data input for a typical cell. Continue to monitor the paddocks as you move your animals. If the relative quality measures do not reflect the forage availability of the cell revise them to be more realistic and rerun the spreadsheet.

STOCK TABLE

In order to calculate the correct ADA requirements for your herd, the number and type of animals grazing the cell need to be entered into the stock table. The results might look like Table 2, which follows. The stock table simply keeps track of the number of animals in the herd each month.

Since cows have different nutritional requirements depending on what stage of the pregnancy cycle they are in it is necessary to input the calving dates into the spreadsheet. The month when the cows are expected to calve needs to be known in order to keep track of the increased nutrient requirements of the cows during critical periods. For example, the final trimester of pregnancy, lactation and breeding periods require increased emphasis on cow nutrition. A typical situation might be as in Table 3, which follows.

ANALYSIS OF RESULTS FROM SPREADSHEET

The results of the spreadsheet are displayed in Table 2. The first thing to check for is whether the moves planned by the spreadsheet and the initial levels of forage will result in enough forage available to last through the expected dormant season with appropriate considerations for drought reserve. If the projected plan meets these requirements the the guidelines can be used to plan the rotation of animals through the paddocks. As you make your moves, be sure to monitor the forage conditions and modify and rerun the spreadsheet when conditions change.

CONCLUSIONS

The use of the spreadsheets described above can reduce the drudgery of making the calculations necessary for management of a grazing cell. In addition they can be used to evaluate quickly many what if questions. What if I add 20 cows? What if the dormant seasons is two months longer than usual?

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FROM:

Arizona Ranchers' Management Guide
Russell Gum, George Ruyle, and Richard Rice, Editors.
Arizona Cooperative Extension

RANGE MANAGEMENT TERMS/DEFINITIONS

Bill Frost[1] and George Ruyle[2]

Allotment — Area of federal lands designated for the grazing use of a prescribed number and kind of livestock under a specific plan of management.

Allowable Use — The degree of utilization considered desirable and attainable on various parts of a ranch or allotment considering the present nature and condition of the resource, management objectives and level of management.

Animal Impact — The sum total of the direct physical influences animals have on the land: trampling, dunging, urinating, salivating, rubbing, digging, etc.

Animal Unit — One mature (1,000 lb.) cow or the equivalent based upon average daily forage allowance of 26 lbs. dry matter per day under range conditions. This allows for forage trampled or used by other animals.

Animal Unit Month. — (1) Amount of forage required by an animal-unit for one month. (2) Tenure of one animal-unit for a period of one month.

Annual Plant — A plant that completes its life cycle and dies in one year or less.

Annual Range — Range on which the principal forage plants are self-perpetuating, annual, herbaceous species.

Apparent Trend — An interpretation of trend based on observation and professional judgment at a single point in time (see Trend).

Available Forage — That portion of the forage production that is accessible for use by a specified kind or class of grazing animal.

Available Soil Moisture — Water in the soil that is accessible to plants for growth and development.

Bare Ground — All soil surface not covered by vegetation, rock or litter.

Basal Area — Cross sectional area of the stem or stems of a plant or of all plants in a stand. Herbaceous and small woody plants are measured at or near the ground level; larger woody plants are measured at breast or other designated height. (s*ynonym - basal cover*)

Base Property — See Commensurate Property.

Biennial — A plant that lives for two years, producing vegetative growth the first year and usually blooming, fruiting, and dying in the second year. Usually grouped with annuals.

Biomass — The total amount of living plants and animals above and below ground in an area at a given time.

Biome — A major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions, such as the desert, chaparral or grassland biomes.

Brittle Environments — Characterized by unreliable precipitation (regardless of amount), poor distribution of precipitation through the year as a whole, high rate of oxidation and physical decay (weathering) in old plant and animal material, very slow successional development from bare and smooth soil surfaces and, with a lack of adequate physical disturbance for years, the plant communities become simpler, less diversified and less stable. A continuous scale exists from nonbrittle to brittle environments.

Browse — Leaf and twig growth of shrubs, woody vines, and trees available for use by animals. Also, to search for or consume browse.

Bunchgrasses — Grasses that reproduce by seed and/or tillering and grow in tufts.

Canopy Cover — The percentage of ground covered by a vertical projection of the outermost perimeter of the natural spread of foliage of plants. Small openings within the canopy are included. It may exceed 100%. (*synonym - crown canopy*)

Carrying Capacity — The average number of livestock and/or wildlife which may be sustained on a management unit compatible with management objectives for the unit. In addition to site characteristics, it is a function of management goals and management intensity.

Climax Community — The final or stable biotic community in a successional series; it is self-perpetuating and in equilibrium with the physical habitat. The assumed end point in secondary succession. Determined primarily by climate but also influenced by soil, topographic, vegetative, fire and animal factors.

Commensurability — Capacity of a grazing permittee's base ranch property to support permitted livestock during the period such livestock are off public land.

Commensurate Property — Land or controlled livestock water which qualifies a person for a grazing privilege, permit, or preference on other land, either public or private.

Community — A general term for an assemblage of plants and/or animals living together and interacting among themselves in a specific location.

Community Type — An aggregation of all plant communities with similar structure and floristic composition.

Comparison Area — An area with a documented history and/or condition that is used as a standard for comparison.

Continuous Grazing — Grazing an area without rest periods or rotation.

Cool-Season Plant — A plant which generally makes the major portion of its growth during the winter and spring and sets seed in the late spring or early summer.

Cover, Total — Percentage of ground area covered by aerial parts of live plants, litter, gravel and rocks.

Cover, Total Vegetative — Percentage of ground area covered by live aerial parts of plants.

Critical Area — An area which must be treated with special consideration due to inherent site factors, size, location, condition, values or significant potential conflicts among users.

Decreasers — Plant species of the assumed original or climax vegetation that decrease in relative amount with continued overuse. In grass communities, they are usually the taller, more palatable grasses on the site.

Deferment — Delay or discontinuance of livestock grazing on an area for an adequate period of time to provide seed production, establishment of new plants, or restoration of vigor of existing plants. Generally defined as delay of grazing until the seed of the key forage species is mature.

Deferred-Rotation Grazing — Moving grazing animals to various parts of a range in succeeding years or seasons to provide for seed production, plant vigor, and for seedling growth.

Density — Number of individuals or stems per unit area.

Desired Plant Community — Of the several plant communities that may occupy a site, the one that has been identified through a management plant to best meet the plan's objectives for the site. As a minimum, it must protect the site.

Dual Use — Use of range by two kinds of livestock within the same grazing year or season.

Dominant — Plant species or species groups, which by means of their number, coverage, or size, have considerable influence or control upon the conditions of existence of associated species. Also, those individual animals which, by their aggressive behavior or otherwise, determine the behavior of one or more animals resulting in the establishment of a social hierarchy.

Ecological Site — A kind of land with a specific potential natural community and specific physical site characteristics, differing from other kinds of land in its ability to produce vegetation and to respond to management.

Ecological Status — The present state of vegetation and soil protection of an ecological site in relation to the potential natural community for the site. Vegetation status is the expression for the relative degree to which the kinds, proportion and amounts of plants in a community resemble that of the potential natural community. Soil status is a measure of the present vegetation and litter cover relative to the amount of cover needed on the site to prevent accelerated erosion.

Ecosystem — A complete interacting system of organisms (i.e. community) considered together with its environment.

Ecotone — A transition area of vegetation between two communities, having characteristics of both kinds of neighboring vegetation as well as characteristics of its own.

Foliar Cover — The percentage of ground covered by the vertical projection of the aerial portion of plants. Small openings in the canopy and intra-specific overlap are excluded. Foliar cover is always less than canopy cover.

Forage — Browse and herbage which is available to and may provide food for grazing animals or be harvested for feeding. Also, to search for or consume forage.

Forage Production — Weight of forage produced within a designated period of time on a given area.

Forb — Herbaceous plant, usually with broad net-veined leaves. In general, any herbaceous plant other than those in the grass, sedge or brush families.

Forestland (Forest) — Land on which the vegetation is dominated by trees. Lands shall be classified forestland if the trees now present will provide 25% or greater canopy cover at maturity.

Frequency — The ratio of the number of sample units that contain a particular species and the total number of sample units.

Grasses — Plants of the *Gramineae* family. Usually herbaceous plants with narrow, parallel-veined, two-ranked leaves.

Grassland — Lands on which the vegetation is dominated by grasses, grasslike plants, and/or forbs.

Grasslike Plants — Plants of the *Cyperaceae* and *Juncaceae* families. Usually herbaceous plants with slender, usually solid, round or three-angled stems and parallel-veined, often three-ranked leaves.

Grazing Capacity — Same as carrying capacity.

Grazing Management — The manipulation of grazing and browsing animals to accomplish a desired result.

Ground Cover — The percentage of material, other than bare ground, covering the land surface. It may include live and standing dead vegetation, litter, cobble, gravel, stones and bedrock.

Habitat Type — The collective area which one plant association occupies or will come to occupy as succession advances. The habitat type is defined and described on the basis of vegetation and its associated environment. Habitat type is similar in concept to ecological, site depending on how specifically plant associations are defined. Habitat is commonly misused to refer to classification of vegetation or wildlife habitat rather than a land classification.

Herbage — The above-ground material of any herbaceous plant.

Half-Shrub — A perennial plant with a woody base whose annually produced stems die back to the woody base each year.

Herb — Any plant that is not woody above ground, such as forbs and most grasses.

Herd Effect — The impact on soil and vegetation produced by a large herd of animals in an excited state. Generally produced by concentration with excitement such as at supplements or other attractants, and then applied to areas of the range where required.

High-Intensity/Low-Frequency Grazing — Heavy, short-duration grazing in which all livestock in a set of several range units or pastures graze one pasture at a time. The animals are left in a pasture until the desired degree of use is obtained and then are moved to another pasture.

Historical Climax — The plant community considered to best typify the potential plant community of an ecological site prior to the advent of European man. May no longer be one of the potential plant communities for the site.

Increasers — For a given plant community, those species that increase in amount as a result of a specific abiotic/biotic influence or management practice.

Indicator Species — (1) Species that signify the presence of certain environmental conditions, seral stages or previous treatments. (2) One or more plant species selected to determine the level of grazing use.

Introduced Species — Species not a part of the original fauna or flora of an area.

Invaders — Plant species absent, or present in very small amounts, in undisturbed portions of original vegetation on a specific range site which invade following disturbance or continued overuse.

Key Area — A relatively small portion of a range selected because of its location, use or grazing value as a monitoring point for grazing use. It is assumed that key areas, when properly selected, reflect the overall acceptability of current management over the range and serve as an indicative sample of range conditions, trend or degree of use.

Key Species — Forage species whose use serves as an indicator to the degree of use of associated species. Those species which must, because of their importance, be considered in the management program.

Leaf Area Index — Sum of total leaf area expressed as a percentage of ground surface. Leaf area index may exceed 100%.

Litter — The uppermost layer of organic debris on the soil surface; essentially the freshly fallen or slightly decomposed vegetal material.

Mulch — A layer of dead plant material on the soil surface, or an artificial layer of material such as paper or plastic on the soil surface. Also, the cultural practice of placing rock, straw, asphalt, plastic or other material on the soil surface as a surface cover.

Native Species — One which is part of the original fauna or flora of the area in question.

Nonbrittle Environments — Totally nonbrittle environments are characterized by reliable precipitation regardless of amount, good precipitation distribution through the year as a whole, a high rate of biological decay in old plant and animal material, speedy successional community development from smooth and sloped surfaces, and the development of complex and relatively stable communities with a lack of disturbance over many years. A continuous scale exists from nonbrittle to brittle environments.

Overgrazing — Grazing during active growth which is both severe and frequent. Generally results in reducing vegetation production and ultimately in death of the plant.

Overrest — Rest of any perennial plant that is so prolonged that accumulating old material hampers growth and/or kills the plant.

Palatability — The relish an animal shows for a particular plant as forage. This varies with succulence, fiber content, nutrient and chemical content, and morphological features such as spines or thorns. Palatability and preference are sometimes incorrectly used interchangeably.

Perennial Plant — One with a life cycle of three or more years.

Pioneer Species — A plant or animal capable of establishing itself in a bare or barren area and initiating an ecological cycle.

Plant Association — A kind of climax plant community consisting of stands with essentially the same dominant species in corresponding layers.

Plant Community — An assemblage of plants occurring together at any point in time, thus denoting no particular ecological status.

Plant Community Type — See Community Type.

Plant Succession — Vegetation change.

Poisonous Plant — One containing or producing substances that cause animal sickness, death or deviation from a normal state of health.

Potential Natural Community — See Potential Natural Vegetation.

Potential Natural Vegetation — An historical term defined as the stable vegetation community which could occupy a site under current climatic conditions without further influence by man. Often used interchangeably with Potential Natural Community.

Potential Plant Community — One of usually several plant communities that may become established on an ecological site under the present environmental conditions, either with or without interference by man.

Preference — Relative consumption of one plant over another by a specific class of animals when given free choice at a particular time and place.

Proper Use — Degree and time of use of current year's growth which, if continued, will achieve management objectives and maintain or improve the long term productivity of the site. Proper use varies with time and systems of grazing. (syn*onym - proper utilization*)

Range — Includes rangelands and forest lands that support a cover of herbaceous or shrubby vegetation suitable for grazing by livestock or game.

Range Condition — A generic term relating to present status of a unit of range in terms of specific values or potentials. Specific values or potentials must be stated. Also defined as the present state of vegetation of a range site in relation to the climax (natural potential) plant community for that site.

Range Condition Class — One of a series of arbitrary categories used to classify range condition as that term has been variously defined.

Range Condition Trend — Direction of change, whether stable, toward (upward) or away (downward) from the site's potential.

Range Degradation — The process that leads to an irreversible reduction in capability of an ecological site to produce vegetation.

Range Improvement — Any activity or program on or relating to rangelands which is designed to improve production of forage, change vegetation composition, control patterns of use, provide water, stabilize soil and water conditions, or provide habitat for wildlife and livestock.

Range Inventory—The systematic acquisition and analysis of resource information needed for planning and for management of rangeland.

Range Site—Synonymous with ecological site when applied to rangeland.

Range Type—An historical term which refers to, and only to, the 18 standard range vegetation types recognized by the 1937 Task Force (Interagency Range Survey Committee).

Resource Value Rating (RVR)—The value of vegetation present on an ecological site for a particular use or benefit. RVR's may be established for each plant community capable of being produced on an ecological site, including exotic or cultivated species.

Rest— Prolonged non-disturbance to soils and plant community.

Rest-Rotation Grazing—A system in which one part of the range is ungrazed for an entire grazing year or longer, while other parts are grazed for a portion, or perhaps all, of a growing season.

Retrogression—An historical term used to mean succession in reverse.

Rotation Grazing — A system in which animals are moved from one range unit or pasture to another on a scheduled basis.

Serial Community—The relatively transitory communities which develop under ecological succession (s*ynonym - seral stage*).

Serial Stage—See seral community.

Sere — The whole series of communities which develop in a given situation during ecological succession.

Short Duration Grazing —Grazing system involving many pastures where animals are in each pasture for a short period of time. Pastures are grazed several times during each year. (*Synonyms - rapid-rotation, time control and cell grazing*)

Shrub — A plant with persistent, woody stems and relatively low growth. Generally produces several basal shoots (stems) and many branches.

Site Conservation Rating—An assessment of the protection afforded a site by the current vegetation against loss of potential.

Site Conservation Threshold—The kind, amount and/or pattern of vegetation needed as a minimum on a given site to prevent accelerated erosion.

Sodgrasses—Those that reproduce by stolons and/ or rhizomes and form a dense turf.

Species Composition—Proportions of various plant species in relation to the total on a given area. Proportions may be expressed in percentages based on weight, cover, density, etc.

Standing Crop — The total amount or number of living things or of one kind of living thing in an area at a given time.

Stocking Rate—The number of specified kinds and classes of animals utilizing a unit of land for a specific time period. May be expressed as animals per acre, section or the reciprocal (land area/animal).

Succession—Process of vegetational development whereby an area becomes successively occupied by different plant communities of higher ecological order.

Tree — A large woody perennial plant, usually single stemmed, that has a definite crown shape and characteristically reaches a mature height of more than 10 feet.

Trend — The direction of change in ecological status or resource value rating observed over time. Trend in ecological status should be described as toward or away from the potential natural community, or as not apparent. Trend in a resource value rating should be described as up, down or not apparent. Trends in resource value ratings for several uses on the same site at a given time may be in different directions, and there is no necessary correlation between trends in resource value ratings and trend in ecological statues.

Usable Forage — That portion of the forage that can be grazed without damage to the basic resources; may vary with season of use, species and associated species.

Use, Utilization — Proportion of current year's forage production consumed by grazing animals. May refer to the use of a pasture or individual species.

Vegetation Management Status — The relative degree to which the kinds, proportions, and amounts of vegetation in the present plant community resemble the desired plant community chosen for an ecological site.

Vegetation Type — A kind of existing plant community with distinguishable characteristics described in terms of present vegetation that dominates the aspect or physiognomy of the area. Examples include sagebrush, creosotebush, mesquite, shortgrass, tallgrass, etc.

Vigor — Relates to the relative robustness of a plant in comparison to other individuals of the same species. Reflected primarily by the size of a plant and its parts in relation to its age and the environment in which it is growing.

Warm-Season Plant — One that makes most of its growth during the spring and summer and sets seed in the late summer or early fall. It is normally dormant in winter.

Weed — Any unwanted or undesirable plant, whether grass, forb, shrub or tree.

Wolf Plants — Individual plants of generally coarse, moderately-palatable species that when ungrazed become stemmy and remain ungrazed year after year.

Glossary of Acronyms Commonly used in Federal Land Planning Documents

AMP - Allotment Management Plan — Contains action program needed to manage the range resource for livestock grazing with consideration to soil, watershed, wildlife, recreation, timber, and other resources on lands within a range allotment.

AUM - Animal Unit Month — Quantity of forage required by one mature cow, or equivalent, for one month. Tenure of one animal-unit for a period of one month.

CE - Categorical Exclusion — The act of excluding an Environmental Analysis from being documented in an Environmental Assessment or Environmental Impact Statement because no significant environmental effects were predicted.

C&T - Condition and Trend — Refers to range condition and trend.
Condition - Current developmental stage of the range in relation to the potential or climax stage of which the area is naturally capable, either in terms of species composition or productivity.
Trend - Direction of change whether stable, toward (upward) or away (downward) from the site's potential.

CYL - Cattle Year Long — One animal grazing for an entire year.

DM - Decision Memo — A decision document that is prepared when projects are categorically excluded from preparation of an Environmental Assessment or Environmental Impact Statement. A Decision Memo documents the rationale for the project and the project's exclusion from documentation.

DN - Decision Notice — The decision document that accompanies an Environmental Assessment and Finding of No Significant Impact documenting the rationale for the decision.

EA - Environmental Assessment — A report that documents the analysis and the determination of whether or not to prepare and environmental impact statement.

EIS - Environmental Impact Statement — A document or set of documents prepared for projects having significant environmental effects that disclose the effects of the project and alternatives.

FONSI - Finding of No Significant Impact — A brief document that accompanies an Environmental Assessment in which the determination was that an Environmental Impact Statement would not be prepared because the environmental effects of the project are not significant.

FSM - Forest Service Manual — The manual used by Forest Service employees which contains the regulations, policies, and direction for Forest Service activities.

ICO's - Issues, Concerns, and Opportunities — ICO's are what projects will resolve or capitalize on. Commonly called "issues".

IDT - Interdisciplinary Team — A group of people including the project leader, are primarily responsible for the project design and analysis. Also known as Project ID Team.

IRM - Integrated Resource Management — The Integrated Resource Management Process is the Region 3 standardized format for tying Forest Plan Implementation and National Environmental Policy Act and other legal requirements together.

A land management philosophy which recognizes that all natural resources are connected through an intricate series of interrelationships. An interdisciplinary approach to project design is used to define resource relationships and integrate procedural requirements.

LAC - Level of Acceptable Change — A system of planning recreation in wilderness.

LO - Line Officer — The person with decision authority on the project, i.e., District Ranger, Forest Supervisor, Regional Forester, or Chief.

LMP - Land Management Plan — Defines long-term direction for managing the Tonto National Forest. Purpose is to provide for multiple use and sustained yield of goods and services from the Forest in a way that maximizes long term net public benefits in an environmentally sound manner.

NEPA - National Environmental Policy Act of 1969 — A Congressional Act which established a national policy for the environment, and provided for the establishment of the Council on Environmental Quality (CEQ).

NFMA - National Forest Management Act of 1976 — Requires each National Forest to prepare a Forest Land Management Plan. All subsequent management actions must be directed at effective implementation of the Plan.

NI - Natural Increase — Livestock offspring which are held over (past Jan. lst) to take advantage of winter and spring annuals in the desert ecosystem.

NOI - Notice of Intent — A notification published in the Federal Register to inform the public that an Environmental Impact Statement will be prepared for a project.

PIL - Project Initiation Letter — The letter from the District Ranger to the project leader to start the IRM process on the project.

PR - Project Record — The file of all products of the analysis phases.

PRIA - Public Rangelands Improvement Act of 1978 — A Congressional act which established a national policy for Forest Service and permittee roles in allotment management.

PU - Production-Utilization Surveys — A document which provides information on forage availability for: 1) determining estimated grazing capacity (allowable forage harvest) by livestock and wildlife; 2) analyzing opportunities to improve management technique; 3) correcting grazing problems; 4) establishing correct grazing management; and 5) locating needed range improvements.

RATM - Resource Access Travel Management — A management plan being developed to determine access to resources through the current Forest systems roads, i.e., which roads will remain open and which roads should be closed.

RBF - Range Betterment Funds — The portion of the funds collected through grazing fees which comeback to the Forest and District where they were collected for use on range improvements.

ROD - Record of Decision — The record of decision documents the rationale for selecting the project alternative, developed in the preparation of the Environmental Impact Statement, which will be implemented.

RPA - Forest and Rangeland Renewable Resources Planning Act of 1974 — Requires the preparation of a program for the management of all acres of land administered by the Forest Service.

SO - Supervisor's Office — Office where the Forest Supervisor and his/her staff are located.

SRP - Salt River Project — Organization formed to manage the water along the Salt River for Phoenix area farmers.

T&E - Threatened and Endangered Species — Threatened and endangered species of plants and animals that are listed by the US Fish and Wildlife Service and must be protected under the terms of the Endangered Species Act.

TES - Terrestrial Ecosystem Survey — Survey used in making land management decisions through integration of soils, vegetation and climate data.

VQO - Visual Quality Objective — The desired level of excellence based on physical and sociological characteristics of an area.

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Arizona Ranchers' Management Guide
Russell Gum, George Ruyle and Richard Rice, Editors.
Arizona Cooperative Extension

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MONITORING RANGE-LAND BROWSE VEGETATION

George Ruyle[1] and Bill Frost [2]

Rangeland vegetation monitoring is a useful tool to detect changes in plant communities induced by management practices and/or natural processes. Information obtained through vegetation monitoring can be used to determine if management goals are being met and to adjust management practices if needed.

There are many attributes of plant communities that may be monitored, but not all of these are useful to interpret or feasible to measure. The appropriateness of a particular attribute depends upon the vegetation type (e.g. shrubs or grasses) and the management goals for which the data will be interpreted.

Some of the important measurable attributes of shrub communities are:

1. **density** - the number of individual plants per unit area.

2. **cover** - an expression of the soil surface which is overhung (covered) by either the plant crown and shoot (canopy) or encountered by basal stems (basal cover).

3. **age and form class** - age classes consisting of seedling, young, sprout, mature and decadent (25% or greater dead wood) and the degree of hedging (form class) describing the availability of the shrub to browsing animals and the degree of hedging the plant has received.

There are a variety of other plant attributes such as height, stem diameter, leader length, and biomass, but for shrub dominated rangeland, density, canopy cover and age and form class are those which can be measured and interpreted for analysis for resource managers. Belt transects are used to determine density and age and form class, and line-intercept data are collected to estimate canopy cover.

Belt transects are merely two-dimensional, very long rectangular plots. The line-intercept method is based on the principle of reducing the belt-transect with dimensions of length and width to a line with only one dimension; length.

DENSITY & AGE AND FORM CLASS

Determining plant density is accomplished by counting the number of individuals in a known area. Density counts should be kept by species, and by age and form class within species. The age classes give a representation of the diversity present in the shrub community and the form classes represent the amount of use the shrubs are receiving. The age and form class designations are:

Age Classes	Form Classes
S - seedling	1 - All available, little/no hedging
Y - young	2 - All available, moderately hedged
Sp - sprout	3 - All available, closely hedged
M - mature	4 - Largely available, little/no hedging
D - decadent	5 - Largely available, moderately hedged
	6 - Largely available, closely hedged
	7 - Mostly unavailable
	8 - Unavailable

These data can be collected, for example, by establishing a 100 foot transect and recording the plants present (species, age and form class) along a belt 6 feet on either side of the 100 foot tape (12 foot width total). The results can easily be converted to plants per acre on either a species, age and form class, or age and form class within species basis. The length of the transect and width of belt will vary depending upon the shrub community to be measured. Where shrubs are numerous, smaller transects and belts may be used whereas sparse shrub communities will require larger sampling units. As a general rule, 20 to 30 individual shrubs of the target species should be contained within the belt transect.

PLANT COVER

Usually cover is defined as the vertical projection of the crown or shoot area of a plant to the ground surface expressed as a fraction or a percent of a reference area (canopy cover). Cover may also apply to the basal area in relation to ground surface (basal cover). The basal area is the area outline of a plant near the soil surface.

Cover as a measure of plant distribution is often considered as being of greater ecological significance than density, largely because cover gives a better measure of plant biomass than does the numbers of individuals. Also very important is the relationship of plant cover to the potential for soil erosion.

A fast and efficient way to estimate shrub canopy cover over large areas of rangeland is with the line-intercept method. As mentioned earlier, the line-intercept method is based on the belt transect, a long, rectangular quadrat, which has two dimensions and reducing it to one dimension; length. This line consists of a tape laid out on the ground on the center of the belt transect and the plant crowns that overlap or intercept the line are recorded by species. The beginning and end of where the canopy overhangs the tape is recorded and later converted to percent cover. Where plant canopy gaps occur within individual shrubs, rounding out canopy edges and filling in interval gaps is recommended (Figure 1). The line-intercept is most useful where cover assessment of a large area is required.

These methods may be modified based on attributes of specific plant communities and objectives for the analysis. But for general estimates of shrub numbers and cover some form of belt and line intercept transects are efficient and reliable sampling methods.

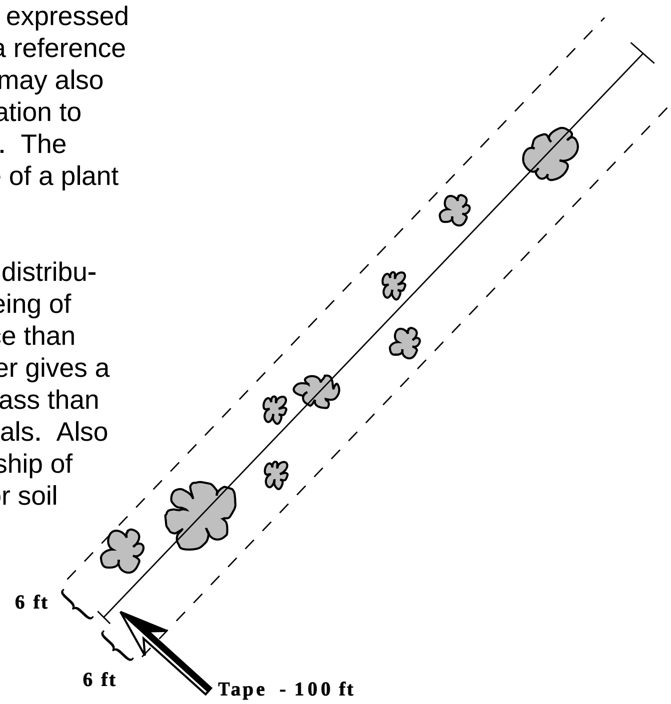

Figure 1. Where gaps occur within plant canopies along the tape, visual projections of edges and gaps are required.

THE BASIC PROCEDURES

1. Select monitoring location.
2. Establish rain gauge.
3. Establish transect end points with permanent stakes.
4. Establish photo point (take picture)
5. To read transect:

   a. record positions along tape where shrub canopies intercept line.

   b. walk along tape holding a 12 ft pole horizontally to transect so 6 ft project on each side of line. Count and record the number of shrubs in each species of interest in one of the age and form classes. The length of pole may be variable, depending on the shrub community to be measured. Sampling poles can be made of PVC segments to fit together into various lengths.

EQUIPMENT

1. 100 ft or 30 m tape (longer if vegetation is very sparse)
2. stakes for transect end points
3. springs for each end of tape (optional)
4. photo ID placard
5. metal fence post
6. PVC pipe, capped to serve as rain gauge (add inch or so of oil to limit evaporation)
7. 12 ft pole (or other chosen length)
8. data forms (example in figure 3).

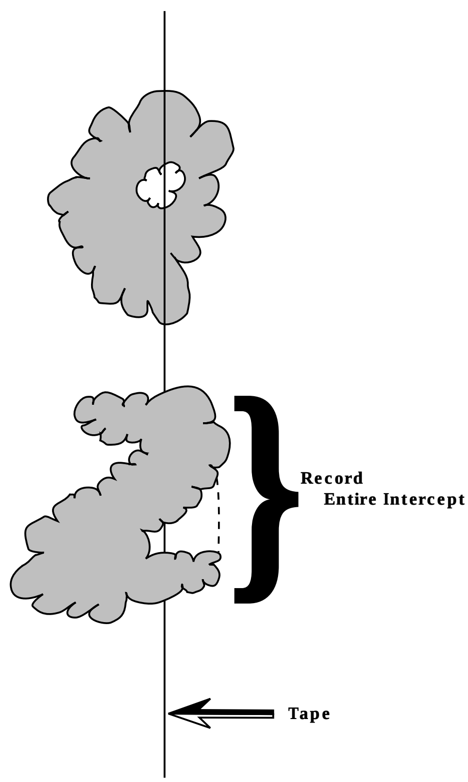

Figure 2. Diagram of line-intercept and belt transect indicating shrub cover and density. Dotted line represents imaginary boundaries created by moving pole down center line.

Figure 3. Example of a data form used to record density, cover and growth form data.

Line Intercept Transect

Location:										Transect No. Length:		Examiner		Date
Species			**Species**			**Species**			**Species**			**Species**		
Actual Intercept	Total Inches	Age & Form Class	Actual Intercept	Total Inches	Age & Form Class	Actual Intercept	Total Inches	Age & For Class	Actual Intercept	Total Inches	Age & Form Class	Actual Intercept	Total Inches	Age & Form Class
Total														

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Disclaimer

INTENSIVELY MANAGED ROTATIONAL GRAZING SYSTEMS FOR IRRIGATED PASTURE

Daniel J. Drake[1] and James Oltjen[2]

Harvest of forage from irrigated pastures can be distinct, at a given time and a determined amount. A simplified analogy between the hay grower and rotational grazing systems may be made. The manager of a grazing system determines when and how much plant material is harvested. The manager uses livestock instead of equipment to make the harvest.

Just as the hay grower must understand plant growth principles, the manager of grazing livestock must understand pasture growth principles. These must be balanced with knowledge of and performance goals for the livestock. The objective of the grazing management plan is to quickly and uniformly harvest the desired amount of plant material. Plans, however, should be considered as guidelines and remain flexible.

A practical intensively grazed pasture system consists of a number of pastures or paddocks. Pastures are grazed for one to four days, with some period of rest between grazing. A uniform harvest with minimum selectivity and repeated defoliation is encouraged when pastures are properly stocked and short grazing periods are used. The manager determines the number of livestock per paddock, the amount of time spent grazing on each paddock and the amount of time (rest) between grazings. That is, livestock are managed to conduct a timely, uniform and prompt harvest of pasture much like a swather for making hay.

Intensive grazing systems can be one of the most cost effective management activities for pastures. However, to be successful, plant varieties, composition, fertility, and water management must be considered.

STOCKING RATES, GRAZING INTENSITY AND DURATION

Uniform removal of plant material from pasture is encouraged by using a relatively "high" density or number of livestock per unit area (acre) of pasture. Picture a mass of cattle moving through a pasture, cutting (grazing) as they move. Typically, the ideal number of livestock will remove the desired amount of pasture in at least 3-4 days of grazing. When livestock are left to graze a pasture for greater than 3-4 days, regrazing of plants previously bitten will occur. The result is areas of overgrazing, which selectively discourages desirable plants while encouraging undesirable plants.

Grazing should remove a portion of the plant while leaving some leaves to capture sunlight for the plant to use in growing new leaves. The new leaves or regrowth will be removed in subsequent grazing after an adequate period of time for regrowth. Typical recommendations are to leave about 2-4 inches of plant leaves for the plant to use in regrowing. Therefore the amount of material available for grazing is all of the plant taller than about 2-4 inches (Figure 1).

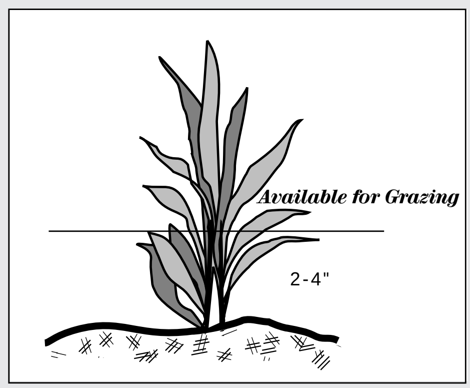

Figure 1. Grazing should harvest plant material leaving 2-4 inches. The residual serves as the basis for regrowth of new plant material for subsequent grazing.

It would be much simpler to plan rotational grazing systems, if an accurate and rapid method existed for estimating the total amount of plant material to be removed by grazing. A device marketed as a "Pasture Probe"[1] is adequate for making gross estimations. With experience, which the Pasture Probe can accelerate, growers can visually estimate amounts of plant material for grazing. In the Spring, improved pastures of fescue or orchard grass with some clover can typically be grazed when about 12 inches or taller.

The number of cattle per acre is best estimated as a weight relationship rather than number of head. For cows and calves the combined weight of cow and calf should be used (1). For example, about 15,000 (typical range is 15,000 to 25,000) pounds of livestock per acre are generally satisfactory when the duration of grazing is about 3 days. For cattle weighing 600 pound each, then 25 individuals (15,000 divided by 600) per acre would probably be satisfactory. If a paddock consisted of 5 acres then a total of 125 cattle (25 X 5), each weighing 600 pounds would be grazed for 3 days. Similarly if the cattle were cows with calves and their combined weight was 1350 pounds each (ex. cows 1100 plus 250 pound calves), then each acre might be grazed with 11-12 cows with their calves (15,000 divided by 1350). If the calves had been born in the Fall and weighed perhaps 400 pounds by the start of the grazing season we would use 1500 (1100 plus 400) pounds as the weight of an individual unit (pair). Thus, only about 10 pairs with larger Fall born calves might be grazed on each acre.

These examples are illustrated in Table 1 and your plans can be started in the space provided. This table provides information on management of one pasture or paddock that will be grazed for only 3 days at one time, we next need to consider additional paddocks for the entire grazing system.

There is no "correct" number of paddocks in a grazing system. For practical reasons eight paddocks is a reasonable compromise: fewer paddocks will result in overgrazing or inadequate rest between grazings, while more paddocks can increase performance of the pasture system, but requires considerably greater labor with smaller incremental returns.

Eight paddocks, when used with a rotational grazing scheme of 3 days of grazing on each paddock, results in rest periods of 21 days. This meets minimum typical rest recommendations of 21 to 30 days. Typically in the Spring the rancher is anxious to start cattle on pasture as early as possible, but pasture may be a little shorter than desired. Grazing plans can be adjusted slightly by

Table 1. The number of livestock for a single pasture or paddock of a grazing system (collection of pastures used in a rotational grazing plan) can be based on the desired weight of beef per acre rather than the number of head. Typical weight per acre is from 15,000 to 25,000 pounds of beef per acre (column E). The "density" or number of livestock to be grazed in a single pasture is calculated in column F.

A	B	C	D	E	F	G	H
Total Acres Available	Number of Pastures (Paddocks)	Size in Acres of a Single Pasture or Paddock (A ÷ B)	Weight of Individual "Unit" Pair, Steer, etc.	Desired Weight Per Acre	Total Number of "Units" (D's) on 1 Acre (E ÷ D)	Total Number of "Units" (D's) for a Single Pasture or Paddock (F x C)	Total Number of "Units" (D's) for all Land Available (G)
40	8	5	600	15,000	25	125	125
40	8	5	600	25,000	41-42	205-210	205-210
40	8	5	1100	15,000	13-14	65-70	65-70
40	8	5	1100 + 400	15,000	10	50	50
Your Values							

[1]Design Electronics, Palmerston, New Zealand. Available for demonstration purposes from some Cooperative Extension offices.

leaving the cattle for only 2 days in the first paddocks. This will provide enough forage for the cattle and not overgraze the pasture. Then with rapid Spring growth, pastures grazed later will have more than enough forage for 4 days of grazing. The combination of grazing for 2, 3 or 4 days, depending on forage availability will result in adequate rest to return to the first paddock with at least 21 days of rest.

Due to hotter weather after about the Fourth of July, pastures typically regrow less rapidly. The grazing manager has several alternatives for adjustment to this change in plant growth.

1. Reduce the number of livestock, adjusting for specific pasture growth conditions.
2. Stock slightly low (for the Spring period) from the beginning, but adequate for the hotter, summer season. Some "extra" feed may build up on the pasture to permit extending grazing periods to 4 days after the Fourth of July. This would result in rest periods of 28 days.
3. Provide supplemental feed.
4. Stock adequately for the summer season and during rapid Spring growth do not graze or reduce grazing to create an extra "buffer" paddock. This can be grazed during periods of slow plant growth. This "buffer" paddock might be hayed in June and allowed to regroup for a later grazing period.

Option 1 can be very effective in increasing total carrying capacity but requires more flexibility. Many managers select option 2.

FLEXIBILITY AND ADJUSTMENTS

Intensive grazing management plans should be flexible. The following are observations from some managers useful for making beneficial adjustments. If hard, dry cow patties seem to be accumulating, it is frequently a symptom of low stocking density. More livestock per acre will tend to break up or reduce the occurrence of cow paddies. Another alternative to reduce manure accumulation is irrigating immediately after grazing. This is not always feasible.

Another symptom of low stock density is the appearance of pastures that are "getting ahead" of the cattle. Forage is still tall after the planned three (3) days of grazing, or the plants are beginning to mature as evidenced by developing seed heads. Solutions are to increase livestock density, increase grazing duration on the pasture or mechanically cutting the excess. The excess, if practical, might be baled. Increasing grazing duration is only a temporary solution since the result is more days of growth on the next pasture which will result in even more excess forage when it is grazed. If the excess is great enough a hay cutting might be taken instead of grazing that pasture.

FACILITIES

Pastures of approximately the same size work much better than unequal sized pastures when used in a rotational system. Sometimes instead of thinking how to divide pastures into eight units (or whatever number are planned), one needs to consider what existing pastures can be grazed together to make eight units. Frequently 3-4 existing pastures can be easily split into two or perhaps three pastures each, making a total of 8 units.

Figure 2 shows a typical layout. Two water troughs provide drinking water for all 8 pastures. Perimeter fencing can be barbed wire or newer style high tensile smooth wire fence. Smooth wire fence may be built to provide for electrification. It should be four strands with alternating charged and non charged (grounded) wire. Interior

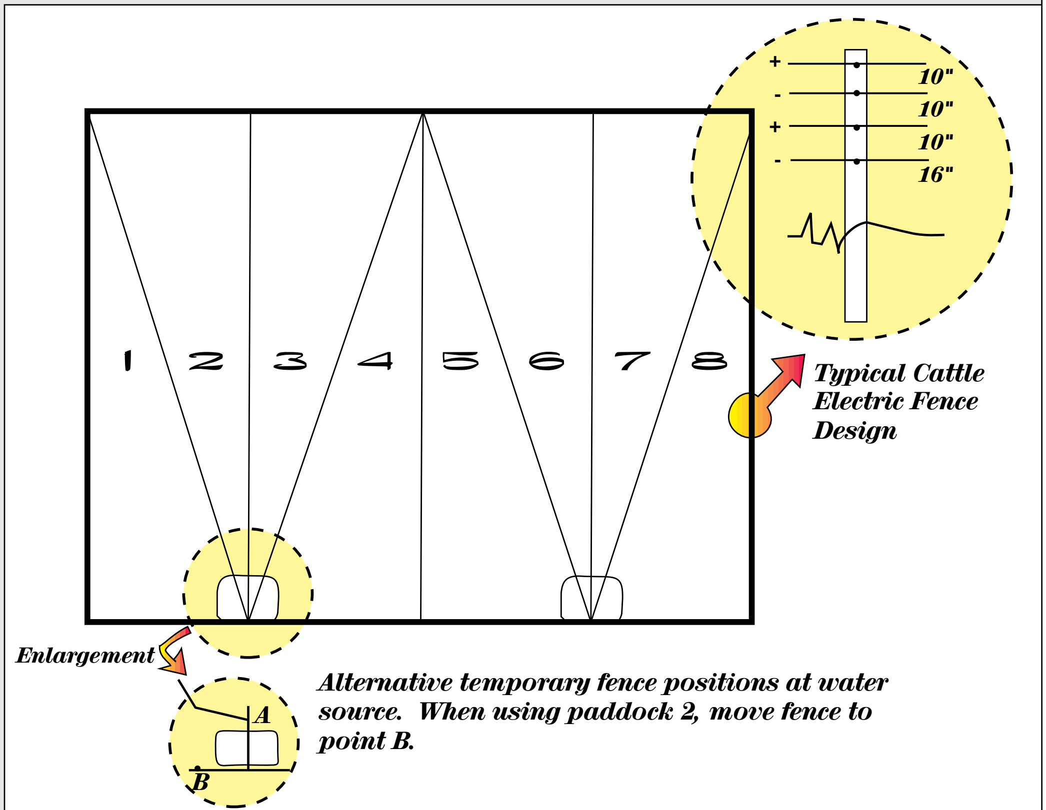

Figure 2. Aerial view of paddocks showing possible fencing arrangement and alternatives. Inset details electrification pattern for electric fence.

fencing can be multiple strands of smooth wire, or a single strand of smooth wire or woven plastic/metal wire, commonly marketed as Polywire or the equivalent. Limited experience suggests the wider Polytape is more visible, but may be less resistant to deterioration than Polywire.

Chargers should be high voltage (about 5,000) but low amperage - "New Zealand" type. These are very resistant to grounding out. The most important aspect of the energizer is adequate and proper grounding. If the fence does not work, always check the ground first.

Fence posts can be wooden or metal T posts with insulators, or nonconducting posts such as plastic or special nonconducting wood, such as ironwood. Single wire interior fencing can use short, plastic tred-in posts that are easily moved. In addition, they are short and flexible enough for wheel lines to move over them.

A wide variety of fence "posts" are now available for specific installations such as pivoting types for center pivot irrigation systems, and tumble wheels, which facilitate moving.

When livestock drinking water is shared by numerous pastures, as shown in Figure 2, sacrifice areas or areas of heavier use occur near the water. In the illustration in Figure 2 for paddocks 5, 6, 7 and 8, this sacrifice area is minimized. The design does not require additional water development. However, due to the small portion of the water trough available, adequate flow to quickly fill the tank should be available. The inset illustrates for paddocks 1 and 2 an alternative arrangement that increases trough space but suffers from a larger sacrifice area. A single trough is shared by paddocks 1 and 2 with the fence being moved to permit fuller use of the trough. The manager would have to weigh these various consequences for each application.

IRRIGATION

Besides drinking water, irrigating intensively grazed pasture systems is the second major difficulty. Fencing and grazing management strategies should be designed with existing irrigation systems in mind. With rapid cattle rotation and typically more fencing, irrigation can be difficult.

Irrigation systems should be designed and operated to provide adequate amounts of water in a timely manner. Amounts required can be closely estimated by using evapotranspiration (ET) information. ET data estimates the amount of water used or lost through evaporation from soil and transpiration of plants. Historical data from many locations is available and current season data may be available through your land grant university or local Cooperative Extension office. Adequate irrigation will insure water is not a limiting factor in crop production and resultant grazing potential.

Rotational grazing can be accomplish with either sprinkler or flood irrigation. It is usually not recommended to irrigate while cattle are on a pasture. However if this has been a historical and acceptable practice, it could be continued with rotational grazing.

Wheel line sprinklers usually cannot be used when the lines are perpendicular to fences creating physical barriers to cattle movement throughout the paddocks. Wheel lines parallel to fences can be moved over fencing and are compatible with rotational grazing. Center pivot irrigation systems with their high supply lines can be used in conjunction with break over (pivoting) fence posts.

Regardless of irrigation system, many growers attempt to irrigate immediately after grazing. This may facilitate regrowth and certainly appears to reduce or eliminate any fecal deposits. The critical factor is to design the grazing system to work in conjunction with the irrigation system: during the growing season provide irrigation to satisfy crop needs, thereby avoiding water as the limiting resource.

CATTLE SELECTION AND MANAGEMENT

No specific breed restrictions apply to intensive grazing systems. Breeds with Brahma influence can be used successfully, although extra care to avoid their agitation maybe important. As with set stocking, steers and heifers are typically not grazed together; however, from the grazing response standpoint this is not a problem. Similarly large differences in animal weights should be avoided, but no more so than with other grazing management schemes.

Some grazing managers have found whistling or making some distinctive sound when moving cattle leads to a “learned” response. Cattle will be trained to move when the sound is repeated.

Ideally cattle should be trained to an electric fence before putting them on pasture. The only reason for this is to avoid the possible labor involved in gathering cattle if they should break a fence. An ideal time to train cattle is when cattle are confined in a well enclosed area. A short strip of electric fence can be constructed, perhaps across a corner of a familiar corral, and a small amount of hay placed on the ground on the opposite side of the electric fence. As the cattle smell the hay they will get acquainted with the electric fence. This will not harm cattle and they will learn about electric fences in a controlled and safe manner.

The manager of intensively grazed cattle needs to decide who is making the decisions, the cattle or the manager. If an individual animal is causing significant problems, will management bend to the whims of that individual or will the manager put that problem somewhere else and get going with the program?

ANIMAL HEALTH

Several considerations should be taken to maintain acceptable animal health levels when planning rotational grazing systems. When livestock are managed to more completely utilize pasture, the potential for grazing of harmful plants occurs. As management encourages more complete utilization livestock may consume plants previously avoided.

Potentially increased density of livestock per unit area may also increase the risk of internal parasitism and transfer of contagious diseases. However, specific animal behavior with any grazing system may result in time periods or areas of high livestock concentration, that are conducive to disease transmission. Preventative measures should be adopted.

ECONOMICS

Rotational grazing management plans which include length of grazing, rest periods and other factors ultimately impact stocking rates and economics. Considerable evidence indicates as stocking rates increase, such as may occur with more intensive rotational grazing, daily gain of individual cattle decrease. This response has been described as linear (see Figure 3). By definition this response to increased stocking rates when converted to gain per area is curvilinear (Figure 3). These trends are theoretical representations in the graph and specific values and relationships vary.

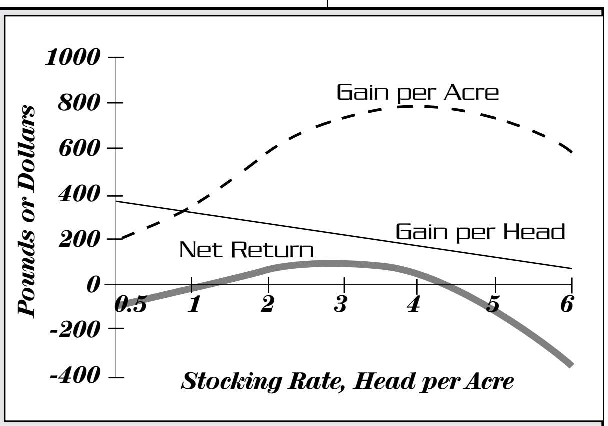

Figure 3. Theoretical responses to stocking rate.

It is noteworthy to recognize that gain per acre does decrease when stocking levels go beyond some high stocking level. Also illustrated on the graph is the relationship between stocking rate and net returns. This is again a curvilinear response. With traditional stocking rates and economics, net return per acre peaks at lower stocking levels than gain per area. However, this may vary with changes in economics.

Record keeping should permit evaluation of performance for both livestock and pastures. Data collected should permit calculation of amount of livestock gain per acre, daily gains per head, stocking rates, and net returns. Supplemental feeds or additional hay production should also be included.

An example worksheet illustrates the types of information and calculations useful for either planning or evaluating grazing systems.[2] It is important to understand differences in evaluating alternatives on a per head or per acre basis. Livestock performance has traditionally been evaluated on a per head or individual basis. Grazing systems should also include monitoring and evaluating of land based values.

The computer program facilitates the comparison of alternative grazing strategies. It provides both a per head and per acre value for data. Additionally, the computer program provides some measure of risk and allows consideration of alternatives to alter or reduce risk.

[2] The computer program for IBM and compatible computers is available from Dan Drake, University of California, Cooperative Extension, 1655 So. Main, Yreka, CA 96097; (916) 842-2711.

SUMMARY

Rotational pasture grazing systems can significantly increase carrying capacity or production of beef per acre compared to continuous or less managed systems. Rotational systems utilizing livestock for grazing can be implemented to mimic hay harvest with equipment: leading to timely, uniform and planned harvest of pasture plants. Successful plans will incorporate both plant and livestock concepts to achieve desired personal, economic and environmental goals.

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141 Stocker Cattle Profit or Loss and Risk Calculator				by	
142 Version 9.25.91				Daniel J. Drake	
143.					
144 Name: Intermountain Example, Typical Stocker Cattle					
145 Date: 11/11/92		**INFO**			
146		**SUPP-**			
147 Comments:		**LIED**	**CALCULATIONS**		
148					
149 **GENERAL INPUTS AND ASSUMPTIONS**			**Pessi-mistic**	**Opti-mistic**	
150					
151 Size of pasture, acres	:	40			
152 Number of cattle	:	80			
153 Days on feed, total	:	150			
154 Purchase weight, lbs.	:	500			
155 Expected purchase price, $/cwt	:	90			
156 Purchase price variability, %	:	10	99.00	81.00	
157 Expected selling price, $/cwt	:	83			
158 Selling price variability, %	:	15	70.55	95.45	
159 Daily gain, lbs/head	:	1.67			
160 Gain variability, %	:	10	1.50	1.84	
161.					
162 **PASTURE INPUTS**			**Per**	**Per**	
163			**Head**	**Acre**	**Total**
164 Rent $/head/month	:	9	45.00	90.00	3600.00
165 Land, taxes, other $/acre	:	0	0.00	0.00	0.00
166 Land, taxes, other Total $	:	800	10.00	20.00	800.00
167 Irrigation Costs					
168 Water costs, $/acre foot	:	18	20.25	40.50	1620.00
169 Water amount, acre feet/acre	:	2.25			
170 Fertilizer Costs					
171 Amount, lbs/acre	:	300			
172 Cost, $/ton	:	125	9.38	18.75	750.00
173 Spread charge, $/acre	:	5	2.50	5.00	200.00
174 Labor cost, $/month	:	200	12.50	25.00	1000.00
175.					
176 **MANAGEMENT INPUTS**					
177 Vet & Medicine, $/head	:	5	5.00	10.00	400.00
178 Supplement					
179 Lbs./head/day	:	0.25			
180 Cost, $/ton	:	398	7.46	14.93	597.00
181 Days fed, all = 150	:	150			
182 Death loss, %	:	1	4.55	9.10	364.00
183 Yardage, $/head/day	:	0.05	7.50	15.00	600.00
184 Transportation, $/head	:	1	1.00	2.00	80.00
185 Brand insp., Beef pro., $/head	:	1.9	1.90	3.80	152.00
186 Insurance, Misc. $/head	:	0	0.00	0.00	0.00
187 Comm., % of buy cost	:	0.75	3.38	6.75	270.00
188 Comm., % of sell income	:	3	18.69	37.37	1495.00
189 FINANCIAL INPUTS					
190 Equity, $/head	:	75	75.00	150.00	6000.00
191 Cattle interest rate, %	:	12	18.49	36.99	1479.45
192 Op. Capital interest, %	:	11.25	3.44	6.88	275.37
193 CME Livestock Options					
194 Put Option strike price, $/cwt	:	0			
195 Option Cost cents/lb	:	1.2	0.00	0.00	0.00
196 Basis	:	-2.25			
197 Number of contracts 44,000# each	:	0			
198 Commission, total $	:	0	0.00	0.00	0.00
199 Critical Profit (1), $ total	:	30000			
200 Critical Profit (2), $ total	:	-2000			
201.					
202.					
203.					

204	**R E S U L T S**			
205	**EXPECTED**	**Per**	**Per**	
206		**Head**	**Acre**	**Total**
207	Cattle cost, total	450.00	900.00	36000.00
208	Cattle equity, $	75.00	150.00	6000.00
209	Cattle interest, $	18.49	36.99	1479.45
210	Pasture cost	99.63	199.25	7970.00
211	Management cost	71.41	142.82	5712.82
212	Pasture & Management Cost	171.04	342.07	13682.82
213	Pasture, Manage. & Cattle Cost	621.04	1242.07	49682.82
214	Gain over total period, lbs.	250.50	501.00	20040.00
215	Total cost per lb. gain	0.68	1.37	
216	Selling weight, lbs	750.50	1501.00	60040.00
217	Total dollar receipts	622.92	1245.83	49833.20
218	Total receipt minus cattle cost	172.92	345.83	13833.20
219	Profit or loss	1.88	3.76	150.38
220	Breakeven sell price, $/cwt (cost of prod.)	82.75		
221	Return on equity, %	2.51		
222	Breakeven buy price, $/cwt	90.38		

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USING SALT FOR LIVESTOCK

E. P. Schwennesen[1]

The elements of common salt, sodium and chlorine, are essential for animal life. They are part of several functions in maintaining osmotic pressure in body cells which is vital to the transfer of nutrients and waste products across the cell membrane. Salt is a major component of fluid blood, which contains about 0.17% of both sodium and chlorine. Experiments have shown conclusively that extended deprivation of salt (up to one year) will cause a marked breakdown in animal production.

Livestock have shown that they are fairly capable of regulating their own intake of salt if given a reliable source of it. Under range conditions about 20 pounds per head per year has been recommended, with most available during the active growing season to assist the animal with the faster metabolism of succulent feeds.

Overdoses of salt are relatively rare, as sodium chloride is readily excreted in the urine; however it is possible to induce rumen acidosis when using salt to limit feed supplement rations, especially if a generous source of drinking water is not available.

SALT AS A MANAGEMENT TOOL

Efforts by ranchers throughout the Southwest to improve the productivity of the range have shown that a tremendous advantage lies in using salt as a tool, as well as a mineral supplement. Almost anywhere a "salting ground" can be found, the effects of continuous attraction of livestock and wildlife are obvious. These usually bare, trampled areas are often blamed on the effect of salt on the soil, rather than the result of many years of daily trampling, loafing and nearby continuous grazing. In fact, a growing number of Arizona ranchers are realizing the benefits from using salt to attract the impact of the cattle herds' feet into areas that need the short-term disturbance.

TIME

As long as the salt source remains, animals will be attracted to it. Many ranches place large, hard salt blocks in the same place year after year to be sure that the stock will be able to find it. However, while grass is growing the recovery time from grazing effects is critical. To the plant, removal of its leaves by biting or trampling has a similar effect in that either way, it will have to draw on root reserves to replace the lost leaves. If animals are still in the vicinity when the new leaves are regenerating and before root reserves are replenished, that plant will be overgrazed.

In Arizona, during summer grass growth, the plant needs a minimum of roughly 30 days to recover from loss of its leaves. From this it is easy to realize that if the salt source still attracts animals within that recovery period, the local vegetation will suffer. The biggest single benefit of salt on rangeland is that by moving it around with plant recovery time in mind, plants in any one area can be effectively grazed, but protected from overgrazing. **Never leave a salt source in one spot longer than the time it takes for the first nearby desired plants to begin regrowth.**

their animals exposed to as much of the forage as possible.

AMOUNT

The statement above will make some stockmen imagine the unacceptable amount of work it would take to find, pick up and move one or several large salt blocks every few days. That is a management choice, but unnecessary. The easiest way to move salt while controlling time is to place only enough salt, that it will be completely consumed in a day or two. Then, the next salt should be placed somewhere else. Depending on the time of year and size of the herd, as well as the amount that wildlife consume, some experimentation will quickly show how much salt is needed.

LOCATION

There are literally an infinite number of locations on Arizona rangelands where the brief placement of salt will be a positive management tool. A cursory glance through the pasture inventory will show many locations that are far away, on steep hillsides, in dense brush or suffering from rodent dens where the concentrated short-term effect of the herd chasing salt can be a beneficial event. We are seeing a growing number of examples of small, soft salt blocks placed at the bottom and on the sides of actively eroding gullies, where the efforts of the animals to reach the salt for a few days has rounded over the eroding banks, filled in the bottom and stirred enough seed into the soil that vegetation has been able to stabilize the erosion. **The least desirable location for salt on rangeland is close to the water source.** This is because the water is already a long-term attractant which tends to concentrate the time of animal use for too long, and salt will only increase the animal pressure. Some ranchers in southeast Arizona deliberately place their salt as far from the water point as the pasture will allow, so as to get their animals exposed to as much of the forage as possible.

EFFECTIVE USES

Salt is a powerful attraction to animals of every description. As such, it gives the land manager a valuable way to use animal impact for the improvement of the land and vegetation. By moving salt sources frequently, herds are persuaded to go into and utilize areas they never use, and just as importantly are attracted away from areas already impacted to allow vegetation to fully recover. As "bait", salt will help:

- Break down standing (dead) litter
- Control grazing time in any one location
- Concentrate livestock use within a pasture
- Attract heavy animal impact into areas needing disturbance, such as dense mesquite, blackbrush, manzanita thickets
- Attract wild stock out of hiding, allow them to associate salt provider with familiarity
- Bring effective forage use into areas neglected for long periods

MANAGEMENT

All of the effects listed above require the active, thoughtful management of the rancher and/or land manager. By developing a careful, detailed plan of the land, vegetation and animal life and their various needs, the manager can make the lowly salt block one of the most effective resource improvement tools in the inventory.

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FROM:

Arizona Ranchers' Management Guide
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STRATEGIES FOR MANAGING GRAZING ALLOTMENTS ON PUBLIC LANDS

George Ruyle,[1] Lamar Smith,[2] and Phil Ogden,[3]

Most ranches in Arizona are dependent, in one way or another, on federal and/or state grazing permits. The U.S. Forest Service (U.S.F.S.), Bureau of Land Management (B.L.M.) and the Arizona State Lands Department (A.S.L.D.) administer 28.6 million acres in Arizona that are grazed by livestock. Public and state land grazing permits and leases account for over 85 percent of the state's grazing land outside of Indian reservations. Approximately 63 percent of the beef cows raised in Arizona graze at least part of the year on public lands.

Public land grazing allotments are increasingly under the scrutiny of the regulatory agency involved and the general public, primarily through the vigilance of individuals from various environmental organizations. Restrictions imposed by legislation have also increased, influencing ranchers' flexibility to manage livestock on these allotments. Often, grazing permits are reduced where conflicts have arisen over real or perceived resource damage.

Generally, these conflicts can be mitigated through an organized approach to grazing allotment management planning. This effort may be initiated by the permittee and requires the same level of attention that other aspects of the ranching business demand.

We have identified six general areas that provide ranchers a process to improve range management and their ability to reduce and/or mitigate public land management conflicts. Many of the suggestions or scenarios discussed are obvious or common-sense approaches. Nonetheless, allotments targeted for administrative action often lack many of these characteristics.

1. MAINTAIN OPEN LINES OF COMMUNICATION WITH THE AGENCY PERSONNEL ASSOCIATED WITH YOUR GRAZING ALLOTMENT

Communication with the land management agencies is essential. To communicate you need to speak the same language. Increased attention to multiple range resources is often warranted in addition to discussions about livestock. Interest in soils, vegetation, wildlife and watershed values may be a common ground for further discussions. Learn what range condition means and how grazing influences range trend. Grazing can have both positive and negative effects on plants and management can have a direct bearing on these processes. Application of range management principles can directly influence permitted livestock numbers.

Listen carefully to what the agency people and others think are the problems on your allotment. Often these perceptions can be resolved with little change to management, but they have to be identified before they can be addressed. Future management strategies can be developed to cope with current and developing conflicts as perceived by agency personnel and others.

2. GATHER AND ORGANIZE AVAILABLE INFORMATION

Organizing and studying key information will enable you to become the expert on all aspects of your grazing allotment. These documents and data provide the framework for future planning and management decisions as well as a foundation for defending your actions. A place to begin is by requesting copies of your allotment files from the respective agencies. These files contain much outdated and obscure information, however, and a better approach might be to go to the office and look at the files, then request copies of specific documents. Usually these are easily obtained, but in the unlikely event that there is resistance to your request you can also invoke the Freedom of Information Act. Under this Act, there are strict deadlines and requests will elicit prompt responses although it is not a very friendly approach.

Agency maps will also be available and should be obtained. There will likely be a number of different kinds of maps, each focused on specific types of information. Maps should delineate specific land status and locate all range improvements. Soils and vegetation type maps are also often available. Other maps might report range condition and trend as well as grazing utilization levels on a periodic basis. Maps such as these are key to allotment management and should be updated periodically or developed if they are not available. Many agency maps will be out of date but will nonetheless be provided to any permittee.

Although they are not critical, aerial photos may be available and are very useful. These may have vegetation types delineated. They may also show locations of study plots. Data from any study plots that may exist for an allotment should be located and reviewed. These may include transect records and photos from permanent range trend plots or fenced exclosures. Dates of data collection should be clearly indicated.

A documented history of ownership and stocking records for the allotment should also be obtained where available. Records of past livestock use, both permitted and actual, along with any reductions or increases in permitted numbers are useful for future management and to show a history of beneficial resource use in a legal sense.

Additional records on the history of the ranch may include related deeds that reference range rights, water rights, permits or other documents. The more complete the record of range use the better.

Documentation of water rights is a complicated topic not to be addressed here. Suffice it to say that water rights should be properly filed in your name and the chain of title is brought to current ownership. The Arizona Cattle Grower's Association can help with these procedures.

Finally, all range improvements should be recorded and mapped. Kinds of improvements, locations, and dates built and/or maintained should be recorded. Records of the expense of the improvements should also be kept. Agency records of costs, private contributions and other improvement related data are only kept for a limited number of years so it is helpful for permittees to maintain permanent records.

3. DESIGN AND IMPLEMENT A MONITORING PLAN TO DOCUMENT VEGETATION CHANGES OVER TIME

Vegetation changes on rangeland grazing allotments are due to a complex interaction of events that include environmental and management factors. Natural fluctuations in climate, plant population cycles, fires, insect manifestations and grazing animals are some of the major influences on vegetation changes. Many procedures are available to keep track of these changes.

Specific objectives for the use of the vegetation monitoring data will determine the kinds of data to collect and are not discussed in detail here. Certain procedures, however, are useful to design and implement vegetation monitoring in most situations. The first decision is the location of study areas. These are usually located according to key areas and critical areas. Key areas are representative of conditions over most of the allotment and should be located on soils or sites of major importance to forage production. Critical areas need not be extensive but are important to monitor for specific resource values or because they may be more sensitive to grazing damage than is typical. Additionally sites expected to show changes due to management should be monitored. Historical study plots should also be considered for a renewed monitoring effort.

Transects can be established at each selected area depending upon the sampling design. A typical layout for monitoring range trend might consist of 10 transects, running perpendicular to a baseline. Data for plant frequency, density and ground cover or other attributes may be collected by locating a series of quadrats along each transect. Forage utilization data should also be collected at these sampling areas.

Establishing a photographic record of vegetation changes is also important. Photographs repeated over the years display vivid evidence of vegetation changes. Specific details on vegetation monitoring are available in other publications.

Again, communication with management agency people is important. They will usually accept a rancher's data, but need to know what monitoring is being done and may desire to be actively involved in the data collection.

4. LOCATE AND STUDY PROBLEM AREAS

Any allotment management plan will probably have one or more of the following goals.

a. To maintain or increase the proportion of certain plant species by regulating the intensity, frequency and/or season of grazing on those plants. Specific goals might be to increase the proportion of cool season grasses or forbs or simply increase the diversity of plant species present, or improve ground cover on an allotment.

b. To prevent accelerated erosion or allow present erosion to heal.

c. To avoid excessive conflict between livestock and other uses, such as wildlife, riparian zones, etc. This has become a primary motivating force for public land grazing management.

Any part of the allotment where these goals are not being met can be identified as a problem area. Problem areas will primarily center around plant species composition, soil protection and critical wildlife habitat. You can identify problem areas through analysis of agency maps plus your own knowledge of the allotment.

Study agency maps of range condition and/or utilization in addition to whatever study plot data which are available. Look for areas in poor range condition and areas of heavy utilization (in excess of 50%). These are likely to be areas identified as problems. Keep in mind that condition reflects management in the past. Trend should indicate what is happening under current management and should be related to current utilization patterns.

Problem areas that are visible to the traveling public can create a bad impression of the entire allotment. These areas should be identified and consideration given to their improvement. Most allotments will contain only localized overgrazing or heavy use.

Several common scenarios that may need attention are listed below.

a. Condition is poor, trend is down or stable and utilization is high. This is sure to be a problem area and your objective should be to reduce use in such an area, perhaps initially providing for growing season rest.

b. Condition is poor but current utilization is low. This may be due to heavy stocking for prolonged periods in the past which has been changed by reducing livestock numbers and/or the timing of use. In this case trend should be up and the objective should be to keep it improving. If you have no evidence that there was ever heavy stocking in the area, or if the trend is not upward, then the "poor condition" is probably due to invasion of brush or trees or to a naturally poor site potential. Present procedures may not adequately distinguish between poor condition caused by overgrazing and lack of forage or ground cover caused by poor soil, low precipitation or brush invasion. In these cases it is important to document that these areas of poor condition are not due to improper grazing management.

c. There may be areas of fair to good condition which are currently receiving heavy use. Trend on these areas will go down if excessive use continues without any timing considerations. Changes in management or new improvements such as fences or water development may cause such a situation. The objective in these situations should be to lighten use or change the timing of grazing by altering season of use or shortening grazing periods and providing adequate rest periods in order to maintain good range condition.

d. Other problem areas are those which are especially important for wildlife (critical browse areas or antelope kidding grounds for example), heavily grazed areas along streambanks or near campgrounds, and where active gullies are present.

5. EVALUATE ALTERNATIVES FOR MANAGEMENT

Once you have identified, from available maps, data and your own observations, where your real problems of poor condition and overuse are, you can start looking for ways to alleviate the pressure on these areas. Since no two allotments are alike in either problems or opportunities, there are no formulas for how to do this. The key is your ability to identify where the problems are and your imagination in looking for feasible changes in management to reduce the problems.

An important step is to watch utilization patterns carefully. Keep in mind that annual plants, plants that live for only one growing season, contribute little, if any, to most ratings of range condition or utilization. Therefore, look carefully at the condition and use on palatable perennial grasses and browse.

Identify areas which are not getting much use. If there are not any such areas or there is no feasible way to get use on them, a reduction in numbers may be necessary and beneficial to both range and livestock conditions. However, on many allotments the problem is not so much one of too many cattle but of the timing and distribution of grazing. Often allotments show overuse of some areas and under use of others.

The main objective is to reduce use in problem areas and increase it in areas of light use unless there are specific reasons to do otherwise. One or more of the following strategies to improve grazing distribution or management may work.

a. Move salt and supplemental feeding locations to areas with light use or, at least, move these locations frequently and keep them away from water.

b. New waters can be developed to serve lightly or unused areas. Care should be taken not to overstock these new grazing areas.

c. Herding may also keep cattle distributed. Riding can change natural grazing patterns and introduce animals to new waters and salting areas.

d. New or relocated fences or drift fences can keep cattle off of problem areas. These may also be necessary before grazing management can be effectively implemented.

e. Controlled burning or other brush control measures and/or reseeding also may improve the condition of problem areas or provide enough extra forage to take pressure off problem areas.

f. Finally, grazing management can change the timing of grazing by changing the frequency or season of use. Some type of rotational movement of cattle may give grazed plants a chance to recover and speed improvement of concentration areas. A workable system must be designed to meet the needs of both vegetation and livestock management. Remember that when trying to improve beat-out or critical areas, all livestock must be removed during the recovery periods. Leaving a few bulls or horses may be enough to prevent any positive response on these areas.

   Grazing management need not be complicated or require a lot of new water development and fences. Herding, controlling access to available water and relying on natural behavioral instincts of your livestock may be enough to get started.

6. *KNOW YOUR LEGAL RIGHTS, RESPONSIBILITIES AND APPEALS PROCEDURES*

Grazing permits carry with them both legal rights and responsibilities. Read your permit and understand the requirements. Access and wildlife regulations should also be known and followed, as failure to do so may invalidate grazing privileges.

Where management and communication fail, understand how to use the appeals process. There are a number of alternatives available depending upon the agency and level of your dissatisfaction. You can challenge agency decisions without a lawyer using procedures by the agencies and their parent agencies; the U.S. Forest Service and the U.S. Department of Agriculture; the Bureau of Land Management and the U.S. Department of Interior.

For example, for BLM decisions there are two different kinds of administrative remedies: protests and appeals. A protest is a formal request for reconsideration by a BLM official of any proposed or final decision. An appeal is a formal request for review of final BLM decisions by either an Administrative Law Judge (ALJ) or the Interior Board of Land Appeals (IBLA). The Interior Department has established the IBLA and ALJs to review disputed agency decisions. Certain decisions can only be appealed to ALJs or IBLA while others can only be protested.

The kinds of decisions than can be appealed in the National Forest System are called planned actions. These are written decisions governing plans, projects, and activities to be carried out on the National Forest System that result from analysis, documentation and other requirements of the National Environmental Policy Act and the National Forest Management Act. To appeal a decision a person must file a written notice of appeal with the next higher line officer and simultaneously send a copy of the notice of the appeal to the Deciding Officer (the line officer whose decision is being questioned). Decisions subject and not subject to appeal are listed under 36 C.F.R. Part 217 of the Federal Register, Vol. 54, No. 13, as are definitions, time limitations and details for filing appeals of Forest Service decisions.

Many unfavorable agency decisions can be forestalled using the recommendations set forth in this paper. It all begins with open and honest communication, setting reasonable resource objectives and then monitoring progress. As responsible land stewards it is up to you to take the lead in communication with land management agency personnel, stressing proper resource management, documenting results and creating a positive image with the non-ranching public.

WORKING OUT SOLUTIONS

If management changes are warranted and the allotment is not scheduled for a new Allotment Management Plan, request general planning guidelines from the appropriate range management personnel and use these to write your own proposals. Further technical assistance can be obtained from the Natural Resources Conservation Service, Cooperative Extension, private consultants and other sources.

Before formal appeals, always consider further communication and consensus. Often, an informal meeting with the Forest Supervisor, BLM District Manager or State Land representative will solve the problem.

Methods exist to organize people and efforts to solve range management or other natural resource management issues. These consensus-building procedures have a number of similarities. The appropriate interests must be identified and must have the opportunity to be involved in the process. Allotment management plans are increasingly developed in conjunction with interested groups and individuals in addition to the permitee and the appropriate agency personnel. The Forest Service has formalized this process with their Integrated Resource Management procedures.

In any process, goals and objectives must be agreed to, while considering available resources and land potentials. Management recommendations should then be tied to stated goals and monitoring methods developed to determine whether or not goals are being reached. Finally, there should be procedures that allow corrections to the plan when needed.

Arizona has a memorandum of understanding to participate in the Coordinated Resource Management (CRM) procedure, signed by an executive group comprised of members from the U.S. Forest Service and Bureau of Land Management, Arizona State Land Department and Game and Fish Departments, and The University of Arizona Cooperative Extension. Coordinated Resource Management is often used to identify goals and priorities for planning, managing and monitoring grazing allotments, especially where more than one public agency is involved. Participation in the CRM process begins at the field group level and is a means to provide not only technical expertise but maintain communication among interested parties. The organization of a CRM group can facilitate the development of an allotment management plan.

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FROM:

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USING REPEAT COLOR PHOTOGRAPHY AS A TOOL TO MONITOR RANGELANDS

Larry D. Howery[1] and
Peter Sundt [2]

"Boy, you should have seen this place 10 or 15 years ago. Things sure look better now! Cover has improved. There are more desirable plant species. Wildlife habitat is better than it used to be."

Do these comments sound familiar? Unfortunately, often times there are no data to back them up. When it comes to convincing folks that your management practices have improved the range, you have to pretend for a moment that you are from Missouri, which is known as the "Show Me" state. It is especially important to show people that what you say is true when your critics weren't around 10–15 years ago to see the changes you have seen. A series of photographs taken at the same spot through the years can vividly demonstrate change on the range. This article provides an introduction to repeat color photography and explains how it can be used as an important part of a comprehensive rangeland monitoring program.

BACKGROUND

Why use repeat color photography?

Repeat color photography is a simple and relatively quick way to monitor rangelands. A properly located photo station can reveal changes over space and time in important rangeland attributes like plant growth, species composition, total plant cover, litter, spatial arrangement of plants, and soil erosion (i.e., all aspects that can be related to grazing management practices).

Are there permanent photo stations on public land grazing allotments?

If you are a Bureau of Land Management or United States Forest Service livestock grazing permittee, it is likely that photo stations have already been installed in permanent monitoring sites (called key areas) on your allotment. Ask your range management specialist for a map that depicts the location of key areas and the types of monitoring activities conducted at these sites in the past. Some key areas will have photo stations established on them, while others may not.

Should I establish new photo stations? If so, where and how many?

If permanent photo stations have not been installed on your allotment you can set them up yourself, but involve your local rangeland management professional. Let resource managers know that you are serious about learning how grazing management, weather, or other factors (e.g., rodents, insects, fire) may be influencing rangeland attributes. They will help you locate photo stations in "key areas" which are locations that are typical and representative of larger areas. In grazing studies, key areas are chosen as a sample, a barometer of sorts, of the average grazing impacts in a pasture or vegetation type. Below are a few points to consider when establishing new key areas where photos will be taken.

- As is true of all forms of rangeland monitoring, photography requires clear objectives and careful selection of places to monitor. In most rangeland monitoring studies, the objective is to detect changes in rangeland attributes due to grazing, fire, weather, and other environmental variables. An inventory of range sites, vegetation types, and utilization patterns helps determine where and how many key areas should be located.

- Generally speaking, the more variable the rangeland the more key areas are needed. One key area is probably adequate to monitor an irrigated pasture on flat terrain, but a typical Arizona ranch may need several key areas to adequately represent the different types of country and variation in grazing pressure.

- Remember that key areas are intended to represent typical grazing activities for a larger area. Consequently, don't locate key areas where livestock never graze (e.g., more than a mile or two from water, steep slopes), or where livestock normally congregate (e.g., within 1/4-mile from watering points, fence lines, or at pasture corners). *Note: If your objective is to monitor an "environmentally sensitive area" (e.g., riparian area, endangered species, wildlife habitat), the area monitored is commonly referred to as a* ***critical area*** *rather than a key area.*

- Spurious conclusions may result if a change occurs in a key area because of local events (like a fire or flood), but not in the larger area the site was chosen to represent. For this reason, it's helpful to have more than one key area per pasture or vegetation type so that you can be confident a change is general rather than due to local conditions.

- On the other hand, it is pointless to establish a key area if you don't have time to monitor it. Begin by establishing a few key areas within the highest priority areas of the ranch, and add more as time and your increasing experience allow. The important thing is to get started! As you gain experience, you may want to augment your photos with other more intensive rangeland monitoring techniques (e.g., frequency, dry-weight rank, cover).

What is the difference between a photo-plot and a photo-point?

- ***Photo-plots***, are close-up photos taken of a relatively small, permanently-marked plot on the ground within a key area. Photo-plots are useful if your objective is to intensively monitor changes in individual plant species populations or in soil cover.

- ***Photo-points*** are established to show a general landscape view of a key area. Their objective is to detect changes in major vegetation types, such as the degree of shrub encroachment, across landscapes.

- Both of these monitoring methods are tools that can be used to show how rangeland attributes may change due to management and/or environmental factors.

PHOTO-PLOTS

What is the objective of using photo-plots?

To intensively monitor the changes in size and number of key plant species, and to monitor changes in soil attributes like cover, pedestalling, and rilling.

What size photo-plot should I use?

Photo-plots conventionally vary in size from 1 x 1-meter, to 3 x 3-feet, to 5 x 5-feet (see Illustrations 1–3). You will need a step ladder to ensure a high enough angle to photograph the 5 x 5-feet size. However, the latest interagency monitoring manual recommends using the 1 m^2 size where new studies are being established (Interagency Technical Reference, 1996).

Where should I establish photo-plots?

As discussed earlier, photo-plots should be located in key areas. Each photo-plot is a small sample of the key area. It should include plant species of principal interest, such as key forage species. If soil erosion is of concern photo-plots can be located in a rilled or gullied area. Because of the small area being monitored (i.e., the plot) it may be necessary to have several different photo-plots located within a key area to avoid making wrong conclusions based on too little information.

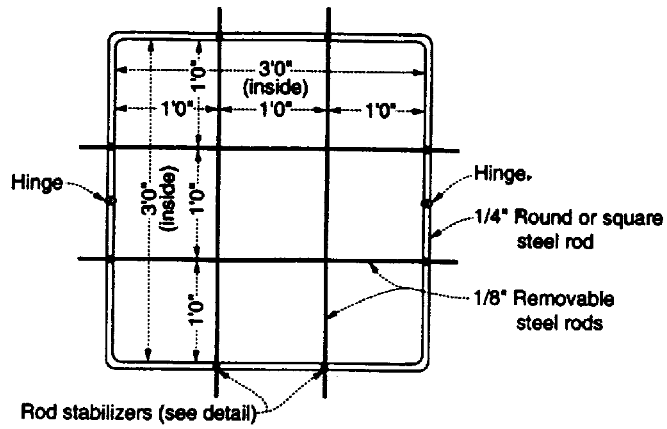
What materials do I need to establish a photo-plot?

1. Frame made of PVC pipe, steel rods, or similar material to delineate the photo-plot.

   Note: You can also use 2, 6-feet wooden carpenter rulers folded at right angles at the 3-feet marks to mark 3 x 3-feet photo-plots.

2. Four rods to divide the 3 x 3-feet and 1 x 1-meter photo-plots into 9 square segments (optional, see Illustration 1).

Illustration 1. Photo plot frame (3 x 3-feet).[3]



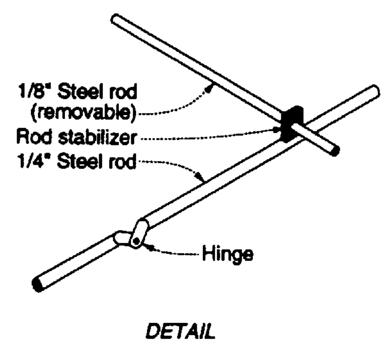
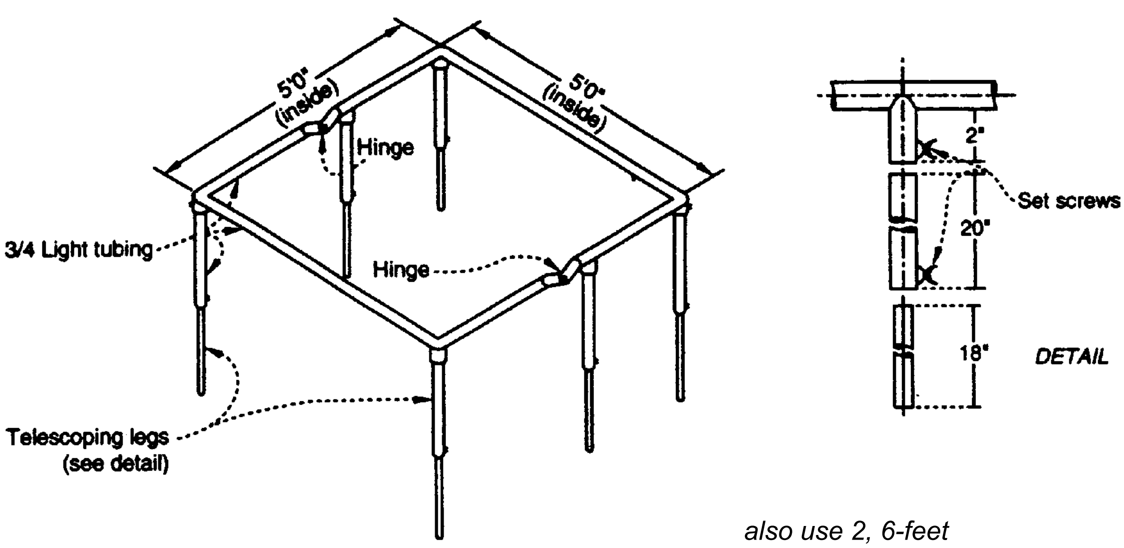
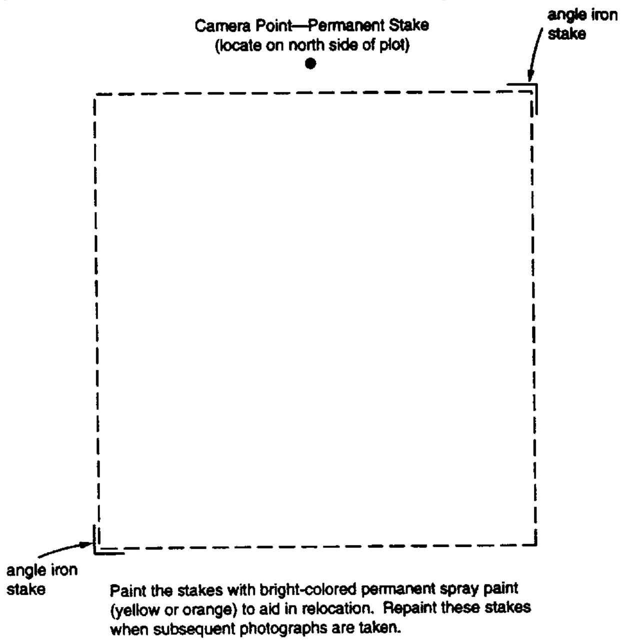


Illustration 2. Photo plot frame (5 x 5-feet).[3]



also use 2, 6-feet

Illustration 3. Permanent photo plot location (3 x 3-feet, 5 x 5-feet, or 1 x 1 meter).[3]



3. Small step ladder (for 5 x 5-feet photo-plots only).

4. Half-inch angle iron stakes (rebar or PVC pipe will also suffice) at least 16-inches long (you will need 3 stakes/photo-plot).

   Note: You may want to use PVC pipe to make stakes. Metal stakes can cause flat tires and injure animal hooves.

5. Hammer.

6. Photo identification form (see Illustration 4), or chalk board.

   Note: Pastel-colored paper (e.g., gray or light green) works better than white paper because white paper can reflect light rendering the labeled form unreadable.

7. Study location and documentation form (to record relocation information and other important data, see Illustration 5).

8. Two clip boards for holding forms.

9. Broad felt tip pen with waterproof ink.

10. Pencil.

11. Compass.

12. Map or aerial photo of the study site.

13. Bright colored spray paint (yellow or orange).

14. Camera with a 28-mm wide angle lens and color film.

15. Steel t-post or some other device to serve as a roadside marker (commonly called a “witness post”).

16. Post driver.

How do I establish a photo-plot?

1. Place photo-plot frame on the ground area you intend to photograph. Align the plot frame so the sides are aligned with the cardinal directions (i.e., north, south, east, and west). Drive 2 stakes into the ground at the diagonal corners of the frame, and 1 stake just outside the midpoint of the north side of the frame (Illustration 3).

2. Label the photo identification form with waterproof felt tip pen to include date, photo-plot number, resource area (if on public land), allotment, and pasture. Be sure to write large and legibly. Place the photo identification form flat on the ground immediately outside of the photo-plot frame.

3. Stand with your toes touching the stake on the north side of the photo-plot. Take your photo making sure the plot frame and photo identification form are included in the photo. *Note: Taking photos from the north side helps reduce shadowing across the plot.*

Illustration 4. Photo identification form.[3]

DATE __________

NO. __________

R.A. __________

ALLOT. __________

PAST. __________

Illustration 5. Study location and documentation data form.[3]

Page ___ of ___

Study Location & Documentation Data

Study Method				Study Number
Allotment Name & Number			Pasture	
District		Resource Area		
Ecological Site		Plant Community		
Date Established	Established by (Name)		Map Reference	
Elevation	Slope	Exposure	Aerial Photo Reference	

	Township	Range	Section	1/4	1/4	1/4	
Location							Scale: ___ inches equals one mile

Key Species

1 2 3

Distance and bearing between reference post or reference point and the transect location stake, beginning of transect, or plot

Distance and bearing between location stake and bearing stake

Transect Bearing	Vertical Distance Between Ground & Aligned Tape
Length of Transect	Plot/Frame Size
Sampling Interval	Total Number of Samples

Notes (Description of study location, diagram of transect/plot layout, description of photo points, etc. If more space is needed, use reverse side or another page.)

Note: Depending on the study method, fill in the blocks that apply when a study is established. This documentation enables the examiners to conduct follow-up studies in a consistant manner to provide comparable data for analysis, interpretation, and evaluation.

4. Take a few "landscape photos" in different directions from the photo-plot (see next section) to show the surrounding landscape. This will help you relocate the photo-plot in the future, particularly if the witness post (see below) is removed.

5. Place the steel t-post (commonly called a "witness post") in a visible location from the photo-plot just off the road or trail.

6. Record on the study location and documentation form all information that will help you relocate the photo-plot in the future, including:

   ■ Compass bearing and distance of photo-plot from the witness post.

   ■ Sketch of prominent physical features of the key area (roads, trees, fencelines, rock out-crops, streams). Be specific because it may be a year or more before you return to the plot.

   ■ Record any observations you deem appropriate to the general area (e.g., actual use, animal concentration, wildlife sign/use, rodent sign/use, insect infestation, flood, fire, rainfall, water availability, open gates, vandalism).

   ■ Record mileage to key area from prominent physical features (e.g., road intersec-tions, other key areas).

   ■ Jot down your rationale for locating the photo-plot in this particular area. *Note: Photo-points (or landscape view photos, see next section) can also be taken at each photo-plot location to aid relocation.*

7. Spray-paint stakes with bright-colored spray paint.

8. Organize your photos and forms in a 3-ring binder by date and photo-plot identification number.

PHOTO-POINTS

What is the objective of using photo-points?

To monitor how rangeland vegetation may change across space and/or time (e.g., grasses to shrubs, or vice versa). The landscape view is especially useful for detecting brush encroachment into grasslands, and for monitoring the spatial arrangement of trees and shrubs.

Where can I establish photo-points?

Photo-points can be established in upland areas to document changes in dominant plant life forms (e.g., grasses to shrubs, or vice versa). In hilly or mountainous country, it helps to locate photo-points so that views can be shot across narrow valleys and hill slopes. These views spread out vertically and aid in plant identification. Often a station can be located to allow a 360 degree panorama of a key area.

Photo-points are also commonly used in riparian areas to document changes in streamside attributes (e.g., bank cover, erosion, stream width, changes in number and size of trees and shrubs). The number of photo-points established depends on your objectives and the size of the riparian area, but a minimum of three (i.e., upstream, downstream, and across-stream) are usually recommended at each photo station.

What materials do I need to establish a photo-point?

You will need item numbers 4–16 listed in the earlier section, "What materials do I need to establish a photo-plot." You will only need one, 1/2-inch angle iron stake (rebar or PVC pipe) at least 16-inches long for each photo-point.

How do I establish a photo-point?

1. Drive the stake into the ground and spray paint the top to mark the permanent photo-point (i.e., point where you will stand each time to take photos).

2. Label the photo identification form as explained for photo-plots. Have someone hold the photo identification form while you take the photo or prop it against a rock or tree, making sure that it is readable in your camera's view finder.

3. Take picture to include the photo identification form as well as prominent reference points (e.g., stream, fence post, fence line, prominent trees and/or rock outcrops, road) in the foreground and background.

4. As with photo-plots, record all pertinent information that will help you relocate and interpret your photos. Again, several landscape photos taken in several directions will help you to relocate the photo-point in the future.

5. Organize your photos and forms in a 3-ring binder by date and photo-point identification number.

How do I make sure that I am photographing the same landscape area each time I go into the field?

1. On each subsequent sampling occasion, bring to the field your 3-ring binder that contains previous photos and forms. Use your previous photos and forms to relocate the photo-point stake.

2. Prepare the photo identification form and place it in the photo area as described above.

3. Refer back and forth between your camera's view finder and a previous photo until you are satisfied that your view finder includes the same landscape shown in the earlier photo. Take the photo.

GENERAL RECOMMENDATIONS

- Take photos at about the same season of year so that differences in plant growth and phenology (e.g., seed-set, flowering) or management activities (e.g., before vs. after grazing) do not confound photo interpretation.

- Whenever possible, establish comparison photo stations in both grazed and ungrazed key areas that are similar in every aspect except grazing (e.g., similar soils, topography, precipitation) to allow evaluation of grazing effects.

- Slide film lasts longer in storage than prints. Slides can be made into prints that can be used to illustrate changes to people in the field and to relocate photo-points.

- Weather permitting, use the same camera lens size, film type and speed each time you sample. We recommend using 100 or 200 ASA film for the bright and sunny days that are typical of Arizona.

FINAL THOUGHTS

Changes in rangeland attributes occur relatively slowly in the arid southwest, particularly in upland areas. Riparian areas have more potential to change rapidly in response to both management and precipitation. Be patient! Repeat color photography will help you document subtle rangeland changes, but probably won't provide sufficient information to evaluate all of your goals and objectives. Consider also collecting quantitative data like precipitation, soil moisture, forage production and utilization, species frequency, vegetation cover, and actual use (i.e., stocking rates).

Repeat color photography should be an important part of any rangeland monitoring program. It is relatively fast and inexpensive, and can help tell a convincing story when implemented over several years. If you are not currently participating in a rangeland monitoring program, repeat color photography is an excellent way to start. It may be the only type of monitoring you have time for, at least initially. So the next time someone says "show me" how things have improved, show them your photos. Remember**, a picture can be worth a thousand words.**

ACKNOWLEDGMENTS

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[3]*All illustrations were originally published in identical or similar form in the Interagency technical reference manual (1996). They are reproduced here by permission of Bureau of Land Management's National Applied Resource Sciences Center, Denver, CO.*

FROM:

Arizona Ranchers' Management Guide
Russell Tronstad, George Ruyle, and Jim Sprinkle, Editors.
Arizona Cooperative Extension

RANGELAND MANAGEMENT INFORMATION ON THE WEB

Barbara Hutchinson,[1] Jeanne Pfander,[2] and Michael Haseltine[3]

INTRODUCTION

For the past four years, an interdisciplinary team at the University of Arizona has been involved in the development of a comprehensive web site on the topic of managing rangelands. Part of a national-level initiative to create an electronic library of agricultural information called the Agriculture Network Information Center (AgNIC), the Arizona AgNIC web site provides access to a wide variety of rangeland resources as well as links to other agricultural information. Figure 1 shows the home page for the site, located at: http://ag.arizona.edu/agnic/range.html.

Besides a section that contains general introductory information about the subject, there are five main categories that include the majority of the site s resources: Rangeland Science; Practical Tools; Policy Issues; Education, Teaching and Careers; and General Resources. The right side panel provides a list of special highlighted resources contained in the web site, while the left side panel gives the user opportunities to learn more about the site and its developers, to search the site, to ask specific questions, and to provide feedback.

NAVIGATING THE WEB SITE

On subsequent pages two icons are used throughout the site to signify whether or not the section was developed by Arizona AgNIC. For instance, if a miniature of the Arizona AgNIC symbol is seen, it indicates that the

Figure 1. Managing Rangelands Home Page

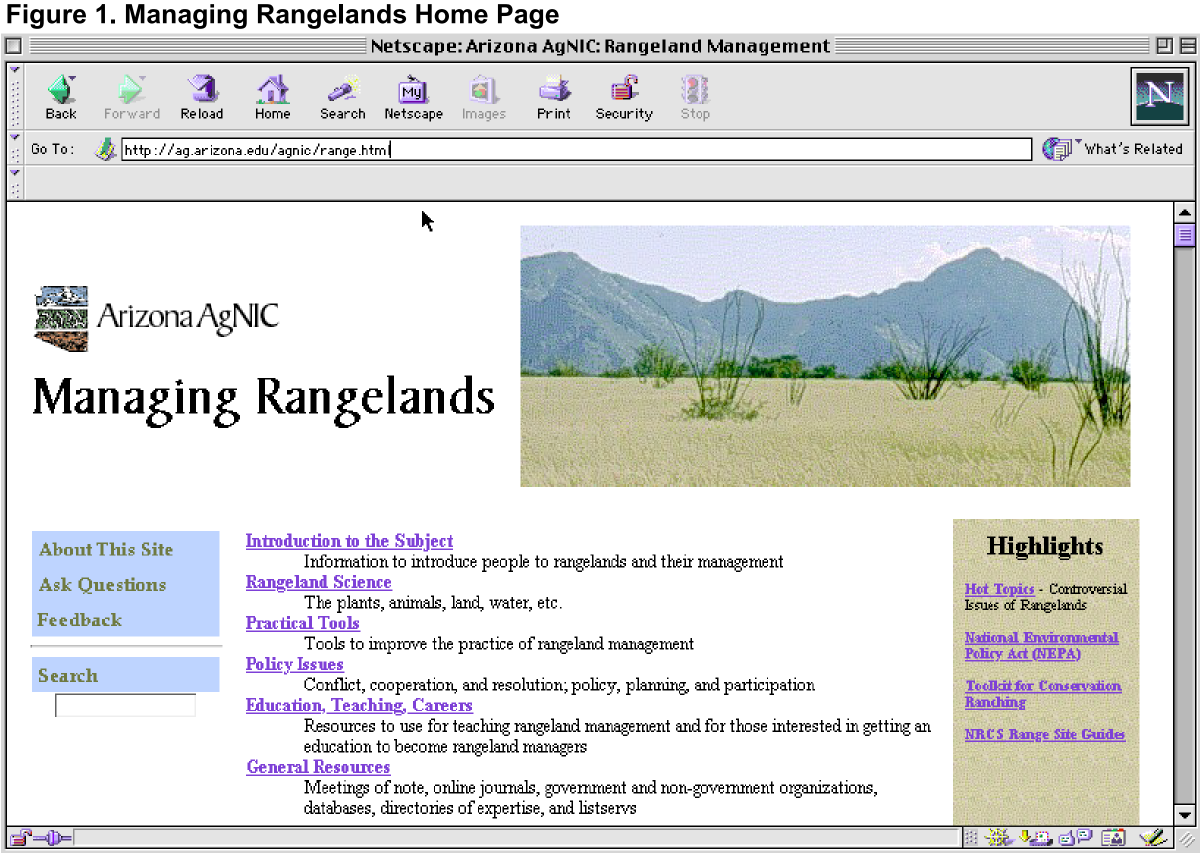
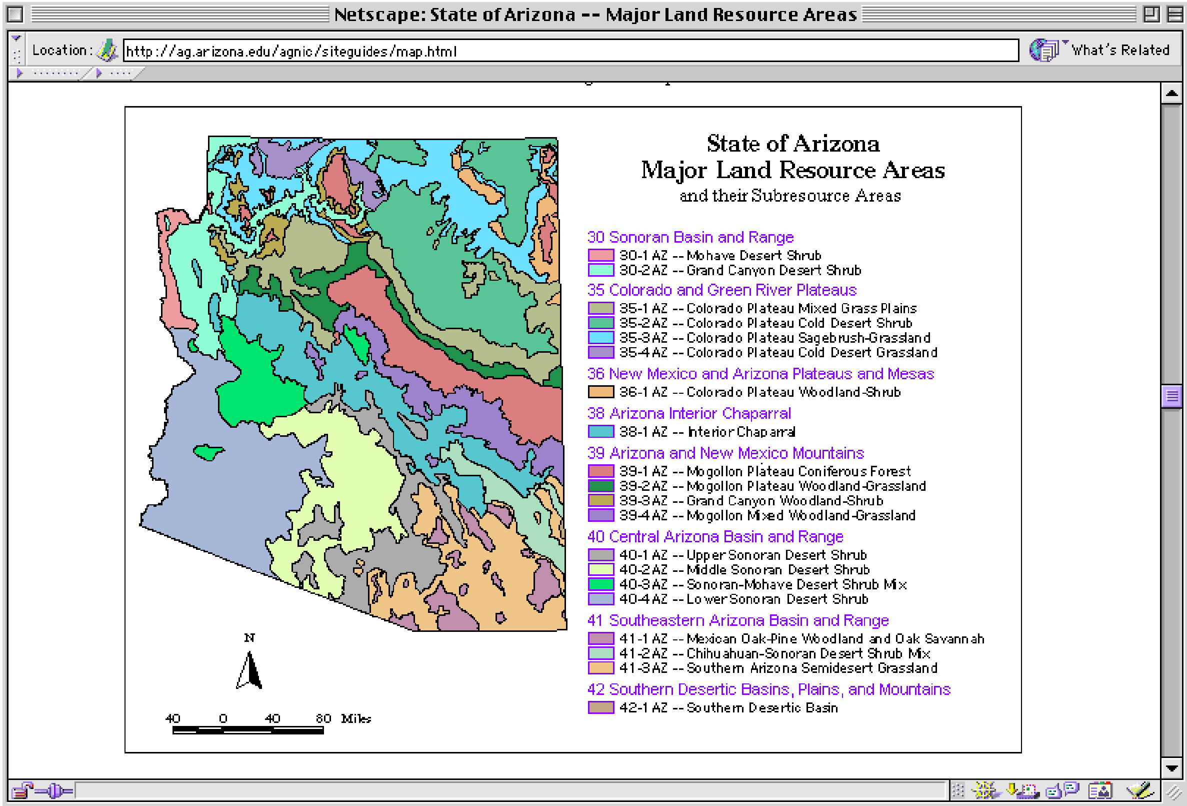


Figure 2. Range Site Guide Interface



link is to pages the AgNIC team has prepared. Links with the offramp sign take users to sites prepared by other people and organizations.

After leaving the home page, the user will notice a blue navigational bar at the top of each page that includes links to every other major section of the site. The Arizona AgNIC symbol at the top and bottom of each locally developed page is a hot link that will always take the user back to the Managing Rangelands home page. If leaving the site via an off-ramp page, the user will need to use the browser s back button/arrow to return to the Managing Rangelands home page.

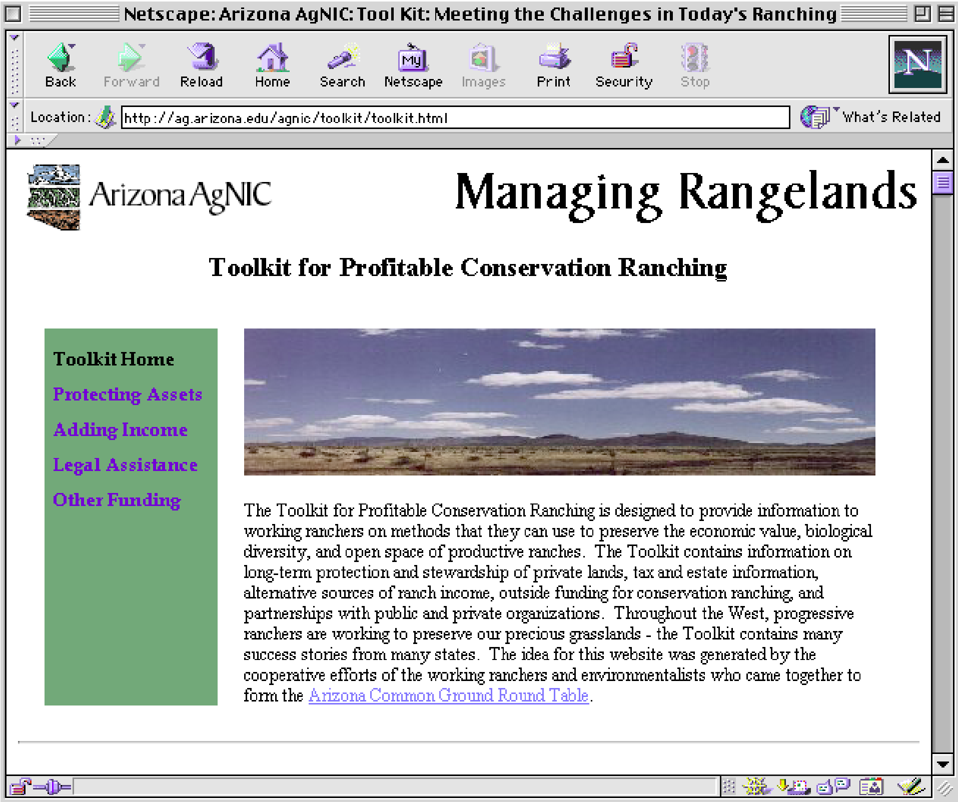
WEB SITE SECTIONS

Rangeland Science

This section is oriented toward the scientific study of rangelands, their understanding and management. Topics on the main page are specified in several different ways. Under the general topic are *Special Resources,* which usually feature those resources created especially for the site by University of Arizona project personnel, but may also include links to particularly noteworthy web resources compiled elsewhere. The *Other Information* section is primarily composed of links to other related sites on the web.

Of particular interest to Arizonans are the selections Range Site Descriptions for Arizona and the Santa Rita Experiment Range. Range (or Ecological) Site Guides are produced by the Natural Resources Conservation Service and provide information on the ability of land to produce vegetation and hence support grazing based on soil and climate. As with much of this web site, the work is ongoing for putting up all Arizona range site guides and creating simple methods for using them. However, interactive maps are available to help the user locate specific information (see figure 2).

Figure 3. Tookit Home Page



The Santa Rita Experimental Range web site provides data and repeat photography from the first experimental range in the United States, founded in 1903, and located south of Tucson. The photos demonstrate changes in vegetation through the years from various locations on the 53,159-acre site.

Other resources are organized by specific topic and can be reviewed by clicking on the topic of choice as noted in the bar at the top: Animals | Climate | Land | Plants | Water. These include links to both Arizona AgNIC and non-Arizona AgNIC web sites with information in these areas.

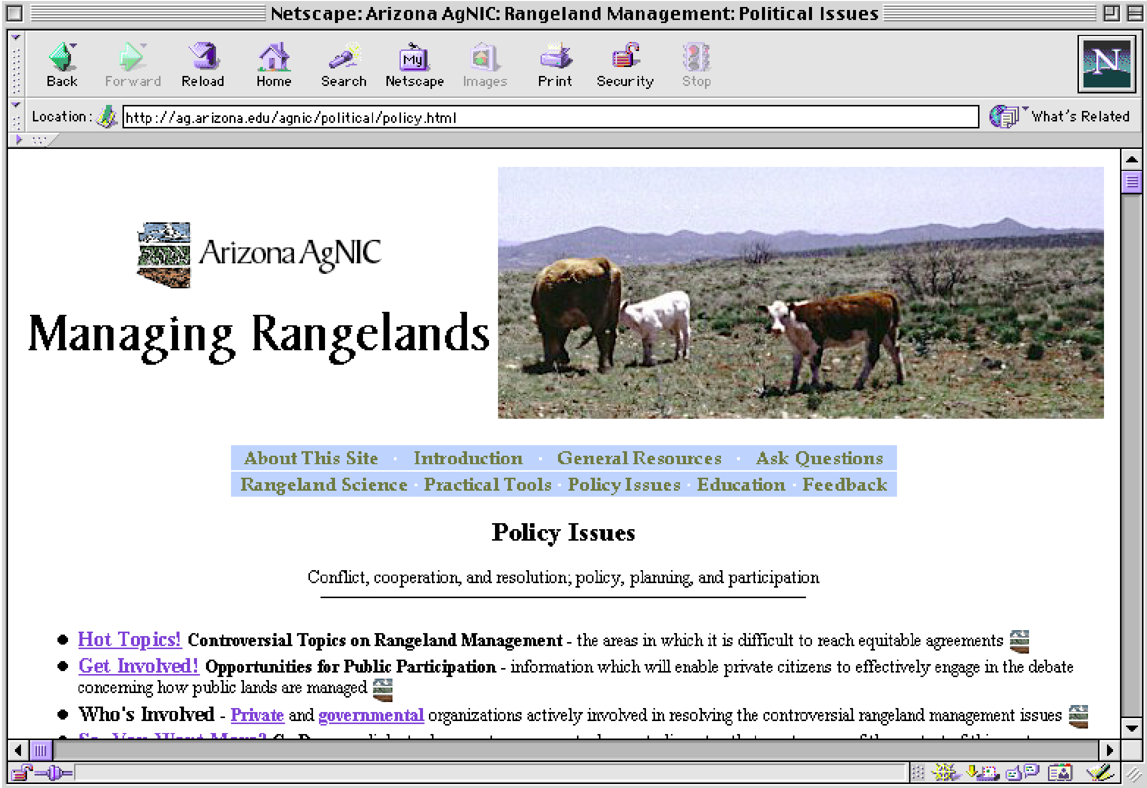
Practical Tools

The main page for the section on Practical Tools is organized similarly to Rangeland Science. At the top are those resources that hold promise for helping users answer questions of a practical nature that can lead to new and better management strategies.

Here you can find links to information on noxious weeds, rangeland health standards, and the full-text of the *Arizona Ranchers Management Guide*.

Of particular note is the Toolkit for Profitable Conservation Ranching (Figure 3). This sub-section was prepared in cooperation with the Arizona Common Ground Roundtable, a state-wide group of ranchers, environmentalists, researchers, public agency personnel, sportsmen, and other interested citizens who are seeking to identify tools and policy changes that will conserve Arizona s open spaces (see their web site at: http://udallcenter.arizona.edu/commonground/). Links provide information on how to preserve open space through such means as conservation easements, land trusts, and family trusts. Alternative forms of income generation for ranches are discussed, such as guest ranches, summer camps, and fee hunting, and the toolkit also includes information on finding

Figure 4. Policy Issues



legal assistance and supplemental grants and funding opportunities.

Policy Issues

Managing the rangelands of the western United States involves many different people, groups, and agencies with differing points of view. Issues surrounding the preservation, conservation, and fair use of rangelands are often controversial and seem intractable. The resolution of those conflicts involves developing a constructive dialog based on finding common ground and areas of compromise. This section of the web site focuses on aspects of the policy and political issues regarding our rangelands.

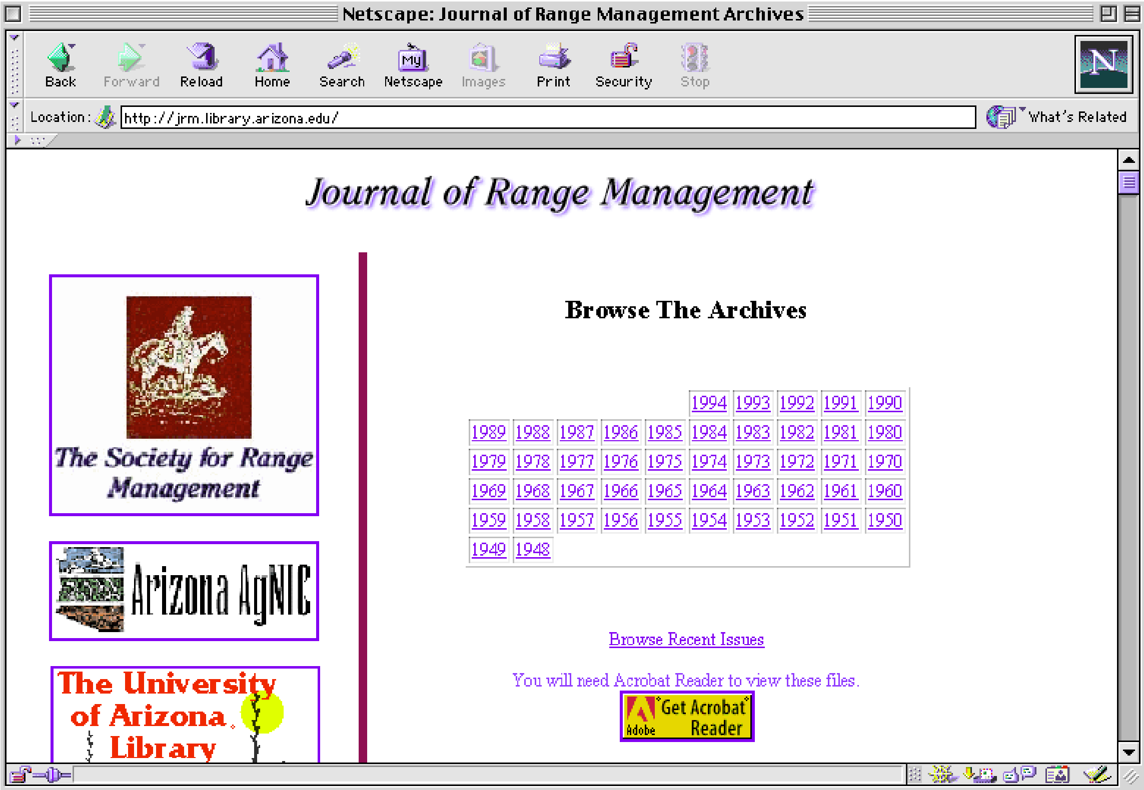
Beginning with a link to a section on hot topics, the user can find links to other web sites on the subjects: Indian Lands, Urbanization, Water and Riparian Areas, Recreation, Mining, Logging, Grazing on Public Lands, and Wildlife and Endangered Species. Each of these topics is divided into three sub-sections providing background information, newspaper items, and information on legal issues.

The Get Involved section provides an in-depth review of the National Environmental Policy Act (NEPA) including a description of federal regulations, various agency implementation procedures, and a discussion of how NEPA has been interpreted by the courts. It also provides links to facilitate public participation in the process of making decisions about how public lands are used.

Education, Teaching, and Careers

To assist teachers and students in their academic pursuits, this section provides links to potentially useful teaching materials, lists of college programs in rangeland management, and guidance in planning for a career in this field. In particular, faculty in the Rangeland Program at the University of Arizona

Figure 5. ***Journal of Range Management*** **Archives**



are preparing an online textbook for the site titled, *Principles of Rangeland Science and Management.* At the time of this publication, Chapter 4 (Ecology and Management of Rangeland Vegetation) and Chapter 5 (Rangeland Inventory and Monitoring) are in place. Within these chapters are links to further explanations and to related readings.

General Resources

This section contains links to academic institutions with rangelands programs, selected Extension publications, online bibliographic databases, online journals, meeting announcements, government and non-government organizations, directories of expertise, and related listservs. Of particular importance, project staff from the University of Arizona Library have worked with the Society for Range Management to digitize articles (Volumes 1—47,1948—1994) of the *Journal of Range Management,* and make them available through this web site. Each article in these issues may be read in its entirety online with Adobe Acrobat Reader, which must be installed.

Ask Questions (Left Side Panel)

The web site provides an interactive form in this section for questions about rangelands. First-time users should read the Frequently-Asked-Questions (FAQ) about this reference service, linked at the top of the form.

Individuals using the query form should fill out all five sections with their name, email address, occupation and affiliation, the question, and additional information that will provide context for the question. A response to the question is usually provided within 24 hours.

Queries have been received from many different geographic locations worldwide and many different kinds of users. Questions from Arizonans make up a large percentage of all queries.

Feedback From Users

The project team for the Managing Rangelands web site is committed to improving the site and making it more useful. The interactive feedback form gives users the opportunity to evaluate the site and make suggestions (additional sites to link to, etc.).

Searching for Specific Information

A search function is provided that allows users to enter words, phrases, or combinations of words using Boolean operators (and, or, not), to find specific locations where those words are mentioned on the Managing Rangelands web site. It provides a means to locate specific information or resources when the user is not sure how to find that information or has tried and not been successful.

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FROM:

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, James Christenson, Director, Cooperative Extension, College of Agriculture and Life Sciences, The University of Arizona.

RUSLE APPLICATIONS ON ARIZONA RANGELANDS

Christopher Jones[1]

INTRODUCTION

The Revised Universal Soil Loss Equation (RUSLE) is a standardized soil erosion prediction equation that can be used for many land use situations. The USDA Natural Resource Conservation Service is the primary user of RUSLE. Because of the variable nature of rangelands and their large size, there are limitations of the use of RUSLE on rangelands. With understanding of those limitations, RUSLE can still serve as an effective and easy tool to indicate average annual soil loss per acre.

Arizona ranchers and rangeland managers often find RUSLE useful to estimate, monitor, and predict soil loss. The tool is site specific, readily available, inexpensive, and fairly easy to use. Its most common application is to examine and address areas with known erosion problems.

Soil loss is important because there is a direct relationship between soil depth and plant growth. It is a valuable parameter to help gauge and determine potential range condition. Land use normally has more effect on soil loss than any other single factor. Of the major factors affecting soil loss, land use is generally the only one that can be changed to control soil loss. A decrease in soil loss over time would demonstrate that management practices being used are environmentally sound. Conversely, an increase may point to a need to address management practices and/or landscape vulnerability.

Efforts to create an equation to estimate soil erosion began in the 1930s (Cook, 1936). Subsequent research by various agencies of the U.S. Department of Agriculture and universities resulted in the Universal Soil Loss Equation, presented in *Agriculture Handbook No. 537* (Wischmeier and Smith, 1978). The revised equation, RUSLE, was made available in 1992 as a computer-based application that can now be accessed over the Internet. It can be found at

http://www.sedlab.olemiss.edu/rusle/

The program is updated on a regular basis and is available as a download at no charge. This website includes links for assistance, including rangeland specialists based out of Tucson, and other complimentary information. Two other resources necessary for using RUSLE are the assistance of the nearest USDA Natural Resources Conservation Service (NRCS) office and the *Agriculture Handbook No. 703,* “Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE)” (Renard et al., 1997).

This paper is intended to provide a basic understanding of RUSLE, concerns for rangeland applications, and what land managers can do to implement RUSLE. Although there is debate about RUSLE’s accuracy for rangeland applications (Weltz, Kidwell, and Fox, 1998), USDA scientists and researchers are continually improving the equation’s utility. Other erosion simulation models, such as the Water Erosion Prediction Project (WEPP), are just too complex and/or cost prohibitive for most rangeland managers. At present, RUSLE is readily available, inexpensive, and fairly easy to execute. Its limitations for rangeland applications are identifiable and can be addresed to provide useful information. Until other erosion simulation models are developed for the general user, RUSLE continues to be the primary soil erosion prediction tool in use today.

THE EQUATION

Based on the 1978 Universal Soil Loss Equation (USLE), RUSLE is as follows:

$$A = R \cdot K \cdot L \cdot S \cdot C \cdot P$$

Where:

A = Average annual soil loss per unit area predicted by the model (tons/acre/year).

R = Rainfall-runoff erosivity factor—the rainfall erosion index.

K = Soil erodibility factor—the soil-loss rate per erosion index unit for a specified soil on a standard plot.*

L = Slope length factor—the ratio of soil loss from the field slope length to soil loss from a 72.6-ft length under identical conditions.

S = Slope steepness factor—the ratio of soil loss from the field slope gradient to soil loss from a 9% slope under otherwise identical conditions.

C = Cover-management factor—the ratio of soil loss from an area with specified cover and management to soil loss from an identical area in tilled continuous fallow.

P = Support practice factor—the ratio of soil loss with a support practice such as contouring, stripcropping, or terracing to soil loss with straight-row farming up and down the slope.

*The standard plot is defined as a 72.6-ft. length of uniform 9% slope in continuous clean-tilled fallow.

Like its predecessor USLE, RUSLE is a lumped empirical model in a simple linear equation, the product of the above six factors. In the equation, all the factors and subfactors are calculated together to give an estimated soil loss as an annual average. As revised, current knowledge of erosion science is incorporated into the subfactors that make up the factors used.

THE FACTORS

The following is a brief description of each factor (Renard et al., 1997):

Rainfall-Runoff Erosivity Factor (R): The R-factor quantifies the effect of raindrop impact and also reflects the amount and rate of runoff likely to be associated with precipitation events. The R-factor is calculated as total storm energy (E) times the maximum 30-minute intensity (I_{30}), or EI, and is expressed as the rainfall erosion index. Index maps are used to determine the local value used for R. The R-factor is estimated by a methodology that includes information gathered from over 1,000 National Weather Station rain gauges.

Soil erodibility factor (K): The K-factor is the rate of soil loss per rainfall erosion index unit as measured on a standard plot, as defined in the above section. It represents the average long-term response of a specific soil and its profile to the combined effects of rainfall, runoff, and infiltration. It is expressed as the change in the soil loss per unit of applied external force or energy.

Slope length factor (L): The L-factor incorporates the ratio of rill erosion (caused by flow) to interrill erosion (raindrop impact) to determine the loss of soil as compared to the standard plot length of 72.6 ft. Slope length is defined as the horizontal distance from the origin of overland flow to the point where deposition occurs (a flattened slope) or runoff concentrates into a defined channel, usually within 400 feet of surface flow. RUSLE is most accurate when slope lengths are considered in 1,000-ft. distances or less.

Slope steepness factor (S): The S-factor reflects the influence of slope gradient on erosion as compared to the standard plot steepness of 9%. The program is designed to account for non-uniform slopes and slopes greater than 20% as well. Slope steepness has a greater effect on soil loss than slope length. The factors L and S are evaluated together in RUSLE.

Cover-management factor (C): The C-factor is used to reflect the effect of management practices on erosion rates. The RUSLE program user can easily compare the relative impacts of management options by making changes in the C-factor to reflect grazing impact or burning. For range-land applications, average annual values for the C-factor are usually used. The C-factor is determined using subfactors for prior land-use, canopy cover, soil cover, surface roughness, and soil moisture.

Support practice factor (P): The P-factor is the ratio of soil loss with a specific support practice to the corresponding loss with upslope and downslope tillage. Soil-disturbing practices such as ripping, root plowing, contour furrowing, and chaining that result in storage of moisture and reduction of runoff are considered the major rangeland support practices.

USING RUSLE

"The principal number that RUSLE computes is average annual soil loss, but it also displays a wide range of other values that provide insight into how conditions at the given site affect soil loss. For example, the amount of ground cover from the previous year's forage is one of those variables. Another important piece of output information is time in the vegetation growth cycle when the soil has reduced cover in relation to when erosive rains occur. If intense, erosive rains occur when the soil is relatively bare, and higher erosion rates can be expected. To control erosion means giving special attention to make sure that the ground has cover when the intense rains occurs."

—G. H. Foster & the RUSLE Development Team 1999

The RUSLE user's most important resource is the local NRCS office. The nearest office can be found in the phone book under the government listings. The District Conservationist and his/her staff are familiar with RUSLE's applications and the erosion science behind it, as well as with the strengths and weaknesses of both. They will be instrumental in helping the user to get the most meaningful information out of RUSLE. Once the local soil conservationist is contacted, he or she will visit the field site, meet with the land user, and discuss the needs and interests of the land user. The conservationist and the land user can develop a conservation plan together where site-specific conditions and the interests of the land user are given primary consideration (Foster et al., 1999).

The Agriculture Handbook No. 703, "Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE)" (Renard et al., 1997), provides maps, graphs, tables, and explanations of each factor of the equation, and is necessary to use RUSLE effectively. It is available at no cost while supplies last. Contact the USDA Agricultural Research Service, Southwest Watershed Research Center, 2000 East Allen Road, Tucson, AZ 85719, to receive a copy. You may also request it through the website http://www.sedlab.olemiss.edu/rusle/ or local NRCS office.

The RUSLE program available at the website is currently version 1.06b. It is free and can be downloaded for use. The website also provides a tutorial for practice. At some time in the near future, a new version of the program will be available, RUSLE 2 (Yoder and Lown, 1995). This version will be Windows-based, making it more flexible and easier to use. RUSLE 2 will also be backward compatible, meaning that it will accept information from earlier versions of RUSLE.

CONCERNS FOR APPLICATION

As there is a direct relationship between soil depth and plant growth, better soil conservation should be a management goal for rangeland managers. Soil loss is a valuable parameter to help gauge range condition and potential.

It is important to remember that RUSLE is only a model of the natural erosion process. It attempts to account for as many variables as necessary to make it practical for a wide range of land uses. In the case of its use for rangelands, however, studies conducted to examine RUSLE's accuracy showed that the soil loss estimates were considerably less than methods RUSLE is evaluated against (Weltz et al., 1987; Renard and Simanton, 1990; Benkobi et al., 1993). Their method of evaluation, single storm simulations, may or may not reflect an annual average as RUSLE is designed to estimate (Renard, 1999).

When applied for rangeland purposes, RUSLE is limited in its ability to account for a very large area. The natural variability of vegetative cover, soil types, topography, precipitation events, and other influencing factors within that area is inherently complex. Weltz, Kidwell, and Fox (1998) point out that the "distribution and connectivity of the bare soil interspaces and vegetation patches are more important than the absolute amount of bare soil in determining potential runoff and soil erosion rates." Research is needed to address the spatial distribution of bare soil and should be incorporated in later versions of RUSLE.

For the Arizona rangeland manager, a great concern for using RUSLE should be the limitation of slope length. Allotments in the tens and hundreds of thousands of acres would require many subsets of slope lengths under 1000 ft. to assure that results are meaningful. This would require detailed and careful design in the selection of slope lengths to estimate annual soil loss over a large area. Use of RUSLE on identified problem erosion areas may be more practical.

The other erosion simulator model developed for rangeland soil loss prediction is the Water Erosion Prediction Project (WEPP) model. WEPP is a process-based erosion simulation model (Nearing et al., 1989), with a continuous simulation option to reflect erosion over time. It is used to estimate soil loss per event, as opposed to giving an annual average soil loss like RUSLE. WEPP separates factors that influence soil erosion and other factors that RUSLE lumps together to calculate. WEPP can be effective on a field size of over 1,975 acres. According to Weltz, Kidwell, and Fox (1998), studies have shown the WEPP model to give good results in predicting runoff volume and peak discharge (Stone et al., 1992; Tiscareno-Lopez, 1994; Kidwell, 1994). However, observations of sediment yields using WEPP have been less consistent (Weltz et al., 1997; Mokhothu 1996).

The greatest limitation of the WEPP model for the general user is its complexity of variables to be estimated and entered by the user. Like RUSLE, it too is limited by slope lengths. The user needs to gather a great deal more on-the-ground information to use the model effectively, which may require substantially more time and expert assistance. According to scientist K.G. Renard, the WEPP model has proven so complex in its application that RUSLE will remain the primary tool for estimating soil loss for the foreseeable future (1999).

Ongoing research and revision of RUSLE is conducted primarily by the USDA Agricultural Research Service, NRCS, and associated Land Grant universities. Limitations to its universal usage, such as in the case of rangelands, are identified and research is conducted to resolve the problem or at least incrementally improve the accuracy of the equation's results. These advances in soil erosion science are then incorporated into the program.

CONCLUSION

The technology behind RUSLE has been developed over decades of research and field-testing by U.S. federal agricultural agencies and universities. Although it has limitations when used for rangeland applications, they are recognizable and assistance is available to overcome and/or interpret results to make RUSLE's estimates useful. Research is ongoing to improve the utility of RUSLE and address limitations for rangeland applications.

Because the RUSLE program is easy to use and resources to apply it are readily available, many rangeland managers should find it worthwhile to estimate average annual soil loss. It can provide an inexpensive but useful parameter to examine how management practices influence range use and soil conservation.

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A SUMMARY OF LIVESTOCK GRAZING SYSTEMS USED ON RANGELANDS IN THE WESTERN UNITED STATES AND CANADA

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[4]*This article was inspired by a presentation made by Dr. Bowns at the Arizona/Utah Range Livestock Workshop held in St. George and Kanab Utah, April 9–10, 1996. Dr. Bowns' presentation was entitled, "Animal Response to Grazing Systems." We acknowledge Thomas DeLiberto, Robin Grumbles, Kim McReynolds, and George Ruyle for reviewing earlier drafts of this manuscript.*

GLOSSARY OF TERMS AS USED IN THIS ARTICLE

Continuous grazing—grazing a particular pasture or area the entire year, including the dormant season (see season-long grazing).
Deferment—a period of nongrazing during part of the growing season (see rest).
Grazing system—planned effort by rangeland managers to leave some grazing areas unused for at least part of the year.
Rest—distinguished from deferment in that nonuse occurs for 12 consecutive months rather than just part of the growing season (see deferment).
Rotation—scheduled movement of grazing animals from one pasture to another.
Season-long grazing—grazing a particular area or pasture for an entire growing season (see continuous grazing).

INTRODUCTION

Specialized grazing systems were first conceptualized in the United States at the turn of the 20th century and became a major focus of range researchers and managers by the 1950s (Holechek et al., 1998). In the intermountain West, deferred-rotation received considerable attention during the 1950s, followed by rest-rotation during the 1970s. More recently, rangeland managers have used short duration grazing to more intensively control when and where domestic animals graze rangelands.

When properly applied, grazing systems are powerful tools that can help rangeland and livestock managers achieve management objectives related to rangeland and livestock production (e.g., forage production, average daily gain), as well as those related to ecosystem structure (e.g., wildlife habitat) and function (e.g., erosion control, water quantity and quality). However, selection of the proper grazing system is contingent upon the uniqueness of the setting in which it is applied (e.g., topography, soils, vegetation types, climate, etc.).

The objectives of this article are to provide an overview of the major grazing systems that have been used on rangelands in the western U. S. and Canada, to summarize the conditions under which they may be applicable (Table 1), and to highlight examples from the southwestern U. S. when relevant. Our discussion is largely a synopsis of Holechek et al.'s (1998) recent review of grazing systems (chapter 9), and of Vallentine's (1990) discussion of the same topic (chapters 13 and 14).

CONTINUOUS AND SEASON-LONG GRAZING

Continuous and season-long grazing are technically not grazing systems *per se* because there is no attempt to leave a portion of the range ungrazed by livestock for at least part of the growing season (see glossary). Some have speculated that desirable plants, particularly grasses, will be grazed excessively under continuous or season-long grazing. However, research does not support this view when proper stocking is implemented. With continuous grazing, stocking rate must be very light during the growing season because adequate forage must be left to carry animals through the dormant season. Under light stocking, animals are allowed maximum dietary selectivity throughout the year. For example, cattle and sheep preferentially select forbs (i.e., broad-leaved plants) during certain times of the year, which can greatly reduce grazing pressure on grasses. Rotation systems that restrict livestock from part of the range during the growing season can waste much of the forb crop because many forb species complete their life cycle quickly and become unpalatable after maturation. Another advantage of continuous or season-long grazing over rotation systems is that livestock are not moved from one pasture to another. Moving livestock too frequently can reduce animal production (weight gains, calf crops, etc.).

Continuous or season-long grazing works best on flat, well-watered areas (i.e., watering points no more than 2 miles apart) where precipitation occurs as several light rains throughout the summer, and where most plants have some grazing value (e.g., the shortgrass prairie, northern mixed prairies of the Great Plains). Continuous or season-long grazing has also worked well in the California annual grasslands where annual plants need only to set seed each year to maintain themselves, in contrast to perennial grasses that must store carbohydrates for use during dormancy and for use during the initiation of growth when dormancy breaks.

DEFERRED-ROTATION

Deferred-rotation grazing was first developed in 1895 and later implemented in the early 20th century by Arthur Sampson (the "father of range management") in the Blue Mountains of Oregon. Sampson's system involved dividing the range into 2 pastures with each pasture receiving deferment until seed set every other year. Several modifications of deferred-rotation have been used involving more than 2 pastures; however, its key feature is that each pasture periodically receives deferment (typically every 2 to 4 years, depending on the number of pastures).

According to Holechek et al. (1998), *plant response* for deferred-rotation grazing was superior to continuous or season-long grazing on Palouse bunchgrass ranges, mountain coniferous forest ranges, sagebrush bunchgrass ranges, and tallgrass prairie ranges. *Animal performance*, however, did not differ in studies comparing continuous, season-long, or deferred-rotation systems on Palouse bunchgrass (Skovlin et al., 1976) or coniferous mountain ranges (Holechek et al., 1987). In the tallgrass prairie, individual animal performance decreased with deferred-rotation compared to continuous grazing (Owensby et al., 1973), possibly due to lower forage quality (i.e., older, more mature forage) in the deferred pastures. However, grazing after seed set, when perennial grasses tend to be more tolerant to grazing, may allow higher stocking rates and compensate for lower gain per animal without damaging rangeland resources.

Deferred-rotation has been used as a tool to address seasonal preferences for riparian plant species exhibited by livestock. Seasonal deferment (and hence, seasonal grazing) can help sustain a balance of riparian species in some wetland areas by alternating grazing and browsing pressure on herbaceous and woody plants, which inhibits one life form from gaining a competitive advantage over the other. For example, deferment has been applied in the spring and early summer to reduce livestock use of riparian herbaceous plants such as grasses, sedges, and rushes, while summer and fall deferment has been used to reduce livestock use of riparian shrubs and trees (Swanson, 1987). Thus, deferred-rotation, as described here, draws on our knowledge of animal foraging behavior to exclude livestock from riparian areas during the season(s) in which they are most likely to preferentially overuse herbaceous or woody plants. This is important because riparian plant species are often cited as critical structural components of wildlife habitat for both game and non-game species (e.g., nesting and hiding cover; Kauffman et al., 1982; Chaney et al., 1990), and as playing a functional role in capturing sediment and dissipating erosive energy in streams (Riparian Area Management, 1993).

REST-ROTATION

The rest-rotation system was designed by Gus Hormay of the U. S. Forest Service and was first implemented in the 1950s and 1960s. Although the original system was designed to rotate grazing and rest periods among 5 pastures using 1 to 3 herds over a 5-year cycle (Hormay, 1970), other variations of rest-rotation have used 3 or 4 pastures in a 3- to 4-year cycle. Hence, under rest-rotation, 1 or 2 pastures are rested the entire year while the remaining pastures are grazed seasonally depending on the number of pastures and herds. For example, 1 pasture in a 3-year, 3-pasture rest-rotation might be managed as follows during a 3-year cycle: 1) Graze the entire year or growing season; 2) Defer, then graze; and 3) Rest. This schedule rests about 1/3 of the range annually.

Rest-rotation has shown superiority over continuous and season-long grazing on mountain ranges where cattle may heavily use riparian areas under all grazing strategies (Platts and Nelson, 1989). Rest provides an opportunity for the vegetation around natural or developed water to recover and helps meet multiple use objectives (e.g., providing hiding cover for birds and mammals, leaving ungrazed areas for public viewing and enjoyment). Hence, rest-rotation provides many of the advantages for riparian habitats discussed under deferred-rotation. Additionally, rested pastures provide forage for emergency use during severe drought years, and provide opportunities to implement relatively long-term rangeland improvement practices (e.g., burning, reseeding, brush control) during scheduled rest periods. However, a disadvantage of all grazing systems that periodically exclude livestock is that elk or other wild herbivores may graze “rested” pastures, negating some of the benefit of rest or deferment from livestock grazing (Halstead, 1998).

Other disadvantages cited for rest-rotation are reduced individual animal performance due to forced animal movements from pasture to pasture, and increased stocking density in grazed pastures, which can reduce dietary selectivity (Gray et al., 1982). However, this criticism may emanate more from failure to properly adjust stocking rates to compensate for resting 20 to 40% of the total grazing area each year, rather than a definite failure of rest-rotation. For example, research on mountainous range in northeastern Oregon showed that cattle weight gains per hectare or per animal did not differ among rest-rotation, deferred-rotation, and season-long grazing systems when utilization averaged about 35% for each system over a 5-year period (Holechek et al., 1987). The point to remember is that the benefits of a full year of rest can quickly be nullified if previously rested pastures are overgrazed, particularly in arid regions where frequent drought conditions can impede rangeland recovery (Cook and Child, 1971; Trlica et al., 1977).

SANTA RITA

The Santa Rita grazing system is basically a 1-herd, 3-pasture, 3-year rest-rotation system that was modified for midsummer rainfall and concomitant forage production patterns that typically occur in the hot semi-desert grasslands in southeastern Arizona (Martin and Severson, 1988). A 3-year rotational schedule for 1 pasture is as follows: 1) Rest 12 months (November to October); 2) Graze 4 months (November to February); 3) Rest 12 months (March to February); and 4) Graze 8 months (March to October). Each pasture receives rest during both early spring and "summer-monsoon" growing periods for 2 out of every 3 years, but each year's forage production is also grazed (first year's growth is grazed in winter). A full year of rest before spring grazing allows residual vegetation to accumulate which helps protect new spring forage from heavy grazing. Target utilization levels in grazed pastures are 30-40%. Martin and Severson (1988) concluded that the Santa Rita system promoted recovery of ranges in poor condition, but had little advantage over moderate continuous grazing on ranges in good condition.

SEASONAL SUITABILITY

A common practice of seasonal suitability grazing systems is to partition and manage diverse vegetation types that differ due to elevation, ecological site, ecological condition, or precipitation, and to move animals based on seasonal forage production in the partitioned vegetation types (Holechek and Herbel, 1982). Disparate vegetation types are typically fenced, but livestock movements can also be controlled by turning on (or off) watering points, the latter technique most commonly employed in the southwestern U. S.

In southwestern deserts, seasonal suitability systems use creosote bush (*Larrea tridentata*) and mesquite (*Prosopis* spp.) shrublands during winter and early spring, while tobosa grass (*Hilaria mutica*) and alkali sacaton (*Sporobolus airoides*) ranges are used during summer (or during spring with adequate moisture). Although creosote bush and mesquite dominated shrublands typically have little perennial grass understory, they may contain nutritious plants like 4-wing saltbush (*Atriplex canescens*), winterfat (*Ceratoides lanata*), and cool-season annual forbs, which are preferred by livestock when perennial grasses are dormant (Holechek and Herbel, 1982). Tobosa grass and alkali sacaton are comparatively less nutritious during dormancy, and more efficiently utilized by livestock when they are actively growing. Pastures dominated by Lehmann lovegrass (*Eragrostis lehmanniana*), a warm-season grass introduced from South Africa, can also be used in this system to relieve summer and early fall grazing pressure on native perennial grasses.

Seeded introduced grasses may be an important component of other seasonal suitability systems because of their ability to provide forage both earlier and later than native range. For example, rotating livestock through native range in summer, crested wheatgrass (*Agropyron cristatum*) pastures in spring, and Russian wildrye (*Elymus junceus*) pastures in the fall more than doubled grazing capacity in Alberta (Smoliak, 1968). Seasonal suitability has also been used on mountain ranges in the northwestern U. S. where grassland (south-facing slopes), forest (north-facing slopes), and meadow (riparian) vegetation types provide late spring/early summer use, late summer/early fall use, and fall grazing, respectively (Holechek and Herbel, 1982). In Utah, seasonal suitability has been practiced where desert (winter use), foothill (spring use), and mountain ranges (summer use) are managed as separate, seasonal grazing units (Cook and Harris, 1968).

BEST PASTURE

Because summer rainfall in the southwest U. S. usually comes in the form of intense but isolated thunderstorms, summer moisture patterns are typically spotty and unpredictable. It is not uncommon for areas of a ranch separated by only a few miles to vary greatly in the amount of precipitation received from a storm event. The best pasture grazing system, as originally proposed by Valentine (1967), attempts to match cattle movements with irregular precipitation patterns and associated forage production without regard to a rigid rotation schedule. For instance, when a local rain event causes a flush of annual forbs in a particular pasture, cattle are moved to that pasture, and then moved back to the previous pasture once acceptable utilization levels of the ephemeral forb resource have been achieved. On the other hand, if a pasture that is tentatively scheduled for grazing continues to miss localized rainstorms while another pasture continues to receive moisture, the rotation schedule for the two pastures could be flip-flopped. Because livestock movements are not rigidly timed to a particular timetable, the best pasture system requires that land managers command a mindset of high flexibility.

The best pasture system may also be timed to match seasonal forage quality changes across ecological sites, and thus, embraces some elements of the seasonal suitability system. For example, pastures containing black grama (*Bouteloua eriopoda*) as the primary forage species may be deferred until the dormant season when it is higher in protein compared to pastures dominated by blue grama (*Bouteloua gracilis*) or hairy grama (*Bouteloua hirsuta*). Because black grama is relatively less resistant to grazing than many other perennial grasses, winter grazing has less impact on this species than use during the growing season. This approach works best when some of the pastures in the "rotation" contain winter annuals and palatable shrubs.

As with the seasonal suitability grazing system, the best pasture system may involve turning on (or shutting off) watering points in grazed (deferred or rested) pastures. Cattle learned within a year to follow active watering points on a 3,160-acre ranch in southeastern Arizona (Martin and Ward, 1970). Because localized heavy grazing around watering points was controlled during Martin and Ward's eight-year study, perennial grass forage production nearly doubled with the best pasture system compared to continuous grazing.

SHORT DURATION

Short duration grazing differs from other specialized systems in that a grazing area is typically divided into several small pastures (also called paddocks or cells), each of which may receive *more than one period* of nonuse *and* grazing during a single growing season. The number of nonuse and grazing periods depends on the rate and amount of forage produced within each pasture. Short duration grazing commonly uses 5 to 12 pasture units in which there are grazing periods lasting from 3–14 days. Pasture rotations may be conducted more frequently during periods of rapid growth and less frequently during periods of slower growth. A grazing period is followed by a variable nongrazing period of up to 60 days to allow for forage regrowth. The actual duration of each pasture's nongrazing period depends on growing conditions.

Proponents of short duration grazing maintain this system benefits rangeland resources and domestic livestock production in several ways when properly implemented, including: improved soil water infiltration and increased mineral cycling due to animal impact (e.g., "hoof action"), increased photosynthesis that provides longer periods of available leafy forage to livestock, improved animal distribution and plant utilization, reduced percentage of ungrazed "wolf" plants, lower labor costs, better individual animal performance, and improved rangeland condition. The most attractive contention of short duration grazing to livestock producers is that higher stocking rates and stock densities can be used because of the "shorter duration" of grazing and more intensive management.

Rangeland research indicates that managers should carefully consider several factors before investing in a short duration grazing system, particularly in arid regions (see Holechek et al., 1998, 2000, for recent reviews of short duration grazing research). Arid areas typically have short growing seasons (less than 60 days) due to low precipitation levels, cold weather, or both; this minimizes the positive aspects of repeated periods of heavy defoliation followed by nonuse, especially when inadequate growing conditions (e.g., drought) can limit the regrowth potential of heavily grazed plants. Concentrating a large number of animals in smaller pastures that have recently received high intensity storms can cause soil compaction and decrease infiltration rates. Increased trail density around water has been problematic in pastures that have been partitioned around a central watering point. Short duration grazing usually calls for extra labor for herding and large amounts of fencing to partition a large grazing area into smaller grazing areas because it is more costly to fence arid rangelands (less forage/unit area = more fence needed) than more productive areas (more forage/unit area = less fence needed). Frequent pasture rotations can take a toll on animal production measures and care must be taken to prevent mother-dam separations during livestock movements. Finally, there is simply less room for error in arid regions to decide when animals should be moved or destocked; failure to move animals at the correct time or to destock during drought can cause long-term damage to desert grasses.

Holechek et al. (1998) asserted that short duration grazing works best on flat humid areas that have extended growing seasons (at least 3 months), greater than 20 inches of average annual precipitation, and an average annual forage production of greater than 2000 lbs./acre. However, the same authors identified 2 cases where short duration grazing might be successfully used in arid areas: 1) in flat, low-lying areas with deep, productive soils that collect water runoff from less productive upland areas, and 2) on exotic grass seedings (e.g., Lehmann lovegrass, crested wheatgrass) where grazing resistance and capacity may be higher than native rangeland.

SOME FINAL THOUGHTS ON GRAZING SYSTEMS

- There is an infinite combination of climates, soils, topography, and vegetation types that occur across the western U. S. and Canada, which makes choosing the "correct" grazing system a challenge. No grazing system will work everywhere, or, as Dr. William Krueger from Oregon State University puts it, "every grazing system will fail somewhere." The system you choose must be tailor-made to your unique situation (Table 1).

- Implementing a grazing system does not eliminate the need to heed basic principles of grazing management (stocking rates, season of use, frequency of use, kind or mix of animals, animal selectivity, etc.).

- Grazing systems require greater, rather than less management input, compared to continuous or season-long grazing. Increased attention to range and livestock *management* (see next point) may often be a primary reason for the success of a particular grazing system.

Table 1. Distinguishing features of grazing systems used in the western United States and Canada, and situations where they may be applicable (see text for details).

Type of grazing system	Distinguishing features	May be applicable when you have…
Continuous or Season-long	Continuously graze an area the entire year (continuous), or the entire growing season (season-long). These are not grazing systems per se (see text).	…flat, well-watered rangeland, where most plants have similar grazing value, with a uniform precipitation pattern that encourages regrowth. …also, may be applicable in some areas of the California annual grasslands.
Deferred-rotation	Periodically defers each pasture in the rotation. Animals are rotated through the other pastures on a seasonal basis.	…distribution problems where animals habitually overuse "convenience areas" (e.g., riparian areas), or where there are multiple use objectives.
Rest-rotation	Periodically rests each pasture in the rotation for 12-months. Animals are rotated through the other pastures on a seasonal basis.	…generally, same criteria as deferred-rotation.
Santa Rita	Modification of the rest-rotation system to where each pasture receives rest during both the early spring and "summer-monsoon" growing periods 2 out of every 3 years.	…semidesert grassland where forage production is irregular and heavily influenced by midsummer 'monsoons' and winter precipitation.
Seasonal suitability	Diverse vegetation types are partitioned and grazing rotation is managed based on seasonal changes in forage production.	…diverse vegetation types that can be partitioned and managed as separate units based on seasonal differences in plant phenology, forage quantity, and forage quality.
Best pasture	Matches cattle movements to vagaries of forage production due to irregular precipitation patterns or disparate range (ecological) sites.	…irregular forage production due to spotty precipitation patterns, or grazing areas that require special management due to species differences in forage production and/or resistance to grazing.
Short duration	Frequently rotates a single cattle herd through multiple, smaller pastures allowing for relatively brief periods of rest in previously grazed pastures. Use levels are typically heavy due to increased stocking rates and stock densities.	…generally, the same criteria as for continuous and season-long (but see text). This system typically requires more capital investment and labor than other grazing systems.

- Animal distribution tools such as riding (Budd, 1999), proper placement of nutrient blocks (Martin and Ward, 1973), selective culling based on animal behavior characteristics (Howery et al., 1996, 1998), range improvements (burning, reseeding, water developments), and control of access to watering locations (Martin and Ward, 1970) should be implemented in ways that complement the intended management outcomes of grazing systems.
- Flexibility is the hallmark of successful range management in arid regions. Strict adherence to animal numbers and livestock movement dates without regard to vagaries in forage production can be counterproductive to both rangeland and livestock production. Adjust stocking rates and rotation dates so that livestock numbers are in balance with forage supply (Howery, 1999).

- Rangeland monitoring is critical to document both successes and failures of grazing systems and other management activities (Smith and Ruyle, 1997). Rangelands are extremely variable in the kind and amount of vegetation they are capable of producing. This variability is apparent across the land (space) and across the years (time) as anyone who has spent time on a ranch knows. Monitoring techniques are available to help you determine how much variability you can expect on your ranch across both space and time. Monitoring data are really the “proof of the pudding” as to whether your grazing system and management practices are accomplishing your goals and objectives (Smith and Ruyle, 1997).

- Evaluate a new grazing system over a period of 6–12 years so that several weather cycles can be evaluated (Martin, 1978). This prevents erroneously assigning success or failure to a new grazing system when abnormally high or low precipitation years may be the primary cause.

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SPECIALIZED LINES FOR BEEF BREEDING HERDS

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UA RESEARCH

Research conducted by The University of Arizona Animal Sciences Department indicates that the use of specialized sire and dam lines could improve productivity of commercial beef breeding herds.

This conclusion is based on an experiment which compared the breeding performance of topcross progeny of three inbred sire lines with each other and with an outbred control herd. Comparisons involved birth weights, weaning weights, and weaning conformation and condition scores of 400 bull and heifer calves. The cattle were from the registered Hereford herd owned by the San Carlos Apache Indian Tribe. The herd is maintained approximately 60 miles east of Globe, Arizona, on a semi-arid range at an elevation of approximately 5,000 feet. The breeding season normally extends from May 1 to August 1, and calves are weaned and evaluated in October or early November. No supplement was provided for cows and calves during the period of this study.

The topcross parental stock involved in this study were the progeny of eight sires from three inbred lines (1, 6 and 9) of the U.S. Range Livestock Experiment Station, Miles City, Montana.

Since some of these lines have become very popular in the beef industry, a brief history of their development is presented.

Line 1 cows traced back to stock purchased in 1926 from George M. Miles of Miles City, Montana. Most of the foundation cows were sired by Colonel Perfection and his two sons, Colonel Grayfield 2nd and Colonel Defender 3rd, and two other bulls, Domino Perfection 3rd and Blanchard 40th. These cows were mated to two half brothers, Advance Domino 20th and Advance Domino 54th, purchased from a Colorado breeder. The first calves were dropped in 1934, and the line has remained closed to outside breeding since that time.

Line 6 was initiated in 1948 with the purchase of 30 heifers and two bulls of Real Prince Domino breeding from a Nebraska breeder. The foundation sires were Perfect Lad 18th and Maude's Mischief 19th. The first calves were dropped in 1949.

Line 9 resulted from twenty-eight head of heifer calves and one bull calf of King Domino breeding purchased from a Montana breeder in 1948. The foundation sire of this polled line was Seth Domino. The first calves were dropped in 1951.

Of the original sires (grand-sires of the calves included in this study), four were from line 1 and two each from lines 6 and 9. Parents designated SC (San Carlos) were the progeny of 30 purebred sires originating within the herd. With the exception of the control matings (SC X SC), the parental stock was composed of 50% SC breeding and 50% of the respective line involved in the topcross mating. Topcross sires were chosen from those available to be as representative of the group as possible. The number of sires used were:

L1 X SC-2	L9 X SC-2
L6 X SC-2	SC X SC-3

Results from the experiment are presented in Table 1. Birth weights of the calves averaged 74 lbs., with minor differences among the various breeding groups. Heaviest calves at birth included line 9 cross cows mated to San Carlos bulls, whereas the lightest calves were from San Carlos cows mated to topcross line 9 bulls.

Substantial differences occurred in weaning weights. The heaviest calves were produced by topcross line 6 cows mated to San Carlos bulls (514 lbs.). Surprisingly, the reciprocal cross (line 6 topcross bulls on San Carlos cows) resulted in calves that were among the lightest (469 lbs.). A difference of this magnitude (45 lbs.) has some important implications. First of all, it indicates that factors associated with the cow (maternal ability) are more important under Arizona range conditions than the genetic potential of the calf in determining growth of the calf to weaning. This probably reflects differences in the milking ability of the cow. Secondly, it suggests that there may actually be an antagonism between preweaning growth and maternal ability. Additional evidence for this antagonism is seen in the results of crosses involving line 1. Although the differences between the reciprocal crosses is not as great in this case (16 lbs.), it is still large enough to be of economic importance.

Table 1. Birth and Weaning Traits by Line of Breeding

Sire Line		Dam Line	Birth Weight	Weaning Weight	Conformation Score[a]	Condition Score[a]
			(lbs.)	(lbs.)		
1	X	SC	74	476	11.1	10.5
6	X	SC	76	469	11.1	10.5
9	X	SC	73	470	11.1	10.8
SC	X	1	76	492	11.5	11.1
SC	X	6	74	514	11.8	11.1
SC	X	9	76	466	11.3	10.9
SC	X	SC	75	479	11.4	10.8
	Average		74	479	11.3	10.8

[a] Evaluated on a 15 point scale, with higher values indicating more desirable conformation or greater condition. A condition score of 11-12 is considered optimum.

Conformation and condition scores are also listed in the table. In general, the results followed the same trends as noted for weaning weight. Higher scores were observed when these inbred lines were used in the cow side of the cross. All of the values would be considered very acceptable for Hereford calves at weaning.

These results indicate that two (1 and 6) of the three inbred lines tested were much more valuable when incorporated into cows than in bulls. This would mean that different criteria for selection of bull and heifer calves at weaning would be the most efficient system. A natural outgrowth of this procedure would be a breeding program using specialized sire and dam lines for commercial beef production.

One of the more effective methods of developing specialized lines is through crossbreeding. Breeds of cattle often excel in different desirable traits. These same traits are present within different lines of the same breed of cattle, but the differences are normally not as great as between breeds and thus are more difficult to identify. Desired traits for brood cows are early puberty, high fertility, ease of calving, adequate milk production, adaptability, a strong mothering instinct, etc. Oftentimes large mature size or weight is a disadvantage in the cow herd, especially on southwest ranges. The bull's major contribution is in size and weight as reflected by growth rate of his calves. Other traits are also important, such as the ability to travel, libido (sex drive), desirable muscling, relatively small calves at birth, etc.

One example of such a crossbreeding program is the "terminal sire" system. All of the cows are crossbreeds developed from two (or more) breeds selected specifically for maternal characteristics and adaptability. Bulls are selected from a breed differing from those in the cow herd with primary emphasis on growth and carcass characteristics. All calves produced go to market, hence the term "terminal sire." Research results indicate an increase of approximately 25% in pounds of calf weaned per cow with this system.

The use of specialized sire and dam "lines," either within a breed or through the use of different breeds, provides the breeder with a technique to substantially improve production.

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BULL SELECTION

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One of the most important decisions that a cattle producer makes is the selection of bulls for his cow herd. Bulls contribute half of the genetic material for the cow herd. If replacement heifers are selected from within the herd, the bull will influence the production of the herd for up to 10 years or more.

BASIS FOR BULL SELECTION

Bulls are selected for their genetic potential. It is difficult to determine genetic values of bulls since the outward appearance (phenotype) are a result of both genetic potential and the conditions under which the animal was developed (environment). Nutrition, climate, diseases, parasites and insects plus weather conditions influence the outward appearance of the bull. Where possible the animal should be compared with other animals within the same herd and should be raised under conditions similar to those which he is expected to perform. However, the genetic value of bulls can be determined and compared with bulls throughout the country because of the sire record systems of the purebred beef cattle associations.

INDIVIDUAL EVALUATION

The genetic value of a bull can be estimated by his own performance. In addition, the physical attributes he expresses visually will aid in selection. Genetic values are often available that take into account the performance of his sire, dam, grandsire, granddam, herdmates and brothers and sisters. The genetic evaluation is called Expected Progeny Differences (EPD).

For Bull Selection, a breeder should establish goals for his own herd, evaluate herd strengths and weaknesses and select bulls which will improve the production and genetic merit of the herd. Selection has to include a realistic appraisal of the resources available to support the cow herd and growth of calves.

There are three major categories of bulls needed for commercial beef production.

1. Maternal bulls for use on heifers.
2. Maternal bulls for use on cows.
3. Terminal bulls for use on cows.

One or all of these categories may be useful in a breeding program based upon the goals of the manager and the quality and quantity of feed resources provided by the ranch.

EDP values may be used to achieve desired production goals. However, EPD's for many desirable traits are not available. A listing of important traits for which information may be available is given in Table 1.

Table 1. Traits for Selection of Bulls Based Upon Function

Trait	Maternal Bulls For Heifers	Maternal Bulls For Cows	Terminal Bulls For Cows
Scrotal Circumference	Large	Large	Medium-Large
Pelvic Area	Large	Large	Not Important
Calving Ease	High	High	High
Birth Weight	Low	Medium	Medium
Weaning Weight	Match	Match	High
Milk	Match	Match	Not Important
Total Maternal	Match	Match	Not Important
Yearling Weight	Match	Match	High
Carcass Percent Protein	Conflict	Conflict	High
Carcass Quality	High	High	High

Where match is listed, the bulls selected should be matched with the resources available on the ranch. Matching is illustrated in Table 2.

Table 2. Matching Bulls to the Resources

Mature Size	Milk Level	Availability of Food from Grazing: Low	Medium	High
L	H	-	0	+
L	M	-	+	+
L	L	0	+	+
M	H	-	-	+
M	M	-	0	+
M	L	-	+	+
H	H	-	-	0
H	M	-	-	0
H	L	-	0	+

\+ = Matching mature size and milk production with resources.
0 = Risky, extra feed may be necessary or fertility and production may be affected.
\- = Avoid the combination, production will be unsatisfactory.

High levels of milk production require more feed resources. An increase of 5 lb. in milk production increases energy required by 15%, protein required by 21% and minerals (calcium and phosphorus) by as much as 37%.

Larger cattle require more feed. An increase in mature cow size from 1000 to 1200 lb. results in a 15-20% increase in the maintenance requirement.

Most of the genetic traits available from performance records and EPD's are based upon increases in the weight and growth of cattle. If we all select for size increases, the result may be a mis-match of resources to support the herd, loss of maternal factors affecting fertility and a reduction in the efficiency of production. Excessive size is not desired by the meat industry, therefore, requirements for the final product must be involved in selection.

Size affects weight required for puberty, successful reproduction and desirability of the final product. For example, a 1400 lb. cow will produce heifers that will not reach puberty until they weigh 900 and steers that will not grade choice until they reach a weight of 1300 lb.

Heifer development and fertility are important and resources normally available will not produce the desired puberty of large animals at a young age. Cattle feeders, packers and retailers do not desire excessively heavy cattle. Therefore, sire selection has to be matched with the resources available, maternal efficiency of heifers produced and the product desirable to feeders, packers, retailers and consumers.

Breeding systems to achieve productivity, fertility and a desirable final product can be classified into three systems.

1. **All purpose:**

   Cow size and milk production are matched with feed resources and bulls of the same biological type are selected. Replacement will have similar desired attributes as the cow herd.

2. **Combination:**

   Cow herd size and milk production matched to the feed resources. Replacements are produced by mating bulls with maternal desirability with heifers and young cows.

   Mature cows, 4 years old or older, are mated to terminal sires, all calves are sold.

3. **Terminal Sire System:**

   Matched cows are mated to large bulls. All calves are sold. Replacements are purchased or bred separately.

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RANGE BEEF HERD GROWTH SELECTION

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A major economic goal of the cattle producer and others in the beef industry is the genetic improvement of growth traits in range cattle. Superior genetic growth potential is reflected in improved feedlot efficiency and carcass desirability. These factors make it imperative that the cattle producer use accurate objective measurements and selection methods to identify the superior genotypes in his herd.

The growth performance of range beef cattle in areas of year-long grazing reflects forage availability as well as climatic stress conditions. Because annual rainfall and temperature patterns in an area directly influence quantity and quality of range forage, all range stock are subjected to varying periods of feed or nutrient restriction. Live weight and body measurement data show that with only range feed available, growth in weight is strictly seasonal from weaning to maturity.

A successful selection program for improvement of performance traits in beef cattle depends on selection for a specific trait and understanding how selection for one trait may influence other traits. The major purpose of the study to be described was to obtain information on genetic parameters of growth of range beef cattle under a practical management system. This information should be directly applicable to a performance testing program for the range cattle producer.

MATERIALS AND METHODS

Data were obtained from the registered Hereford herd owned and maintained by the Apache Indian Tribe at San Carlos, Arizona. With the initiation of the study, individual breeding pastures were developed for the registered herd. Each pasture carries 30 to 35 cows and averages about 600 acres in size. Cows were allotted to the breeding pastures in January for calving during the following three months and remained in the individual pastures through the breeding periods, May 1 to July 30.

The general range area is at an altitude of 5,000 feet, with range forage consisting primarily of desert grassland vegetation. Annual rainfall averages about 14 inches with most of it occurring during the summer months of July and August. Temperatures may range from -20°F in January to 95°F in July.

Individual data recorded at birth included identification, birth date and weight. The calves were ear tattooed with individual identification numbers. During the nursing period pertinent comments concerning unusual maternal or calf information that could affect performance were noted.

In the fall all cows and calves were brought to corrals for weaning. The calves were weighed and individually scored by three judges for conformation and condition.

Bulls and heifers were maintained separately after weaning. Subsequent weights and scores were obtained in the early spring (about March 1) before the appearance of new range forage, again in the fall at weaning time and the following spring. Thus, four stages of development were represented, with an average mean age at each stage of 8, 11, 20 and 23 months. Records from more than 1,500 calves were utilized in this 10-year study.

None of the bull calves were castrated during this period. The herd was maintained on a year-long grazing program with little, if any, supplementation. It should be noted that during the more severe winters of the test period snow cover remained on the ground for several days at a time.

Sires used in the herd during the years of this study came from many different sources. They included purebred herds from Arizona and surrounding states, the Arizona Agricultural Experiment Station, United States Department of Agriculture performance tested lines, and bull progeny produced in the herd.

RESULTS

Average weights and the heritabilities of the weight at each age are summarized in Table 1. Only the bull calves are included in this report, although similar results were obtained with heifers. The average weaning weight of 480 lbs. at an average age of eight months translates into a daily gain from birth to weaning of 1.7 lb. This emphasizes the importance of having cows calve early in the season, as one month's difference in birth date resulted in an average difference of 50 lb. for the calf at weaning.

Table 1. Average Weights and Heritabilities

Age	Weight (lbs.)	Heritability Percent
Birth	76	50
Weaning	480	15
340 days	440	30
600 days	825	50
710 days	700	50

The weight losses that occurred over the two winter periods (weaning to 11 months and 20 to 23 months of age) should be very typical of unsupplemented range cattle in Arizona and many other parts of the world. It is not uncommon for animals to lose 10% or more of their weight from fall to spring under these conditions.

The highest values for heritability (50%) were for birth weight, long yearling weight (20 months) and weight as coming two-year olds.

The lowest heritability was for weaning weight (15%), with short yearling weight having a heritability of 30%. Many times the meaning of heritability is misunderstood. Probably one of the best ways to use a heritability value is in predicting how much improvement can be made when selecting for a particular trait. As an example, assume we selected replacement bulls and heifers in this herd that averaged 50 lb. above the weaning weight for the herd. We call this value (50 lb.) the selection differential. If we mate these replacements together, then we would expect their calves to have an average weaning weight 15% (heritability) of the selection differential (50 lbs.) above the herd average (480 lb.). In this case, that would be 15% x 50 lb. + 480 = 487.5 lbs. Obviously, the higher the heritability value for a trait, the more improvement we will make in the process of selection.

The major questions posed in this study were (1) what effect does selection for a specific trait have on other traits, and (2) when would be the "best" time to select replacement animals. To help understand Table 2, let's consider the information on the first line. In this case, we are selecting only for heavier birth weights (which we probably would not do). If this were the actual situation, birth weight would be increased by 5 lb. per generation. Due to what we call the correlated response, the other weights would also increase. In this example, selection for birth weight would also result in weaning weight increasing by 4 lb., yearling weight by 5 lb., and 20 and 23 month weights by 10 lb. each.

Table 2. Direct and Correlated Response to Selection

Trait Selected For	Change in Weight (lb.) At: Birth	Weaning	11 months	20 months	23 months
Birth weight	5	4	5	10	10
Weaning weight	1	6	7	9	8
11 month weight	1	7	12	13	15
20 month weight	2	7	11	25	22
23 month weight	2	6	12	22	25

If we are primarily concerned with weaning weight, we would expect to improve it by 6 lb. per generation if we selected directly for it. However, we can make just as much (or more) improvement in weaning weight if we select for weights measured later in life. This may not seem reasonable, but it is due to three factors: 1) the heritability of weaning weight is low; 2) the heritability of yearling or two-year old weights is higher; and 3) the correlation between the latter traits and weaning weight is high. The weight taken at long-yearling age (20 months) appears to be "best" when we consider both preweaning and post-weaning gain performance, as it is the youngest age which results in a near-maximum improvement of all traits. One possible disadvantage of selecting for this weight is a greater increase in birth weight than we would expect by selecting at weaning time. To overcome this problem, we could use an index which selects against heavier birth weights and at the same time selects for heavy long-yearling weights. One index that has been suggested is 1 = Y - 3.2B, when 1 = index value, Y = yearling weight, and B = birth weight. As compared to selection on yearling weight alone, this index would reduce the expected increase in birth weight by 55% while reducing the improvement in yearling weight by only 10%. Thus, near maximum improvement can be made in growth rate while minimizing the usually undesirable increase in birth weight.

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ESTRUS SYNCHRONIZATION AND ARTIFICIAL INSEMINATION FOR BREEDING BEEF CATTLE

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Artificial insemination of cattle has proven to be very effective for the improvement of the genetic potential for production. In dairy production, over 80% of all cattle are now bred artificially. The success of dairy producers in improving milk production has been impressive. A large proportion of the success is due to improvement of the genetic potential of dairy cattle through use of outstanding sires by artificial insemination.

Artificial insemination in beef cattle has had limited use. The management necessary for success has limited its application primarily to seed stock producers. One of the main barriers to use in commercial beef cattle operations is the time and labor necessary for detection of estrus (heat) and insemination at the proper time during heat.

This barrier has been effectively removed with the availability of methods to synchronize heat. With estrus synchronization groups of cattle can be induced into fertile heat and bred at a specified time following initiation of the heat period. The success of this program is based upon a total management program. **Synchronization will not improve cattle fertility.** In fact, it is difficult to achieve fertility levels similar to those resulting from natural mating. For success, a total fertility management program is necessary.

KEY ELEMENTS OF FERTILITY MANAGEMENT

There are three groups of animals which need to be considered separately:

1. *Replacement heifers*
2. *Young cows with their first calf*
3. *Mature cows, having 2 or more calves*

Replacement Heifers

If the goal is to breed the replacement heifers at 12-14 months of age, a special heifer development program is essential. Some general rules apply:

1. They must be at least 12 months old or preferably older at breeding.
2. They must weigh at least 650 lb at breeding.
3. They must have a body condition of 5 or higher at breeding.

When replacement heifers are selected, usually in the fall, plans for the development program must be made.

1. Evaluation of heifers in the fall:

   An estimate of the age, weight and condition of the heifers is required so that the heifer development plan can be made.

   For example: For a heifer, born in March/April and weaned on or about 1 October, the following calculations should be made:

Weaning weight	500 lb
Age at weaning	6 months
Target weight breeding season	650 lb
Gain necessary to meet target wt.	150 lb
Breeding date desired	1 May
Days weaning to breeding	211 da
Average daily gain to breeding	0.75 lb/day

   Nutrition required to achieve target weight:

Generally the nutrients which are most likely to be required for growth and development are protein, energy and phosphorus.

Requirements for the desired gain are:

Protein	lb/day	1.5		
Energy	lb TDN daily	10.0		
Phosphorus	Daily	14.0g	.03lb	.5 oz

In alfalfa hay equivalents the heifers would require:

Alfalfa hay 16% protein, 52% TDN, .25%P	
For protein requirement	9.4 lb daily
For TDN requirement	19.2 lb daily
For phosphorus requirement	12.0 lb daily

The heifers would have to eat 19 lb alfalfa hay daily to meet energy (TDN) requirements. At the weight and age of our example, they would not likely eat 19 lb. Therefore, to ensure desired performance, a better energy source would be necessary.

For our calculations, we will feed an average of 9 lb alfalfa hay daily and choose a good energy source for the rest of the ration:

For example:

1. *Corn at 80% TDN to supply required energy:*

TDN required		10.0	
TDN from hay 9 lb x .52	=	4.7	
TDN needed from corn		5.3	
Lb corn = 5.3/0.80	=		6.6 lb corn daily

Ration for heifers:

9 lb alfalfa hay
6.6 lb corn
15.6 lb Total

2. *Whole cottonseed at 90% TDN to supply energy:*

5.3 lb TDN required/.90 TDN cottonseed = 6 lb cottonseed daily

Ration for heifers:

9 lb alfalfa hay
6 lb cottonseed
15 lb daily ration

Heifers, pregnant with first calf in the fall.

Evaluate weight and condition of heifers in the fall. Condition is the most important indicator of management needs prior to calving and rebreeding for second calf:

In fall, condition of these heifers should be at least 5-6. During winter, without extra feed, except range forage, they would be expected to lose weight and at least one condition score. If the condition score at breeding in the spring is 4 or less, the fertility in the breeding season will be lowered. At fall evaluation, you can anticipate whether or not supplements may be required during late pregnancy and into the breeding season for this group. If fall condition appears to be marginal, supplements begun 1 month prior to calving and into green feed following calving should be planned.

It takes about 80 lb gain in weight to improve 1 condition score. Cattle will not usually gain weight during the winter and most likely will lose weight on range forage. Heifers should be handled separately, if possible, and wintered on the best winter range. A second condition evaluation about 1 month prior to calving should be made and supplements of PEP planned if needed. If a gain of 80 lb is needed (1 condition score) two months prior to the breeding season, the animals would have to be fed to gain 1.3 lb per head daily. For this gain the requirements are as follows:

	Last 1/2 Pregancy	Lactation/Breeding
Protein (lb/day)	1.7	2.0
TDN (lb/day)	10.0	12.0
Phosphorus (g/day)	19/0	25.0
Again, alfalfa hay required lb/day		
Protein	10	12.5
TDN	18	22
Phosphorus	16	24

It would require about 20-25 lbs alfalfa hay daily which could be provided and eaten. However, a combination of hay plus an energy source could be superior.

For example: Feed 10 lb alfalfa daily

TDN required	12
TDN from alfalfa	5.5
TDN from energy source	6.5 lb

With corn 6.5/.82 = 8 lb corn daily

Ration: 10 lb alfalfa hay
8 lb corn

With cottonseed
6.5/.9 = 7 lb cottonseed daily

Ration: 10 lb alfalfa hay
7 lb cottonseed

The ration to be fed approximately 1 month prior to calving up to greenup.

Much less feed would be required if the cows were condition score 4 or higher just prior to calving. Ideally condition would hold up from the fall without more than a supplement containing PEP fed at 3-4 lb/head daily, 1 month prior to calving and up to greenup.

Mature cows, age 2 or more in the fall.

Fall condition score should be 5 or greater.

Generally extended feeding of the cow herd should not be necessary except for unusual years where summer/fall range growth and quality is limited by drought. An evaluation of the condition of the cows and of the quantity of forage available in the fall should help you to anticipate potential fertility problems the next spring. A minimum supplement of 1-2 lb. daily may be required if the range is primarily grass. Supplements should be fed based upon cow condition and nutrient content of the range forage.

Generally: cows will not gain weight or condition in the winter. Therefore, fall condition evaluation will identify potential problems and culling/supplementation decisions made accordingly.

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CROSSBREEDING SYSTEMS FOR ARIZONA RANGELANDS

Jim Sprinkle[1]

INTRODUCTION

Thirty years ago, price discounts were applied to ranchers' calves resulting from crossbreeding. Beginning in the 1970s, crossbreeding became popular with many different breeds being imported into the United States over the next fifteen years. Research and ranch records have shown an increase in production through the use of crossbred cows. The use of crossbred cows has been shown to increase overall lifetime production by 25%. At Clay Center, Nebraska, 50% of crossbred cows have been shown to be still in production at age 7. Clay Center also reported that the crossbred cow stays in the herd 1.3 years longer than the straightbred cow.

The establishment of any new breed of livestock is always accompanied by a certain amount of inbreeding depression which reduces conception and survival. Properly managed (no large breed sires on small framed, young cattle), crossbreeding restores to cattle populations some of the fitness which was lost during breed development. The largest advantage seen with crossbreeding is with less heritable traits such as reproduction and cow longevity. Little advantage will be seen with highly heritable carcass traits. The advantage expressed by crossbred cattle over the average of both parents is referred to as hybrid vigor or heterosis. For example, assume Hereford (H) calves weigh 450 lbs. at weaning and Angus (A) calves weigh 400 lbs. The F1 cross calves weigh 440 lbs. for Angus x Hereford (AH) and 450 lbs. for Hereford x Angus (HA). Heterosis for the above example is 5%, using the formulas below from the 1988 publication *Crossbreeding Beef Cattle for Western Range Environments TB-88-1* (Kress and Nelson, 1988).

Amount of heterosis =

$$\frac{AH + HA}{2} - \frac{A + H}{2}$$

or

$$445 \text{ lbs.} - 425 \text{ lbs.} = 20 \text{ lbs.}$$

Percent of heterosis =

$$\frac{\text{amount of heterosis}}{\frac{A + H}{2}} \cdot 100$$

or

$$\frac{20}{425} \cdot 100 = 5\%$$

As Kress and Nelson mention, "heterosis can be positive or negative and there can be positive heterosis even when one of the parental breeds performs better than the average of crossbreds."

MATCHING THE ENVIRONMENT

There are three major areas in which one would wish to utilize heterosis: maternal traits, growth traits, and carcass traits. Maternal traits are those which relate to milking ability, conception, and mothering ability. Growth traits include average daily gain, which in turn influences yearling weight. Carcass traits are related to lean product yield and quality grade. Commercial cattle ranchers commonly seek maternal heterosis by using the crossbred cow with her increase in total lifetime production. As mentioned above, carcass heterosis is not large (0 to 5%), but is commonly practiced by utilizing lean muscle breeds such as Limousin and Charolais in terminal sire breeding programs. These fast growing, heavily muscled sires are used with smaller adapted females that are 4 years old or older and all offspring are sold. Also, carcass heterosis is sometimes sought

Table 1. Breed Comparisons in the Germplasm Evaluation Program at Meat Animal Research Center (MARC)

Breeds Grouped into Biological Types for Four Criteria[a]				
Breed Group	Growth Rate and Mature Size	Lean to Fat ratio	Age at Puberty	Milk Production
Jersey (J)	X	X	X	XXXXX
Longhorn (Lh)	X	XXX	XXX	XX
Hereford-Angus (Hax)	XXX	XX	XXX	XX
Red Poll (R)	XX	XX	XX	XXX
Devon (D)	XX	XX	XXX	XX
Shorthorn (Sh)	XXX	XX	XXX	XXX
Galloway (Gw)	XX	XXX	XXX	XX
South Devon (Sd)	XXX	XXX	XX	XXX
Tarentaise (T)	XXX	XXX	XX	XXX
Pinzgauer (P)	XXX	XXX	XX	XXX
Brangus (Bn)	XXX	XX	XXXX	XX
Santa Gertrudis (Sg)	XXX	XX	XXXX	XX
Sahiwal (Sw)	XX	XXX	XXXXX	XXX
Brahman (Bm)	XXXX	XXX	XXXXX	XXX
Nellore (N)	XXXX	XXX	XXXXX	XXX
Braunvieh (B)	XXXX	XXXX	XX	XXXX
Gelbvieh (G)	XXXX	XXXX	XX	XXXX
Holstein (Ho)	XXXX	XXXX	XX	XXXXX
Simmental (S)	XXXXX	XXXX	XXX	XXXX
Maine Anjou (M)	XXXXX	XXXX	XXX	XXX
Salers (Sa)	XXXXX	XXXX	XXX	XXX
Piedmontese (Pm)	XXX	XXXXXX	XX	XX
Limousin (L)	XXX	XXXXX	XXXX	X
Charolais (C)	XXXXX	XXXXX	XXXX	X
Chianina (Ci)	XXXXX	XXXXX	XXXX	X

[a]Increasing number of Xs indicate relatively higher values. For example, XXXXXX is greatest milk production or oldest age at puberty and X is lowest growth rate and youngest age at puberty. Available at http://www.ansi.okstate.edu/breeds/research/table2.htm.

by breeding a cow herd with less ability to have intramuscular marbling (such as high percentage of Brahman or continental breeding) to sires known to have the ability to deposit marbling (such as British breeds like Angus). The practice of combining the strengths and weaknesses of different breeds to meet marketing goals or to better match a harsh range environment is called complementarity.

It must also be remembered that desirable genetic traits are often correlated with other less desirable traits. For example, accelerated average daily gain and increased carcass yield are usually correlated with large birth weights.

It is possible to exceed the range environment available to the cowherd when designing crossbreeding systems. For example, milk production can become excessive for the amount of feed produced by most rangeland (less than 20 inches rainfall). Milk production for most beef breeds peaks at 60 to 70 days at around 18 to 20 lbs. per day. Heavier milking, dual-purpose breed crosses have peak lactations of 22 to 26 lbs. per day. Each additional lb. of milk production requires approximately .52 lbs. of additional forage intake each day. Another example of exceeding a range environment is by utilizing large breeds in the development of the crossbred cow for an arid environment. An environment characterized by abundant, high quality summer forage and ample winter feed resources can use a large frame size, heavy-milking crossbred cow. Most western rangeland requires the use of intermediate or small framed cattle with moderate milk production. As winter feed resources or available forage for grazing decrease, cow size and milk production need to decrease also. At Havre, Montana in the Bear Paw Mountains (20 in. annual precipitation) Simmental x Hereford cows had superior weaning weight/cow exposed averages when compared to Angus x Hereford cows. When the same type of cows were compared at Miles City, Montana (10 to 12 in. annual precipitation), Angus x Hereford cattle excelled in calf weaning weight/cow exposed.

DESIGNING A CROSSBREEDING SYSTEM

Unlike the dairy industry, there is no particular breed which excels in beef production in the United States. Variation among environments requires the use of different breed combinations. In the Gulf Coast region, use of a heat tolerant breed is needed, while North Dakota would require the opposite. Ranchers should outline production goals for the ranch and then look at possible biological types of cattle to help achieve those goals. Limitations which may influence the success of using different biological types of cattle or different crossbreeding systems should also be considered. Possible limitations include feed and forage resources, labor, rainfall, ability to supplement cattle, number of pastures, size of the herd, herd replacement strategy, temperament desired, adequacy of corral facilities, and commitment to management.

Tables 1 and 2 categorize different biological types of cattle and crossbreeding systems, respectively. In Table 1, cattle are separated into four major traits by biological type. Some traits desired will conflict with production goals. For example, if retaining offspring to slaughter, increased lean to fat ratio may be important. However, for range cows it is particularly important for cows to have the ability to store fat during times of nutritional plenty so they can use it during nutritional deprivation (less lean to fat ratio). If you would like to use a breed in your environment that has a particular trait you would like to be present in the herd (e.g., increased growth rate) but that may also conflict with environment adaptability (e.g., mature size), limit that particular breed to 25% or less of the crossbred cow or consider using the breed as a terminal sire.

For Table 1, much of Arizona can be characterized by these general assumptions:

1. Keep milk production for replacements at XX or XXX (Table 1).

2. Keep age at puberty at XX or XXX.

3. For the cow herd, keep lean to fat ratio (ability to store fat) at XX or XXX. For terminal sires, it doesn't matter.

4. For mature size, keep the cow herd at XX or XXX. For terminal sires, use common sense when combining different breeds (i.e., don't use a XXXXX sire on X or XX mature size cows due to calving problems).

5. For conflicting traits, lean towards cow herd adaptability by following the 25% or terminal sire rule above.

Once biological types are identified for developing a crossbred system (Table 1), constraints may be necessary to achieve uniformity among calves (Table 2). For example, rotational or composite crossbreeding systems require the use of similar biological types to prevent excessive variation among cow generations due to gene recombination. An extreme example would be a rotational cross breeding system utilizing one breed with 2 Xs for growth and another breed with 5 Xs for growth. Cow size and necessary nutritional management would fluctuate wildly from one generation to another, depending upon the current sire being used. If the rancher were to purchase replacement females each year (such as Braford F1 cattle for use in South Texas), fluctuation problems could be avoided. Another constraint inherent with crossbreeding systems is additional management requirements. Cattle have to be separated and maintained by breed or age during breeding for rotational and terminal sire

Table 2. Resource Constraints and Advantages and Disadvantages of Different Breeding Systems

System	% Heterosis	Advantage	Disadvantage	Pastures Needed
Straightbred	0	Easy to manage	No heterosis, no breed complementarity.	1
Periodic Rotation (rotate breeds in herd over 2-4 years)				
	12	Some heterosis with limited additional management constraints. Increased production with crossbred cow.	Limited breed complementarity. Fluctuation among cow types by generation requires use of similar biological types.	1
	16	"	"	1
Rotation				
2 breed	16	Added heterosis with additional management. Increased production with crossbred cows.	Must sort cows by sire and run 2 herds on 2 or more pastures. Limited breed complementarity. Fluctuation among cow types requires use of similar biological types.	2
	20	"	"	3
	22	"	"	4
Composite (4 breed)	17	Once herd is developed, only 1 pasture is required. Can obtain similar heterosis to rotational crossbreeding systems with less hassle. Suitable for small operators. Less generation to generation varability than with rotational systems.	If developing your own, requires large numbers of animals (400 or more) or use of crossbred bulls on crossbred cows. Otherwise, must purchase initial composite cows. At this time, it is not possible to obtain reliable EPDs for composite cattle, limiting selection ability for cows or purchased bulls. As for rotational crossbreds, similar breeds should be used for development of composite breed.	1
Terminal Sire on:				
	9	Some complementarity; individual heterosis on F1 calves. Can change quickly for changing market.	Must separate cow herds into 4 years and older and under 4 years old. Older cows are bred to terminal sires. Younger cows (40% to 45% of herd) generate replacements. Can't select replacements from best old cows.	2
	21	Maximizes breed complementarity for older cows. Can fit changing market	"	3
3-breed rotation	24	"	"	4
	21	More heterosis, less mgmt.	"	2

Heterosis is in weaning weight/cow exposed.
Adapted from: *Crossbreeding Beef Cattle for Western Range Environments* TB-88-1, 1988, D.D. Kress and T.C. Nelson, NV Agricultural Expt. Sta., University of NV-Reno and Table 2, “Make Crossbreeding Work on Your Place,” Part 1, Michael MacNeil, 3/2/96, *Western Beef Producer*.

breeding systems, respectively. This requires the use of additional breeding pastures (Table 2), which may be difficult for some public lands grazing allotments. Alternative crossbreeding systems for smaller herds or those with fewer management capabilities are the periodic rotation or composite systems. When using simplified crossbreeding systems, it is still important to carefully plan which biological types will be used to achieve production goals. Haphazard breeding programs lead to haphazard results.

EXAMPLE CROSSBREEDING SYSTEM

Note: This example is for discussion only to show how a rancher might design a crossbreeding system to fit his particular ranch and production goals. It is not meant to be a blueprint for all ranches in Arizona!

John Smith of the Lazy Upside Down U desires to initiate a crossbreeding system to reap the benefits of both individual (crossbred calves) and maternal (crossbred cows) heterosis. He has a herd consisting of 200 straightbred Hereford cows which graze a USFS allotment (elevation 6200 to 7500 ft.) from June 1 to October 15. From October 15 to May 31, cattle graze BLM or Arizona State Land Dept. pasture (elevation 2700 to 5000 ft.). Calving season is from March 1 to May 15 (unassisted) and bulls run with cows on the USFS permit from June 1 to August 15 at a 1:33 bull:cow ratio. The current allotment management plan on the USFS allotment allows for the cow herd to be split into two herds. Cattle are supplemented with protein once a week (14 lbs. cottonseed meal cake per cow) for January and February only. All calves are weaned on the mountain and sold at weaning except for 40 replacement heifers, of which 20 to 30 will be retained and the remainder sold as yearlings. John's family desires to increase weaning rate while maintaining weaning weights. Although weaning weights have been adequate (403 lbs. for heifers, 458 lbs. for steers), John and his family have had problems maintaining cow body condition during the winter without supplementation during January and February. Calving rate is around 80% and weaning rate is 75%. Mature cows weigh 1100 lbs. and replacement heifers calve at 2 years of age. Everyone agrees that while the nutritional quality of the forage available is generally excellent on the mountain, the forage quality of the winter forage is limiting (when tested over 2 years, hairy grama was 5.5% crude protein and 48% TDN). The family desires to limit supplementation to the current time period. The Smiths have 40 acres private ground of which 12 acres are irrigated hay, the balance being in non-irrigated pasture. Five horses are kept year round on the private ground and there is enough hay left over to keep 40 mature cows for 30 days at headquarters. Weaned replacement heifers are kept at headquarters and fed hay for 1 week and then graze hay stubble for 1 week. Following this, they are put out on a pasture near headquarters until the first of January. For January and February, replacement heifers are brought back to headquarters and fed hay. After this time, they are put out with the cow herd.

Let's look at the constraints that John has with his operation. First, he is limited to two breeding pastures during the summer. Secondly, he must maintain or increase fleshing ability of the cowherd (no more than two Xs from lean to fat ratio for biological types listed in Table 1). The second constraint would imply that John not increase milk production to any extent and that he maintain cow size or decrease it slightly (no more than three Xs for mature size and no more than two Xs for milk production).

When the family reviewed their options, they decided they would like to keep the disposition and "rustling ability" of the Hereford cows. With the two pasture limitation, they decided to implement a two stage crossbreeding program by first developing a herd of F1 females and then crossing the 4-year-old and older crossbred cows to a smaller framed terminal sire (no calving assistance rendered). The sire breeds which fitted the family's criteria were Angus for the initial sires to produce F1 females and Limousin for the terminal sire. Red Poll was considered briefly for the initial sire breed due to the smaller size and younger age at puberty and then eliminated due to the difficulty in obtaining bulls and the possibility of increased milk production. It was felt that the Angus sires would reduce age at puberty slightly (Clay Center has adjusted age at puberty at 359 days for Red Poll, 393 days for Angus, and 411 days for Hereford) and sires with low birth weight EPDs are readily available. The stages in implementing the crossbreeding program are as follows:

Stage 1: Replace all Hereford bulls with Angus with low EPDs for birth weight, yearling weight, and maternal milk. Keep as many of the replacements as possible, allowing for a more rapid turnover to F1 cows. For two years, breed all cows to Angus bulls. From the first calf crop on, start selecting crossbred bulls prospects from the herd at weaning. From weaning until the spring of their yearling year, test bulls in home feedlot and pasture for performance on a roughage based diet. Cull bulls according to performance and breeding soundness examinations. Bull to cow ratio for F1 bulls is 1:15 or 1:20 as yearlings and 1:33 as 2-year-olds.

Stage 2: At the beginning of the third breeding season, a proportion of the bull battery is replaced with F1 bulls. All F1 females over 4 years old will be bred to the terminal sires. When the herd stabilizes at 100% F1 females, 45% of the herd (younger cows) will be bred to F1 bulls for replacements and 55% (older cows) will be bred to the terminal sires in a different pasture with all these calves being sold.

The possibility of inbreeding from retained crossbreed bulls after their third and final breeding season is (on the high side) about 6.5% if the herd stayed in a simple F1 breeding system and about 3% for the combination F1/terminal sire crossbreeding program. In the future, some of this can be alleviated by (a) buying crossbred bulls as they become more popular or (b) by estrus synchronizing the cow herd for 1 heat cycle and using mass AI with F1 AI sires as they become more available.

OTHER INFORMATION

Other information on crossbreeding systems is available from the following publications:

Crossbreeding Beef Cattle for Western Range Environments TB-88-1. 1988. D.D. Kress and T.C. Nelson. Nevada Agricultural Experiment Station, College of Agriculture, University of Nevada-Reno.

Crossbreeding Beef Cattle C-714. 1990. D.D. Simms, K.O. Zoellner, R.R. Schalles. Kansas State University, Cooperative Extension Service, Manhattan, KS.

Detailed information on breed group averages for different traits at Clay Center, NB can be found on the Internet at

http://www.ansi.okstate.edu/breeds/research/marccomp.htm

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FROM:

Arizona Ranchers' Management Guide
Russell Tronstad, George Ruyle, and Jim Sprinkle, Editors.
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UNDERSTANDING EPDS

Jim Sprinkle[1]

Currently, most registered bulls have information available from their own performance records, progeny, or relatives which enables us to predict the performance of future offspring for various traits. An expected progeny difference or EPD is the difference in some trait (usually expressed as pounds, but sometimes as inches for carcass type traits) which one can expect when compared to other animals of the same breed. For example, if a bull's birth weight EPD is +5.0, then on an average his offspring should weigh 5 lbs. more at birth than does a bull with a birth weight EPD of 0. The actual difference you will realize within your herd for a particular trait will depend upon how your herd compares to the breed as a whole. For example, if weaning weights on a particular ranch are greater than the observed breed average, then it is conceivable that a bull's weaning weight EPD in this herd may be less than that listed for the breed.

The traits which are commonly available for sires include birth weight, weaning weight, yearling weight, milk or maternal milk, and total maternal. For all of these traits, an EPD is expressed in pounds deviation + or - from the breed base average of 0. (Note: The breed base average is often outdated by several years, so actual base averages for a given year often exceed 0.) It must be pointed out that milk EPD values are *not* pounds of milk, but the pounds of weaning weight in the offspring of daughters of a bull which can be expected due to milk production alone. In explanation, an EPD value of +12 for milk means that on average you can expect grandsons and granddaughters of calves from a bull's daughters to weigh 12 lbs. more at weaning due to the influence of milk production in the daughters. Total maternal EPD values in grandsons and granddaughters are total pounds of weaning weight expected due to the combined influence of milk production and growth genetics from dams.

Accuracy (often shown as ACC) is the amount of confidence one can place in the estimated EPD. This accuracy figure is related to the number of progeny of a particular bull for which records exist. An accuracy of .93 basically means you are 93% confident that the bull's EPD will be what the record says it is. An accuracy of .40 would be more unreliable. Young, unproven bulls have low accuracy figures.

The EPD values for a bull must be compared within a breed. A birth weight EPD of +5 for a Charolais bull would not have the same effect upon calving difficulty as a +5 for an Angus bull in a commercial crossbred herd because breed averages are different. The respective breed averages for a particular year can usually be obtained by contacting breed associations or reviewing breed sire summaries. Table 1 contains information from more than 4,000 offspring (from Angus x Hereford dams) along with 30 sires per breed. This data was collected in one environment only (Clay Center, Nebraska) and sires were adjusted for 1991 EPD breed averages. Some of the respective rankings may change as cattle move from one environment to another.

In order to utilize heterosis and combine complementary breeds in cow herds, crossbreeding is practiced. One may be concerned about matching cattle to the environment or in meeting a particular marketing niche. To aid in these decisions, EPDs across breeds can be estimated using Table 1 and the individual bull EPDs. The actual difference between bulls of different breeds can be estimated by adding the EPDs to the respective breed averages

Table 1. Breed Averages for Some Traits[a]

Breed	Birth Weight	Weaning Weight	Yearling Weight
Angus	77.8	441	810
Polled Hereford	80.3	450	806
Hereford	81.4	442	800
Shorthorn	83.5	461	832
Brahman	87.8	447	744
Simmental	86.0	471	860
Limousin	83.1	450	798
Charolais	86.0	458	819
Maine-Anjou	87.8	458	826
Gelbvieh	87.3	465	822
Pinzgauer	82.4	440	783
Salers	80.9	464	830

[a] Averages of offspring sired by bulls with EPDs in MARC's GPE project. Adjusted for 1991 EPD breed averages. From *Beef,* September 1993.

Table 2. Across Breed EPDs for Some Traits[a]

Breed	Birth Weight	Weaning Weight	Milk	Yearling Weight
Angus	0	0	0	0
Polled Hereford	5.9	11.3	-27.4	8.8
Hereford	6.1	6.4	-3.7	7.3
Shorthorn	8.7	25.2	11.9	31.9
Brahman	13.8	28.8	34.4	-21.1
Simmental	10.5	49.8	25.4	79.2
Limousin	6.6	28.8	-8.5	20.0
Charolais	9.7	37.2	3.7	52.4
Maine-Anjou	11.9	31.5	23.1	39.7
Gelbvieh	9.6	38.6	27.1	41.8
Pinzgauer	8.7	21.6	7.1	16.4
Tarentaise	4.4	22.3	20.1	10.5
Salers	6.8	30.8	11.9	31.7

[a] EPDs adjusted to a 1992 base with Angus EPDs set to zero in MARC's GPE project. From Barkhouse et. al., 1994. Proc. Beef Improvement Federation 26th Research Symposium and Annual Meeting, West Des Moines, Iowa. June 1-4, 1994.

and then comparing the resulting sums. For example, assume we wish to compare a Charolais bull with a birth weight EPD of +4 and an Angus bull with an EPD of +6. Using the breed averages from Table 1, progeny of the Charolais bull should be 6.4 lbs. heavier at birth than Angus progeny at Clay Center, Nebraska.

$$\underset{\text{Charolais}}{[(86 + 4)} \quad - \quad \underset{\text{Angus}}{(77.6 + 6)]}$$

In this example, the Charolais bull is expected to sire calves with heavier birth weights than the Angus bull even though the birth weight EPD was greater for the Angus bull. While this method does not fully account for the effects of heterosis when combining males and females of two unlike breeds, it is a good starting point for planning breeding programs.

If you have an idea of what your herd averages are for various traits, Table 2 may be more useful to you. Table 2 allows comparison of EPDs across breeds with Angus EPD values being specified as 0 for all traits. For example, an Angus bull with a birth weight EPD of +5 should sire calves with birth weights 5 lbs. heavier than the average Angus bull. If you used a Limousin bull in your commercial herd with a birth weight EPD of +2, then you could expect him to sire calves weighing 8.6 lbs. (2 + 6.6) heavier than an average Angus bull. Table 2 information is also from Clay Center, Nebraska and will not completely account for changes in breed rankings with different environments.

Expected progeny differences can be used as a tool to predict future performance and to plan goals for genetic improvement in your cow herd. Available resources should be evaluated and genetic change should be planned to match these resources. In planning genetic trends in your herd, it should be remembered that one genetic trait is often correlated with another. For example, as yearling weight increases, so does birth weight and mature weight. An environment with 10 inches of rainfall may not be the place to use a sire with a yearling weight EPD of +70 unless all replacement heifers were purchased elsewhere. Otherwise, mature weight of the cows will increase. In arid western climates with limited forage availability, oftentimes the use of smaller cows is required to obtain acceptable conception rates. Bulls with low or negative birth weight EPDs should be used on first calf heifers. High milk production may be a liability in arid environments, so milk EPD values should be moderate. The American Angus Association reported the observations of a breeder who had evaluated EPDs in a range operation. He suggested that for Angus cattle under range conditions, an EPD for milk from -5 to +9 was adequate for calf growth and still allowed for rebreeding success.

In addition to using EPDs in charting genetic change, ranchers with commercial herds can predict genetic change in their herds with the formula below. When this value is divided by 2 (parents only contribute 1/2 of their genes to offspring), it approximates an EPD value on a herd-wide basis.

Genetic change/generation =
h2 • selection differential

The heritability (h2) of birth weight is around .35 to .50, for weaning weight it is around .25 to .30, and for yearling weight around .40

The selection differential is the difference between selected individuals for a specific trait (e.g. weaning weight) and the average for all animals by sex in the herd. For example, the selection differential would be 60 lbs. if heifers at weaning averaged 400 lbs. and selected heifers weighed 460 lbs. When calculating selection differentials, it is important for the animals being compared to have been treated similarly. In other words, if one group of selected heifers were grazed on irrigated pasture and another group was grazed on rangeland, it would not be appropriate to compare these groups without applying a weaning weight discount to the irrigated pasture group.

An example in calculating genetic change is shown below. Selected heifers weigh 60 lbs. more at weaning than the average of all heifers in the herd. The heritability of .25 is multiplied by .60 to give 15 lbs. genetic superiority.

60 lbs. • .25 = 15 lbs.

This must be divided by 2, since the heifers will only contribute 1/2 of the genes to offspring. Therefore, 7.5 lbs. will be added from the female side. A selected bull has a weaning weight EPD of +25 lbs. when used in your herd. Therefore, the predicted increase in weaning weight for the selected heifers and this bull would be 32.5 lbs.

The above example shows the response per year which can be expected for single trait selection. Selecting for more than one trait at a time usually reduces the genetic change expected in single trait selection.

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FROM:

Arizona Ranchers' Management Guide
Russell Tronstad, George Ruyle, and Jim Sprinkle, Editors.
Arizona Cooperative Extension

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BREEDING YEARLING HEIFERS

Donald E. Ray,[1] Albert M. Lane,[2] Carl B. Roubicek,[3] and Richard W. Rice[4]

Many studies have shown returns are increased by breeding yearling heifers to calve for the first time at 2 years of age. Generally this is a sound recommendation, but it requires that replacement heifers are "grown-out" after weaning. They will need to reach puberty and start cycling by 12-14 months of age, which is attainable if heifers are fed adequately over their first winter.

It is common for calves to lose weight after weaning and not start gaining until new forage appears the following spring or summer. This results in breeding replacement heifers to calve first when they are approximately 3 years of age. Under these conditions, the rancher has two alternatives if he wants to breed heifers as yearlings:

1) provide supplemental feed on range after weaning replacement heifers,

   or

2) place them in a drylot environment and provide adequate feed to ensure puberty by 12-14 months of age.

This report summarizes the results of a study designed to evaluate the effects of supplemental feed for replacement heifers under range conditions, and discusses potential benefits of a drylot system.

PROCEDURES

For more than a quarter of a century, The University of Arizona has had a cooperative research project with the San Carlos Apache Tribe's registered Hereford herd at Arsenic Tubs. The heifers used in this study were from this project. The general range area is at an altitude of 5,000 feet with forage consisting primarily of desert grassland vegetation. Annual rainfall averages about 14 or 15 inches with most of it occurring during the summer months of July and August. Temperature extremes may range from -10 F in January to 95 F in July.

At weaning time (October 6) the replacement heifers were divided into three groups of approximately 60 head each on the basis of weight. One group was maintained as a control with no supplemental feed and the other two groups were fed a high energy supplement to gain either 0.5 lb. (low) or 1.0 lb. (moderate) per day until the beginning of the breeding season (May 1). The supplement consisted of 65 percent milo, 25 percent cottonseed meal, 6 percent molasses, 1.5 percent dicalcium phosphate, 1.5 percent urea, 1 percent salt and vitamin A. It was prepared in 3/4-inch pellets and fed on the ground three times per week.

The .5 and 1.0 lb. gain-per-day levels were selected to determine the minimum weight (gain) required to breed yearling heifers successfully. The moderate-gain group would result in heifers weighing an average of 600 lbs. at the beginning of the breeding season. Weights were taken several times during the experiment and feed level adjusted in an attempt to obtain the desired rates of gain. All heifers were exposed to bulls for a 90-day breeding season beginning on May 1.

RESULTS

Heifers receiving supplemental feed were weighed four times during the wintering period; the controls were weighed twice. One of the major difficulties encountered in this study was maintaining the desired rate of gain (Table 1). Although feed levels were increased after each weigh period, the actual gains obtained by March 23 were 0.43 lb/day in the low group and 0.66 lb/day in the moderate group. The greatest difference between actual and desired rate of gain occurred in the moderate group, even though feed levels were increased to almost 8 lbs. per heifer daily in this group from January 26 until the end of supplementation (April 23). Other studies have shown that providing supplemental feed to range cattle results in a decrease in grazing activity and intake of range forage. This would certainly seem to be the case in this study. The amount of pellets required per cwt. gain would indicate that practically all of the nutrient intake was being derived from the supplement.

Table 1. Gain, Feed Levels and Reproductive Performance.

Items	Control	Projected Gain Group 0.5 lb.	Projected Gain Group 1.0 lb.
Number Heifers	61	60	61
Weaning Weight (10-6)	396	396	400
Feed Level and Gain (by period):			
11-17 Avg. Da. Gain, lb.		.41	.79
Avg. Da. Feed, lb.		2.70	2.70
12-21 Avg. Da. Gain, lb.	0.28	.21	.64
Avg. Da. Feed lb.		3.50	4.60
1-26 Avg. Da. Gain, lb.		.40	.33
Avg. Da. Feed, lb.		5.00	6.60
3-23 Avg. Da. Gain, lb.	-.11	0.60	0.83
Avg. Da. Feed, lb.		5.10	7.90
Total Avg. Da. Gain, lb.	-.21	0.43	0.66
Avg. Da. Feed, lb.		4.20	5.60
Total Feed/Heifer		701	946
Cwt. Feed/Cwt. Gain		974	843
Weight, 3-23	361	468	513
Number Exposed to Bull	27	55	59
Number of Live Calves	0	17	32
Percent Calving	0	30.9	54.2
Weaning Rate, Percent			
of Total	-	20.0	35.6
of Those Calving	-	64.7	65.6
Weaning Weight	-	352	336
Total Supplement (lb.)/ 100 lb. Calf Weaned	-	942	747

No additional weights were taken after March 23, although supplemental feeding continued for another month (to April 23). Heifers weighing 400 lb. or more in March were exposed to bulls from May 1 to July 1. The actual numbers exposed were: controls, 27; low gain, 55; moderate gain, 59. None of the control heifers conceived during the breeding season, whereas 30.9 percent and 54.2 percent of the low and moderate groups conceived. Approximately one-third of the pregnant heifers lost their calves at birth or shortly thereafter, primarily due to calving difficulty. This resulted in a very low percent calf crop weaned for the supplemental group (20.0 percent for the low and 35.6 percent for the moderate). Based on the amount of supplement fed, it required approximately 800 lb. of feed to produce 100 lb. of calf at weaning time. Using 1984 prices, this would be roughly $80-$90 per 100 lb. calf at weaning time.

The system for growing-out heifers on the range used in this study was not effective. The biggest problem was maintaining the desired rate of gain with a reasonable amount of supplemental feed. Perhaps other methods of providing supplement would have been more effective, but any system used must address the problem of reduced grazing activity.

It may be more efficient to grow-out heifers after weaning under drylot conditions if they are to be bred at 12-14 months of age. This system has several potential advantages for Arizona ranchers grazing public lands. Heifers could be grown-out and bred while in drylot, and only those replacements that conceived would be returned to the cow herd. A short, 45-day breeding season starting approximately one month in advance of the normal breeding season will assure that replacements would produce early calves and have additional time to rebreed for their second calf.

This system would also permit the use of estrus synchronization and artificial insemination to bulls with proven records for calving ease, as well as enable ranchers to gradually phase into a crossbreeding system if they desired to do so. Finally, there would be a reduction in Animal Units charged against the allotment, thereby reducing grazing pressure on the range during the critical winter and early spring months. Obviously, these potential advantages would have to offset the costs of feeding and breeding replacements under drylot conditions.

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SUPPLEMENTATION OR EARLY WEANING FOR RANGE BEEF CATTLE

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A maximum reproductive rate under range conditions is the most important consideration in a cow-calf herd. Although there are interrelationships between each successive reproductive cycle, probably the most critical stage involves the breeding performance of the first-calf heifer for her second calf. Among the more important factors influencing fertility during this period are 1) how early conception occurred during the previous (first) breeding season, 2) current nutritional status and, 3) level of lactation.

Studies were conducted with a range herd of registered Herefords owned and managed by the San Carlos Apache Indian Tribe to determine the effects on reproductive performance of 1) supplemental feeding prior to and during the breeding season of virgin and first-calf beef heifers on the range and 2) early-weaning calves from first-calf heifers on the range.

EXPERIMENTAL METHODS

The San Carlos Apache tribal herd is maintained approximately 60 miles east of Globe, Arizona at an elevation of 5,000 feet. Range forage consists primarily of desert grassland vegetation. Average annual rainfall is approximately 14 inches with a range in mean temperature from 45°F in January and to 84°F in July.

During each of two consecutive years, approximately 100 two-year-old virgin and 100 three-year-old first-calf heifers were allotted to six single-sire pastures 30 days prior to the breeding season (May 1 to August 1). Breeding pastures were originally designed to minimize differences resulting from forage and water availability. Approximately equal numbers of each age group were allotted to each pasture. In both years two pastures were allotted to each of the following treatments: control, supplementation or early-weaning. The number of cattle in each pasture was based on quantity of available forage. The supplement was pelleted and consisted of the following ingredients: 62% milo, 31% cottonseed meal, 5% molasses, 1% dicalcium phosphate, 1% salt and 10,000 I.U. vitamin A per pound of supplement. Feeding was initiated 2-4 weeks prior to the breeding season and continued for 90 days. The pellet was fed on the ground three times weekly at a rate equivalent of 5 lb. per animal daily. Calves in the early-weaning groups were weaned at an average of 70 to 80 days and placed in drylot on a self feeder.

Weights and condition scores were obtained prior to and following the supplemental-feeding period for virgin heifers in 1970 and for both age groups in 1971. Condition was subjectively rated, with higher values indicating better condition. A score of 6 is considered optimal and 4 adequate condition for normal reproductive performance. Reproductive performance was evaluated by percentage of calf-crop born and average day of birth during the subsequent year.

RESULTS AND DISCUSSION

Results of the first-year study are presented in Table 1. Availability of range forage was considered average

Table 1. Influence of Supplementation and Early Weaning, Normal Year

Heifer Age at Breeding	Item	Treatment			
		Control	Supplement	Early Weaning	Average
2	Initial weight, lb.	701	705	708	705
2	Weight change, lb.	190	201	176	187
2	Initial condition, units	4	4	4	4
2	Condition change, units	1	1	1	1
2	Percent calf crop at birth	79	71	81	77
3		83	73	89	82
Average		81	72	85	79
2	Average day of birth	62	84	65	70
3	(Jan. 1 = 1, etc.)	70	104	74	83
Average		66	94	69	76

during the period of this study. Weights and condition scores were obtained only from virgin heifers. Average daily gain of all groups (1.5 to 1.8 lb.) was considered excellent and all groups showed identical increases in body condition scores.

Both unsupplemented groups (control and early-weaning) had approximately an 80% calf crop born, which was substantially higher than the supplemented group. The average day of birth in the calving season, by treatments, followed the same trend. Milking first-calf heifers had a longer interval to conception than virgin heifers. This is normal and indicates the added stress imposed by the additional requirements for lactation and growth.

The results of this study indicate that supplemental feed or early removal of the calf does not enhance reproductive performance if range conditions are adequate to provide a “flushing” effect immediately prior to and during the breeding season.

The next year’s study was conducted during a period of extreme drought which had started the preceding fall. Results are presented in Table 2. Weights and condition scores were

Table 2. Influence of Supplementation and Early Weaning, Drought

Heifer Age at Breeding	Item	Treatment			
		Control	Supplement	Early Weaning	Average
2	Initial wight, lb.	648	644	646	646
3		780	745	750	758
Average		714	694	697	701
2	Weight change, lb.	18	97	11	42
3		-40	82	-44	0
Average		-11	90	-15	22
2	Initial condition, units	4	4	4	4
3		3	2	3	3
Average		4	3	4	4
2	Condition change, units	0.1	0.6	0.3	0.3
3		1.0	2.7	1.0	1.6
Average		0.5	1.7	0.7	1.0
2	Percent calf crop at birth	92	89	88	90
3		62	84	91	79
Average		77	86	90	84
2	Average day of birth	77	63	63	68
3	(Jan 1 = 1, etc.)	86	76	78	80
Average		82	69	71	74
3	(Jan 1=1, etc.)	86	76	78	80
Average		82	69	71	74

obtained from both age groups (virgin and first-calf) during this study. Initial weights of virgin heifers averaged 60 lbs. less than for the preceding year, reflecting the influence of sparse range forage on growth.

Supplemental feeding resulted in a large difference in weight gain when compared to control and early-weaning treatments. Heifers in both the latter treatments lost weight (11 and 15 lb., respectively), whereas the supplemental groups gained 90 lb. Although weight change was approximately the same for both age groups with supplement, a difference in weight change of approximately 55 lb. existed between the two age groups in the non-supplemented treatments (control and early-weaning). It is interesting to note that first-calf heifers in the early-weaning groups showed the same weight loss as control heifers that were suckling a calf.

Differences in initial-condition scores between the two age groups reflect the effects of gestation and lactation on first-calf heifers (4 vs. 3). Although both age groups had low condition scores, the influence of the drought was more evident among first-calf heifers. Changes in condition differed among treatments (control and early-weaning). The first-calf heifers showed the greatest overall improvement in condition, although their average scores were slightly less than those of virgin heifers at the end of the treatment period (4 vs. 4.5).

Virgin heifers averaged 11% higher calf crop than first-calf heifers. Supplementation did not improve calf crop percentage among virgin heifers (89% vs. 92%), although substantial differences were noted in weight gain between the groups. Among first-calf heifers, both supplementation and early-weaning improved calf crop percentage, resulting in a 22% to 29% increase over control groups. The highest-percent calf crop in first-calf heifers was obtained from the early-weaning groups (91%). This was in spite of the fact that early-weaning heifers lost approximately the same amount of weight as control heifers, although the latter group had only a 62% calf crop. This difference apparently reflects the effect of lactation, independent of weight changes during the breeding season.

Earliness of conception during the breeding season, as measured by day of birth, followed the same general trends as percent calf crop. Both supplemental and early-weaning treatments were associated with earlier calving dates than controls. The average difference between age groups was of approximately the same magnitude as recorded in the previous year's study.

The results of these studies demonstrate that "flushing" virgin heifers does not improve reproductive performance if sufficient range forage is available to maintain body weight. In lactating first-calf heifers, weight loss during the breeding season is detrimental to fertility. If range conditions are not adequate to prevent weight loss, either providing supplemental feed to the heifer or removing the calf will result in normal reproductive performance.

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Arizona Ranchers' Management Guide
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FEEDLOT VS. RANGE PERFORMANCE

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The San Carlos Apache Indian Tribe and The University of Arizona Animal Sciences Department have been cooperating in beef cattle research since 1956. The program involves a 500-head registered Hereford cow herd owned and maintained by the tribe on the San Carlos Apache Indian Reservation. The registered cows observed in the research are maintained as a separate unit on the reservation. Facilities include cattle corrals and working areas, scales, and 20 single-sire breeding pastures.

This cooperative project was included as a part of the Arizona Agricultural Experiment Station contribution to Regional Research Project W-1, the Improvement of Beef Cattle through the Application of Breeding Methods. As a part of this regional effort, some of the participating stations have developed high performance lines of beef cattle selected with use of performance testing procedures. Participating stations agreed to make sires available from these performance-selected inbred lines for use in the San Carlos registered cow herd.

The purpose of the study reported here was to evaluate these inbred lines for economically important traits. The study was also designed to permit a comparison of range and feedlot performance of bull progeny of the test sires. Sires from inbred lines were obtained from Agricultural Experiment Stations at Montana, Wyoming, Utah and New Mexico. Two lines were represented from the Nevada and Colorado Experiment Stations and from the U.S. Range Livestock Experiment Station, Miles City, Montana. The 10 lines were all of registered Hereford breeding. A different bull was provided from each line during four successive breeding seasons during the 1970s.

The registered Hereford cows and heifers used in the test herd were allotted at random each year within age-of-cow classes. Approximately 30 cows were allotted per sire in single-sire breeding pastures. The breeding season extended from May 1 to August 1.

The general range area is at an altitude of 5,000 feet with range forage consisting primarily of desert grassland vegetation. Annual rainfall averages about 14 inches with most of it occurring during the summer months of July and August. Temperatures may range from -20°F in January to 95°F in July.

The calves were ear tattooed, and individual birth dates and weights were recorded. Pertinent comments concerning information that could affect performance were also noted during the nursing period.

In early November, all cows and calves were brought to the corrals for weaning. The calves were weighed and individually scored for conformation and condition. At weaning, half of the bull calves of each sire group were randomly selected for feedlot performance testing. The remaining bull calves were left on the range.

The bulls and heifers on the range were maintained separately after weaning. Subsequent weights were obtained in the early spring (about

March 1) before the growth of new forage, again in the fall in November and the following spring. Thus, four stages of development were represented with an average age of 235, 340, 600 and 710 days. The herd was maintained on a year-long grazing program with no supplementation.

The feedlot performance test was conducted at the Agricultural Experiment Station at Tucson. The bulls were group fed for a 140-day period. Individual weights were taken at 28-day intervals. The test ration containing approximately 50% concentrates was fed free choice during the four years of the test. Average weights at the beginning and end of the test were 469 lbs. and 893 lbs., respectively. This resulted in an average daily gain of 3.03 lbs. The heritability of gain during this test was 54%.

Half-siblings remaining on the range actually lost weight during the same period. (Bulls, -.29 lb. per day and heifers -.50 lb. per day.) This is a common pattern for unsupplemented range calves in Arizona during their first winter after weaning. During the following growing season (340-600 days of age), gains of the calves on the range were excellent, with bulls averaging 1.43 lbs. per day and heifers 1.40 lbs. per day.

DOES FEEDLOT PERFORMANCE REFLECT RANGE PERFORMANCE?

To evaluate the relationship between feedlot performance and range performance requires a look at the correlation between sire groups on the range and in the feedlot. Using the period of growth for the range calves (approximately 12 to 20 months of age), this correlation for the bulls from the same sire groups was 0.84 (perfect correlation = 1.0). The relationship for the bulls on feed test and their half-sibling heifers on the range was less (0.49), but still fairly large and positive. These correlations tell us that a feedlot performance test is a good indication of how the same animals would perform on the range, particularly for bull progeny from the same sire. Simply stated, the higher gaining bulls on a feed test should also be the higher gaining bulls under range conditions. Thus, selecting bulls based on a feedlot performance test should result in improvement of gaining ability on the range.

The fact that the correlation or relationship is not perfect would indicate that some change in ranking bulls based on a feed test or range performance would occur. This leads us to the general conclusion that the best way to evaluate replacment animals for their growth potential is to test them under the conditions we expect them to live. However, substantial improvement can be made by selecting bulls based on a feedlot performance test where they can express their maximum ability to gain.

A COMMENT OR TWO

A word of caution. Simply because a bull is “performance tested” doesn’t tell us he will improve the gaining ability of calves on the range (or anywhere else). We have to use the performance test information in a logical manner by selecting only those animals that are at the “top of their class” in the performance test. Only through this method can we expect substantially to improve gaining ability of beef cattle on the range.

Finally, any valid comparison of performance must be between animals tested in the same environment. To compare records of performance at one ranch with those from another or between one test station and another would not be valid because of different dates, management and other environmental factors.

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Disclaimer

INJURIES AND DISEASES OF BEEF CATTLE ASSOCIATED WITH CALVING

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The pay-off for cow-calf producers is being able to sell a weaned calf. To get this calf to market you must first get your cow pregnant and have her deliver a live calf. There are several common problems that affect cows from late pregnancy through calving.Many of these problems that occur during calving have a rapid onset and require a rapid response, the good news is that if they are attended to early they often have no permanent effect on subsequent breeding.

This publication will present common reproductive problems affecting beef cattle, a short description, underlying causes and possible prevention and common treatment. These problems are presented generally in chronological order, from those conditions seen before calving starts, through the immediate post-calving interval.

1. PROBLEMS PRE-CALVING:

vaginal/rectal prolapse
ketosis

2. PROBLEMS AT CALVING:

dystocia
bruises, laceration, rupture
uterine prolapse
milk fever
obturator paralysis/downer cow
retained placenta
grass tetany

1. PRE-CALVING:

Vaginal/Rectal Prolapse

Causes

The tissue around the birth canal becomes relaxed as the cow starts the last third of gestation, increased pressure in the abdominal cavity will push the vagina or the rectum out. If the tissue is trapped outside the birth canal it will swell and may become infected. In some cases the bladder is also trapped and the animal is unable to urinate.

This condition is more common in older cows but may occur in first calf heifers.

There may be a genetic link.

Overly fat cattle and cattle on pasture with a high legume concentration are at higher risk.

Treatment

Epidural anesthetic is usually necessary.

Replace the tissue and suture in place.

Vaginal sutures must be removed before calving.

Prevention

Remove animals from the herd that develop this condition, don't keep animals that have pre-calving prolapses.

Don't allow cows to gain too much weight during the last trimester of pregnancy.

Ketosis/Pregnancy Toxemia

Causes

Cows are exposed to low nutrition during the last two months of pregnancy.

Cows that are overly fat or are carrying twins are at a higher risk.

Signs

Affected animals become depressed, stop eating and will often stand off away from the herd.

Some animals will have the odor of acetone on their breath.

As the condition gets worse the cow will develop muscle tremors (trembles) and then go down.

Treatment

IV glucose, B vitamins.

Propylene glycol given by oral drench.

Any animal that is down should be lifted by a hip hoist 2 or 3 times a day for 15 to 20 minutes.

In cattle that are in late pregnancy consider inducing calving or a C section.

2. PROBLEMS AT CALVING

Dystocia

Any time a cow is unable to normally deliver her calf a dystocia has occurred. There are many management practices that can be used to reduce the incidence of dystocia. Not all of them may be suitable to every ranching system.

Heifers have many special requirements so they will be discussed first.

Breeding Management

Cull heifers with small pelvic areas before breeding starts.

Select bulls to use on heifers based on the birth weight of the bull, not on his relative size. Use bulls on first calf heifers that will produce small birth weight calves.

Expose heifers to the bull so they will start calving 30-45 days before the adult cows.

Watch body condition during gestation; heifers must not get overly fat or lose weight.

Calving Management

Develop calving grounds. These should be separate from wintering areas, dry and have some shelter from weather if possible (anything from a shelter to trees for a wind break will help).

Separate first calf heifers from the cows.

In large herds the heifer group may need to be divided into subgroups of 40-50 animals.

Surveillance and calving assistance are provided on a 24 hour basis if possible. Restricting the breeding season to 42-60 days will allow personnel to focus their attention to assist in calving for a short, but intense, period.

Feeding at night (between 9-11 pm) will cause more animals to start calving during daylight hours.

The dam and calf should be moved from the calving area to a separate nursery pasture after the calf has nursed, is up and moving about and has bonded onto the dam. This generally takes 24-36 hours.

General Indications for Calving Assistance

The start of calving is indicated by the animal laying down and starting abdominal contractions. The water bag (part of the placenta) appears in the birth canal. The water bag will normally break after 30-60 minutes, and is often followed by a period of restlessness and several position changes. Abdominal contractions become more forceful and the feet appear in the birth canal. Birth is usually completed after 30-60 minutes of hard labor. If the animal has not made any progress after 60-90 minutes, assistance should be given.

The appearance of the head alone, the head and one leg, one leg alone or of the tail are all indications of an abnormal calf presentation and indicate the need for assistance.

Guidelines for Calving Assistance

Comfortably restrain the cow. A squeeze chute will work, but if an animal goes down during a contraction, she may not be able to get up. The best situation is to have a small pen with a head catch. After the animal's head is in the catch, a halter is applied; once the dystocia is corrected and traction is applied to the calf, release the head and allow the cow to lay down in the pen.

The basic guidelines are clean and gentle. Keep the area around the birth canal as clean as possible, keep your hands and arms as clean as possible and use lots of lubricant (mild liquid soap is fine).

The calf can only come out one of two ways,both front feet followed by the head or both back feet out together. If you are unable to correct the position of the calf to get it coming to one of the above presentations, get veterinary assistance. The three most common problems are not getting the head to come out with the front feet (head turning back) and second, having a calf that is too big to be delivered through the birth canal resulting in hip lock. The third abnormal presentation is a breach in which the tail is the only part of the calf visible at the vulva. The presence of any of these problems usually requires veterinary assistance.

When pulling a calf, direct the traction down and away from the birth canal, not straight out behind the dam.

Do not use excessive traction; if you are unable to deliver a calf with two men pulling on the OB chains or when using a calf puller, increasing the amount of traction on the calf won't deliver it; the calf is oversized for the birth canal and should be delivered by C-section.

After delivering the calf, always make sure that there is not a twin present. This is a good time to check the birth canal for any tears and to put some antibiotic pills in the uterus (neomycin-sulfa works well).

Bruises, Lacerations and Rupture of the Birth Canal

Causes

Calving difficulties, rough handling of the calf and maternal tissues and careless use of obstetrical instruments by the operators during delivery of the calf.

Injuries occur more often in cows that have been in labor for several hours and when the birth canal is dry and non-lubricated.

Treatment

Give oxytocin (P.O.P.) immediately to shrink the uterus and control bleeding.

Pack the uterus with antibiotics to control infection and give systemic antibiotics (IM or IV).

Try to control bleeding with coagulant compounds.

Surgical repair may be required if the laceration penetrates completely through the uterine or vaginal wall.

Cows with severe blood loss will require treatment to control shock; fluids, steroids, calcium gluconate or blood transfusions.

Uterine Prolapses

This is the expulsion of the uterus through the vulva to the outside of the body. This condition is seen more often in older animals and occurs very soon after calving.

Causes

Difficult birth with injury or irritation of the external birth canal and severe straining.

Retained placenta.

Loose uterine attachment in the abdominal cavity. There may be an increased prevalence in some families.

Poor uterine tone post-calving. This may be related to low blood Calcium levels.

Poor body condition with malnutrition.

Treatment

An **emergency** condition; rapid treatment is important.

Keep the prolapsed uterus clean and moist.

Apply material to pull fluid from the uterine wall: sulfa-urea powder, urea powder, sugar.

For replacement epidural anesthesia is often required.

Replace the uterus or obtain veterinary aid immediately.

When replacing the uterus all of the organ must be replaced into the abdominal cavity and both horns must be fully everted. Failure to completely evert the uterine horns will cause the animal to continue to strain and prolapse again.

Treat the uterus with antibiotics and give systemic antibiotics.

Most operators will suture the vulva closed for 3-4 days.

Some cows will rupture the uterine artery during the prolapse. If this occurs the cow will hemorrhage internally, go into shock and die.

After Effects

No permanent problem if the uterus is quickly replaced.

Don’t need to automatically cull a cow because of a prolapsed uterus but a severe injury such as freezing, drying or severe laceration may cause infertility.

Milk Fever

Cows that are starting to produce milk are unable to remove Calcium from their bones quickly enough. If blood levels of Ca fall below minimal levels the muscles of the body are unable to function and the cow goes down, is unable to rise and will become comatose and die.

Causes

Incidence of milk fever increases with age and number of calves.

Cows of the dairy breeds or dairy cross have an increased incidence.

High blood levels of estrogen inhibit Ca mobilization; this may be a factor on pastures that are high in legumes.

Clinical Signs

Cow is down post-calving, and will become depressed with a slow heart rate, decreased rumen activity, low body temperature and head turned to the side.

Without treatment most animals will become more depressed, then become comatose and die.

Treatment

Slow administration of IV calcium, usually 300-500 mls. of a commercial type.

Calcium solution is given over 20-30 minutes. Also a second bottle may be given under the skin at the same time.

Decrease the rate of milk removal, i.e. give the calf supplemental feeding so it will not nurse as much from the cow.

Cows that are down more that 12 hours require slinging from a hip hoist, 15-20 minutes twice daily, to reduce nerve and muscle injury.

Animals that do not respond to treatment should be checked by a veterinarian.

Prevention

Decrease Calcium intake during the last two months before calving by reducing legume forages. Cattle that are allowed to graze on a pasture with a high legume content will be at greater risk.

IM injection of Vitamin A/D pre calving, it may help change legume roughage to grass hay, two to four weeks prior to calving.

Obturator Paralysis/Downer Cow

Cattle that have had a difficult delivery will have a variable amount of swelling and tissue trauma around the birth canal. This swelling and bruising may damage the nerves from the spinal cord or those in the hip that supply the legs, preventing normal leg function. In some cases excessive traction while pulling a calf will fracture the middle lower bones of the pelvis.

Causes

Excessive pulling to deliver a calf, pulling a calf straight out from the cow rather than down and backwards or having the calf in the birth canal too long (several hours). Some cows may deliver normally but because of poor footing slip and “split out”. Damage to the pelvis, in this case produces a downer cow.

Treatment

Steroids must be used to reduce swelling and assist in nerve healing.

Cows that are unable to stand should be hoisted 15-20 minutes twice a day.

Cows that split out but can stand, should be in a clean dry pen with hobbles, that prevent the legs from splaying out to the sides.

IM Vitamin E/Se may help.

Retained Placenta

Usually the placenta is passed in 3-8 hours after calving. If it has not passed by 8-12 hours the placenta is retained and the animal should be treated.

Causes

Dystocia, C-sections, fetotomy, twining or abortion will all increase the chance of a retained placenta.

Some infectious diseases such as IBR, Brucellosis, listeriosis and leptospirosis will cause abortion and retained placentas.

Malnutrition and feed deficiencies, especially low carotene, Vitamin A, Iodine, Selenium and Vitamin E.

Treatment

Slight manual traction, gently pull on the placenta. If the placenta resists, stop and pack the uterus with boluses or use fluid douches to keep antibiotics in the uterus. Be very sure to use good hygiene when treating the uterus or the problem will become worse.

Systemic antibiotics are useful, particularly if the uterus develops an infection (metritis).

Prostaglandins may aid in getting the uterus to reduce in size and in releasing the placenta.

Make sure the calf is nursing and treat any other problems that may have caused the retained placenta.

Oxytocin is useful only in the first 48 hours and may be used to reduce the size of the uterus. If used later than 48 hours, the uterus must be sensitized with estrogen.

Grass tetany

Similar to milk fever in that cattle in heavy post calving lactation are loosing large amounts of Magnesium (Mg) in their milk. Most types of mixed pasture grasses are low in Mg. If cows are exposed to cold weather stress during early lactation their blood Mg levels may drop low enough to cause grass tetany.

Clinical Signs

Early most affected cattle will appear restless, stop grazing and have increased activity with an unusual high stepping gait.

As the condition progresses the animal falls down, the legs are stiff and convulsions occur.

The eyes move in an erratic manner and may roll in the head.

The heart rate and body temperature are elevated.

Some animals may become very aggressive and attempt to charge or butt using their heads.

Treatment

IV Mg usually given with Ca.

Treatment is not as effective as with milk fever and many affected animals do not re-spond.

Prevention

Supplemental feed (hay) to lactating cows that are grazing lush pasture particularly during cold, wet weather.

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DISEASES OF BEEF CATTLE ASSOCIATED WITH POST-CALVING AND BREEDING

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Once a cow has delivered her calf the groundwork for the next year's calf crop must be laid. This publication will examine some of the more common problems that occur during the post-calving interval and at the time of breeding. Often these problems are subtle and a producer may not realize there is a problem until the cows are examined for pregnancy or until the next calving season. Once a problem has progressed to this point the individual animal is often culled from the herd or an entire calf crop can be significantly reduced.

1. PROBLEMS POST-CALVING

Metritis (Uterine Infection)

Cows will normally have a discharge from their birth canal for 8-14 days post-calving. The discharge is often thick and reddish in color and has no odor. If the uterus becomes infected from calving the cow has developed metritis.

Causes

Infection of the uterus by bacteria following calving. Often cows that have a difficult birth, retained placenta or have calved in a dirty environment will become infected.

Clinical Signs

Discharge from the birth canal that is thin, watery, with a red to gray color and has a foul smell.

The cow may become sick, and have increased temperature, depression, off feed, diarrhea and stop milking.

Treatment

Administer drugs to evacuate the uterus of infected contents. Usually oxytocin will only work in the first 48 hours after calving. Prostaglandins may be more effective in increasing uterine tone and opening the cervix to drain the uterus.

Antibiotics should be infused into the uterus.

Systemic antibiotics are useful especially oxytetracycline.

If the cow is sick supportive treatment is necessary; fluids, steroids, glucose and antihistamines.

Cattle may develop tetanus or other clostridial infections from metritis so vaccination or use of tetanus anti-toxin may be indicated.

After Effects

Chronic uterine infection, problem breeder.

Endometritis

This is chronic low grade infection of the uterus. The cow very seldom shows any outward signs.

Causes

Often follows metritis or retained placenta.

Often follows difficult calving, twins, abortions or C-sections.

Physical damage to the birth canal during calving or during breeding can cause endometritis.

Clinical Signs

Often no signs other than some flecks of pus in the mucus discharged during the heat periods.

Affected cattle will cycle normally but will not conceive.

Uterus may feel abnormal during rectal palpation.

Treatment

Evacuate the uterus using prostaglandins.

Treat the uterus with antibiotic flushes, best to treat the uterus during a heat to improve drainage.

Often no treatment is done because the problem is not discovered until pregnancy examination and the cow is culled for being open.

Prevention

Identify all cows with calving problems and watch for abnormal discharges.

Consider having a pre-breeding examination done on cattle with potential problems so they can be treated before breeding starts or identified to be culled.

Delayed Uterine Involution

Often associated with difficult births, twins, abortions, C-sections or retained placentas.

Cattle that have had metritis or endometritis often have sub-involuted uterus.

Clinical Signs

None, only found by rectal palpation.

Treatment

Similar to endometritis.

Pneumovagina (Windsucker)

In older cows the cervix and uterus extend forward over the brim of the pelvis, this pulls the vulva forward into the pelvis and allows air to be trapped in the birth canal. Tears or laceration from calving can also allow air to be trapped.

Clinical Signs

Air in the vagina after urination, defecation or after the animal stands up.

Urine is retained in the floor of the vagina, fecal material may also be present.

Because of contamination the affected cow is often a problem breeder.

Treatment

Correct tears and lacerations with surgery and treat the uterus for infection.

Pyometra (Pus in the Uterus)

The cow with pyometra has developed a uterine infection and the cervix has closed to prevent the accumulated pus from draining out. The uterus becomes enlarged and the cow will not show heat cycles.

<u>Causes</u>

Pyometra can result from any contamination of the uterus; problem calving, retained placenta or contamination during breeding.

In some cases cows are pregnant and the fetus dies and becomes macerated.

<u>Clinical Signs</u>

Cow fails to show heat.

Fluid filled uterus found on rectal palpation.

Discharged pus may be seen around the tail and vulva.

<u>Treatment</u>

Prostaglandins to drain the uterus.

Antibiotic flushes and manual massage.

2. Problems At Breeding

No Heat

Beef cattle will respond to environmental and nutritional stress by stopping normal heat cycle activity. Before the breeding season begins, observe the cow herd for signs of estrus activity. You should expect about 5% of the herd to be in heat on any given day. By watching for signs of estrus and getting a rough estimate of the percentage of cows showing heat you have a fair idea of the level of estrus cycle activity in the herd. If you find that the level of activity is lower than expected consider having a number of animals examined to determine if they are cycling or not.

The lack of cycling by individual cows may be the result of uterine problems, pregnancy or stress. Rectal palpation can quickly determine the cause.

<u>Treatment</u>

In most cases prostaglandins will bring a cow into heat if she is cycling normally already. If normal cyclic activity has stopped because of stress the pre-existing condition must be resolved.

Weak/Silent Heats

Often occurs 30-60 days post partum. Cow is having difficulty in establishing normal cyclic activity after calving.

Animals that are stressed will have a more difficult time in starting normal cyclic activity. Cattle that are at greatest risk are first calf heifers that are being bred for the second calf and older cows with poor teeth or chronic health problems.

Marginal deficiencies in copper may cause weak heats.

If a high percentage of cows show decreased heat activity, have several cows examined and check for serum copper levels.

Short term (48 hours) removal of calves may help herds where the cows are showing weak or absent heats.

Persistent Heat

In a small percentage of cattle the follicle that brings the animal into heat does not rupture and release the egg. In these cases the animal will show heats constantly or every few days.

Treatment

Cattle with persistent heats should be examined rectally and if a cystic ovary is found treated to induce ovulation. Cystic ovaries can also cause a lack of heats.

Prolonged Time Between Heats

A prolonged period between heat cycles will occur in a small percentage of cattle. The primary cause is the early death of the fetus, rarely because of congenital problems. A beef producer must be alert to two common diseases that will cause early embryonic death and therefore prolonged intervals between heats. These diseases are trichomoniasis and vibriosis. Both are veneral diseases carried by the bull and infect the cow during breeding. The resulting infection kills the embryo after 4-6 weeks and the cow will then return to heat. These diseases are a particular problem in range operations because infected bulls may be introduced without the owners knowledge.

If you observe an unusual number of cows returning to heat after 45-60 days of breeding, have several cows examined immediately.

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BLACKLEG AND MALIGNANT EDEMA CONTROL

J. Glenn Songer [1]

Blackleg and malignant edema are caused by bacteria of the genus *Clostridium*. Blackleg is caused by *Clostridium chauvoei* and occurs in cattle, sheep, deer and infrequently in swine.

Malignant edema affects most species of warm-blooded animals and is caused by *C. septicum*, although *C. novyi* produces a similar syndrome.

The clostridia are comparatively large, rod-shaped organisms which will not grow in the presence of oxygen. These organisms form microscopic spores which contain all the essential ingredients of the bacterium and are extremely resistant to heat, drying and disinfectants. Clostridia live normally in soil and in the digestive tract of many animals; they also enter the soil from the carcasses of animals which die of clostridial infection, often surviving there indefinitely. Because of their prevalence and their ability to survive under environmental conditions, clostridia must be considered as an ever-present threat to livestock health.

SPREAD OF THE DISEASE

When animals are infected by clostridia, the organisms usually do not spread throughout the body of the animals, but multiply in a localized area. In blackleg and malignant edema, the bacteria produce potent toxins which cause tissue destruction in the area of the infection; spread of the toxin through the blood stream often lead to general sickness and death.

Clostridium chauvoei probably enters the animal's body from the digestive tract, passing into the blood stream and settling in various muscles. Under certain conditions such as bruising of muscle, these organisms begin to multiply, producing the disease.

Malignant edema occurs in horses, cattle sheep and swine, and is somewhat comparable to gas gangrene (*C. perfringens* infection) in man. The disease occurs when a wound becomes infected by *C. septicum*.

Malignant edema and blackleg occur most commonly in animals less than two years of age but are not limited to this age group. Both diseases have been observed in animals over five years of age. These infections are most prevalent in warm seasons but may occur at any time.

SYMPTOMS

The presence of blackleg or malignant edema in a herd is often first indicated by sudden death of one or more animals. If infected animals are observed before death, one may note marked lameness, local muscle swelling and servere depression. Affected animals are often unable to rise. A high fever may be present early in the disease, followed by subnormal temperatures in later stages. Death usually comes within 24 to 48 hours after first signs are observed.

In early stages of the disease, the muscle area in which the infection locates is frequently swollen and hot. Later, the area becomes cold, and fluid and gas may be felt beneath the skin.

Failure to detect such lesions in the live animal does not rule out the possibility that malignant edema or blackleg may be present. Lesions are often small and may be overlooked or they may occur in areas where they are difficult to detect.

DIAGNOSIS

A preliminary diagnosis of blackleg or malignant edema may be made in the living animal on the basis of clinical signs and the presence of typical muscle swellings. Post-mortem examination may reveal areas of dark, discolored muscle with accumulation of bloody fluid and gas bubbles, although these findings may be inconclusive since decomposition of clostridium-infected carcasses progresses rapidly and lesions may be masked by it.

Lesions of blackleg are most often found in the upper part of a leg; although the infection may localize in any muscle of the body including the tongue, jaw, neck, heart or diaphragm. Malignant edema lesions may occur in any muscle but are usually associated with a wound.

In cases where the diagnosis is in doubt, and in order to determine the type of infection present, the examining veterinarian may submit specimens to a diagnostic laboratory. Blackleg and malignant edema must be differentiated from lightning stroke, anthrax, bacillary hemoglobinuria (another clostridial disease also known as redwater), and various acute poisonings.

CONTROL

Control of these diseases is based upon a proper vaccination program. Vaccines are available for most clostridial organisms and are effective if properly applied. Where the disease is known to be common, calves may be vaccinated at an early age; however, if vaccinated before six months old, they should be revaccinated. Calves vaccinated after they are six months of age usually are protected for several years.

Most vaccines currently available provide protection against both blackleg and malignant edema. Some contain blackleg in addition to other products, such as infectious bovine rhinotracheitis (IBR) or Pasteurella.

The prevention program in sheep ordinarily consists of vaccinating ewes about three weeks before they have their first lamb. Animals so vaccinated are usually permanently protected. Lambs born to immune ewes are resistant to the infections until about three weeks of age. Castration and docking should be carried out within this time in order to take advantage of this period of natural protection. Sheep vaccinated before one year of age should be revaccinated as yearlings.

TREATMENT

Treatment of animals affected by blackleg or malignant edema is seldom effective. Occasionally, massive doses of antibiotics given early in the course of the disease may save an animal, but clinical signs are seldom detected early enough to allow effective treatment. The key to preventing losses due to these infections is a good immunization program.

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NEONATAL CALF DIARRHEA

E.J. Bicknell [1] and T.H. Noon [2]

Neonatal calf diarrhea (NCD), also known as calf scours, is a common disease affecting the newborn calf. The most critical period is in the first few days following birth of the calf. Greatest losses occur when calves are kept in close confinement, where the opportunity for transmission of the causative agents of NCD is enhanced by their build-up in the environment.

The diarrhea and other clinical signs seen with the disease are caused by the interaction of any of several possible infectious causes and predisposing factors such as lack of colostrum, failure to absorb colostral antibody, poor nutrition and environmental affects. NCD is a costly disease, with losses estimated to be over $250 million annually and death loss of up to 25% of the U.S. calf crop.

SIGNS AND EFFECTS OF NCD

Neonatal calf diarrhea is characterized by diarrhea (scouring), progressive dehydration and death. The neonatal or newborn calf with scours will have a watery yellow, gray or greenish diarrhea containing varying amounts of mucus which may be tinged with blood. Soiling of the hindquarters and tail with the diarrheic feces is common. Checking the litter in the calf pen may reveal the diarrhea. At first, the animal may appear alert and otherwise normal, but soon refuse's feed and becomes depressed, weak, and unable to stand. Dehydration occurs as a result of fluid loss resulting from the severe diarrhea and is characterized in the calf by sunken eyes, dry skin and weakness. If the disease is allowed to progress untreated, dehydration and electrolyte (ions of body salts such as sodium, potassium, chloride, and bicarbonate) loss will kill the calf. Body temperature readings will vary, depending to some extent on the disease agents involved. One consistent fact, however, is a subnormal body temperature in the terminal stages of the disease. Regular observation of calves several times a day will permit early detection of the disease.

The normally solid fecal mass is formed by absorption of water from the liquid intestinal content by the cells lining the large intestine. Diarrhea or scouring occurs when the capability of the intestine to absorb fluid is impaired. Interference with this absorptive function of the intestine may occur in two ways. Damage to the cells lining the intestine may result from cell destruction by certain infectious agents, resulting in loss of the digestive and absorptive capability of the intestine as well as inflammation. Other infectious agents produce toxins that cause the cell lining of the intestine to produce fluid rather than absorb it. Diarrhea, dehydration and electrolyte loss occur in both instances and have especially severe effects in the newborn animal.

CAUSES OF NCD

There are numerous infectious causes of NCD, which may be present either singly or in combination. The more common ones are described below:

A) Bacteria

Escherichia coli: *E. coli* is a very common and serious bacterial cause of NCD. NCD caused by *E. coli* is called colibacillosis. Several forms of colibacillosis occur with some variation in the symptoms produced. There are many strains of disease-causing (enteropathogenic) and non-disease-causing (non-pathogenic) *E. coli*, so it is essential that the disease-producing types be recovered from the diarrheic animal and properly identified in order for a valid diagnosis to be established. There are no distinctive clinical signs that differentiate scours due to *E. coli* infection from those caused by other infectious agents. Some types of *E. coli* produce toxins that cause the intestine to produce fluid rather than absorb it. Death loss from *E. coli* infection may be high, especially in calves under a week of age. Resistance to *E. coli* infection is acquired by the calf from the colostrum or first milk of the cow. Colostrum administration is very important in the prevention of this infection.

Salmonella: Disease in calves due to Salmonella infection is a common problem in Arizona, particularly in confined animals such as dairy calves. Signs of salmonellosis include fever, loss of appetite, depression, diarrhea, dehydration and often swelling of the leg joints. Salmonellosis is most severe in calves under a month of age. These organisms are the cause of paratyphoid infection in man and constitute a potential health hazard for people associated with calves affected with salmonellosis. Diagnosis of this problem requires isolation of the salmonella organisms from the feces or tissues of the affected calf.

B) Viruses

Rotavirus: Calves 1-7 days of age seem to be most often affected with this disease agent. The disease will appear suddenly and spread rapidly through a calf herd. The virus causes extensive damage to the intestinal lining, resulting in rapid fluid loss and dehydration in calves. Other organisms such as *E. coli* may infect the calf at the same time.

Coronavirus: This virus usually affects calves over one week of age. It is not possible to differentiate this virus infection from other virus infections producing the same signs. Feces and tissues from affected calves may be submitted to a veterinary diagnostic laboratory where the virus can be identified.

C) Other Causes

While usually less common, numerous other infectious causes of NCD exist, including protozoa such as *Cryptosporidia* and coccidia, and additional types of bacteria, viruses and virus-like agents.

Non-infectious causes, while not discussed in detail here, may also be important; these include improper diet or feeding practices, or poor quality milk replacer.

PREVENTION

In general the occurrence of NCD will depend on the level of contamination of the environment by causative organisms and the level of resistance in the calf. Best results in preventing diarrheal disease will be achieved by reducing exposure of the calf to a contaminated environment and insuring adequate resistance by colostrum feeding soon after birth.

A) Reduce Exposure to Infectious Agents

1. Calves kept in confinement should be housed in individual calf pens for at least the first month of life. Portable calf hutches have proven to be very successful, as they afford isolation and can be moved to clean ground when necessary.

2. Clean pens thoroughly between calves.

3. Keep the calf pens clean and dry.

4. Provide overhead shelter for the calf pens.

5. Calves with diarrheal disease should be isolated from healthy calves and fed last.

6. Thoroughly scrub and sanitize feeding equipment after each use.

7. Do not overfeed. Milk intake should be restricted to 10% of the body weight daily for the first 7-10 days. Calves should be fed on a regular schedule with fresh whole milk or **good quality** milk replacer. Inferior quality milk replacer can cause or contribute to diarrhea, as can overfeeding.

B) Providing Resistance for the Calf

The resistance of the calf to disease depends predominately on the quality and amount of colostrum it receives from the cow during the first hours of life after birth, as there is no transfer of resistance from cow to calf before birth. Ideally it should receive colostrum within the first 6-8 hours after birth. Antibodies, which are substances which provide this resistance, are manufactured by the cow's immune system and are concentrated in the first milk, which is called colostrum. The calf's digestive system will absorb these antibodies in progressively decreasing amounts for only the first 24 hours or so after birth. It is absolutely necessary that the calf receive colostrum as soon after birth as possible for maximum absorption. Milking the cow and hand-feeding the calf is the best way to ensure that the calf receives colostrum. Two liters of colostrum fed soon after birth is recommended for dairy calves.

The types of antibodies present in the colostrum will depend on the previous exposure of the cow to disease agents. In order to provide maximum resistance to disease for the calf, a vaccination program must be developed for the cow herd in order to ensure that antibody specific to the disease problem is present in the colostrum of calving cows. A vaccination program should be based on a good diagnostic knowledge of diseases present in the herd. Qualified professional veterinary assistance should be sought in this regard.

TREATMENT

The most important consideration in NCD, regardless of cause, is prompt replacement of fluid and electrolyte (sodium, potassium, chloride and bicarbonate) losses. The calf with severe NCD suffers from dehydration and shock, which progressively worsen and are ultimately responsible for the death of the animal.

The dehydration and electrolyte losses may be corrected by oral administration of formulas containing water, glucose and a mixture of electrolytes. The oral route is the safest and easiest way to administer the formula to the scouring calf.

An easy-to-prepare oral formula, recommended by veterinarians at Colorado State University, has proven to be effective in treating the scouring calf. It is prepared as follows:

1	*2-oz. package jam and jelly pectin*
2	*level teaspoons low sodium table salt*
2	*level teaspoons baking soda*
1	*10 1/2 oz. can beef consommé*
	water to make 2 quarts

Diarrheic calves should be taken off milk or milk replacer and bottle fed two quarts of the oral formula three times a day. After two days, mix half formula and half milk and feed for one day, then resume milk feeding. Mix formula only as needed, as spoilage will occur readily. Commercially prepared formulas are also available from veterinarians or animal health suppliers.

Diarrheic calves that will not nurse a bottle but are strong enough to lie in an upright position may be given formula by stomach tube or esophageal feeder. Esophageal feeders consist of a plastic fluid container and a stainless steel probe, which is passed into the esophagus, and formula is given by gravity flow. The manufacturers of these items usually supply directions for their use or instruction may be obtained from a veterinarian or other individual trained in their use. In general, esophageal feeders should be lubricated and inserted gently, as rupture of the esophagus can occur easily and will be fatal to the calf.

Calves severely dehydrated, down, and with subnormal (less than 100.5^{o}F) body temperature will usually require skilled intravenous therapy and often the results of treatment are poor.

The routine use of oral and injectable antibiotics cannot be recommended, although occasionally they are of benefit. Antibiotic therapy may be of benefit for some bacterial organisms such as salmonella, but antibiotic-resistant strains of bacteria are very common or may develop quickly and these drugs may soon have little or no effect. Indiscriminate or improper use of antibiotics promotes the development of antibiotic-resistant strains of bacteria as does continuous low-level feeding of these drugs. Antibiotics have no effect against viruses and will not compensate for a lack of colostrum. Inappropriate use of antibiotics, particularly nonapproved ones, may lead to the development of illegal residues in the tissues of treated calves. Prolonged treatment or overdosage of calves with antibiotics may lead to fungal overgrowth in the gut resulting in chronic, non-responsive diarrhea and death in calves so treated. In herd outbreaks of NCD, and accurate diagnosis of the cause is essential for optimal treatment. Qualified professional veterinary assistance should be sought in the diagnosis and treatment of herd outbreaks of NCD.

When NCD occurs in a group of calves, every effort should be made to isolate the affected animals from normal ones. All new cases should be treated as soon as they are detected. Underlying any treatment program is the effective nursing care a calf must receive in addition to replacement of fluid losses and, if indicated, antibiotics. The sick calf should be kept in well ventilated, clean and dry quarters, handled gently, and protected from temperature extremes.

SUMMARY

Reduction of the incidence of NCD by using a preventive approach should be the primary objective and is practical in progressive dairy or cow-calf confinement operations, especially if qualified veterinary assistance is utilized. On the other hand, operators buying calves from auctions and a variety of sources and mixing them together will have variable success in reducing the incidence of NCD. Results may range from good to poor when new calves that are susceptible or are carrying infections are continually introduced. These operators usually have no control over whether a calf receives colostrum. Routine diagnostic work-ups are necessary to establish the cause(s) of NCD. This may provide information leading to more specific preventive measures.

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CASTRATING CALVES AND LAMBS

Edward A. Leviness[1]

Castration, stated simply, is the unsexing of a male animal. The practice of castrating males, in animal species used for food production purposes, is universally practiced and is probably one of the oldest surgical operations known to man.

The purpose of castration is not only to prevent reproduction, but to improve the fattening and meat production capability and to make the animal more docile and easy to handle.

In farm animals, other than horses, the job of castration usually involves simple surgery wherein the testicles (male reproductive glands that produce male reproductive cells and a hormone) are removed. Horse castration will not be discussed here, except to mention that with the horse, in addition to the testicles, special attention must be given to the removal of certain tissues adjacent to the testicles, to prevent the animal from exhibiting a level of false sexual activity sometimes referred to as being **proud cut.**

CALF CASTRATION

Equipment That May Be Used:

Jackknife — a cutting device with one or more cutting blades.

Emasculator — instrument designed to crush the tissue before it cuts them, and thus prevents serious hemorrhage.

Elastrator — instrument designed to spread and secure a small rubber ring around the spermatic cords, thus stopping blood supply.

Burdizzo — instrument that crushes the spermatic cords inside the scrotum, thus stopping the blood supply, causing eventual atrophy of testicles.

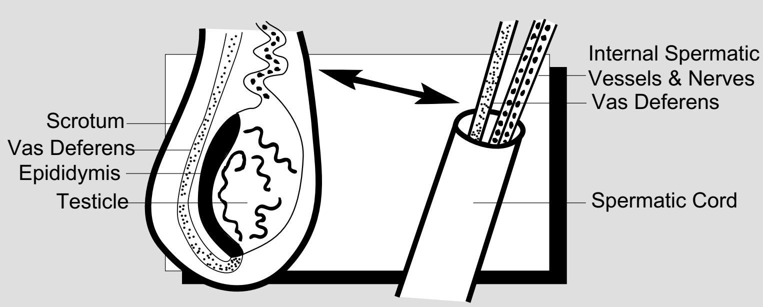
Wound Dressing — medicinal preparation used to prevent infection of wounds and cuts.

Age: It is recommended that bull calves not needed for breeding be castrated sometime between 4-10 weeks of age.

Season of Year: Spring and late fall are the best times of year to castrate calves. This time not only coincides with customary ranch herd roundups, but also is a time when the chance of wound infestation from flies is reduced.

Position of Animal: Young calves, 4-10 weeks old, should be thrown to the ground and held in a recumbent position. If it is necessary to castrate calves 8-9 months of age or older, these animals, when properly restrained, can be castrated in a standing position.

Figure A. Superficial Anatomy of Scrotum and Testicle



Methods of Castration:

1. Surgical — involves cutting into the scrotum, removing the testicles and severing the spermatic cords. This is commonly referred to as "cutting the calf."

2. Burdizzo (bloodless castration) — in this method, the scrotum is not cut, but by the use of a special pressure-leverage instrument, termed a burdizzo, the spermatic cords are crushed and severed inside the scrotum. In using this method, it is necessary to "work" a cord to the side of the scrotum and then clamp the instrument about 1-3/4 inches above the testicle. The instrument should be held in this position for 3-5 seconds. Repeat the same procedure with the other cord, making sure the instrument is clamped about one inch below the point where the first cord was clamped.

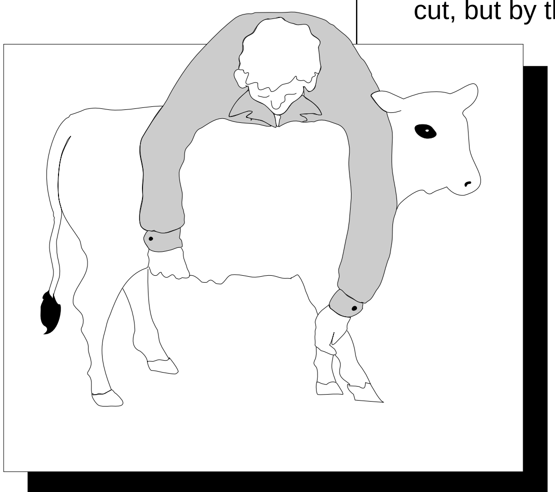


Figure B

3. Elastrator — by the use of a special hand leverage device, called an elastrator, a strong rubber ring, about 3/4-inch in diameter, is stretched open and slid over the scrotum and testicles and around the spermatic cords. When the device is removed, the contracted rubber ring remains and squeezes the spermatic cords to the point that no nutrients can again reach the testicles. This results in an atrophy, or wasting away, of the testicles.

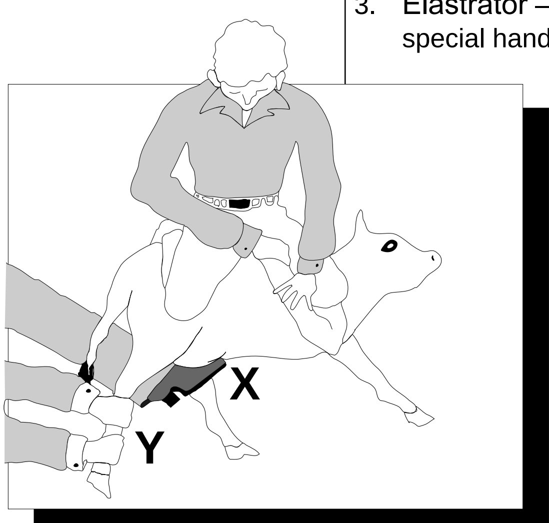


Figure C

Of the three methods of castration mentioned here, surgical castration is the one by far the most commonly used. A description of how surgical castration is used on calves is given in the following.

Procedures:

Step No. 1 — The bull calf is thrown to the ground and securely held in a recumbent position with the hind legs spread apart to permit access to the scrotal area.

To "throw" a calf, a team of "flankers" is used **(Figure B)**. In practice, one member of the team reaches across the animal's back and simultaneously grasps the calf's right leg below the knee with his left hand and the rear flank with his right hand. He then quickly "lifts" the animal with his hands and exerts force under the animal's abdomen with his right knee. This action will throw the calf off-balance and cause it to fall to the ground, resting on its left side **(Figure C)**. The team member now grasps the right (top) leg near the ankle with both hands and flexes it backward and, at the same time, exerts force into the calf's shoulder with his knee(s). As the animal is being tentatively secured in this manner, a second team member quickly grasps the calf's right (top) hind leg with both hands from the rear (Y) and, in a single motion, places his foot above the hock of the calf's lower hind leg (X) and assumes a sitting position behind the animal. By exerting forward leverage with his foot and rearward leverage with his hands, this team member is able to spread the calf's legs longitudinally, allowing access to the scrotal area.

Step No. 2 — Sanitation is important, so dirt or manure in the area of the scrotum should be removed.

Although in regular ranch operations the scrotum is not washed or cleansed, care should nevertheless be taken to keep the area as clean as possible.

Step No. 3 — Force the testicle upward in the scrotum and cut off the lower one-third length of the scrotum with a jackknife. This will expose the testicles from below. Grasp both testicles and pull them out clear of the scrotum. Next, open the jaws of the emasculator, place them around the spermatic cords and slide the instrument up the cords toward the scrotum. When approximately two inches of the cords are visible, close the jaws of the emasculator firmly, and hold the instrument in this position for 3-5 seconds. By the function of the emasculator, the spermatic cords

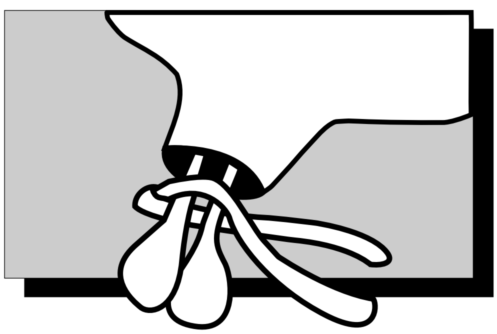


Figure D

will be severed by a crimping and cutting action. This crimping of the cords tends to reduce bleeding and enhances the healing process **(Figure D)**.

Step No. 4 — Apply a wound dressing and fly repellent to the scrotal area.

Customarily, several other management practices such as dehorning, branding, ear marking or vaccinations are carried out while the animal is in this recumbent position. If and when these practices are completed, the animal can be released.

Note: Though the surgical method described in the foregoing is the one most commonly used, some stockmen choose to use a slightly different surgical technique. This technique consists of squeezing the testicle tight against the scrotum and then cutting through the scrotum to expose the testicle. Next, a small slit is cut in the membrane (tunic) covering the body of the testicle; when this is done, the exposed testicle emerges instantly. The testicle is then pulled out and the spermatic cord is severed by the emasculator. The same procedure is followed to remove the second testicle.

LAMB CASTRATION

Equipment That May Be Used: Same with cattle.

Age: Male lambs not to be used for breeding should be castrated anywhere from one to two weeks of age.

Season of Year: Same as for calf.

Position of Animal: The animal is held in sitting position with the hind legs extended upward.

Methods of Castration: Same as with calf.

Procedures:

Surgical Castration Method — The steps in surgically castrating a lamb are the same as those followed in castrating a calf.

Elastrator Method — The elastrator castration method is probably used more with lambs than with any other farm animal. The method is quick, bloodless and very effective, if used properly. A review of the procedure follows:

Step No. 1 — Hold the lamb in a sitting position on a table, with animal's hind legs spread apart and pointing upward.

Step No. 2 — Place the specially designed rubber ring in the elastrator. Stretch the ring open and place it over the scrotum and testicles and around the spermatic cords. Care should be taken to insure that the ring is released well above the testicles and approximately one inch from the abdominal floor **(Figure E)**.

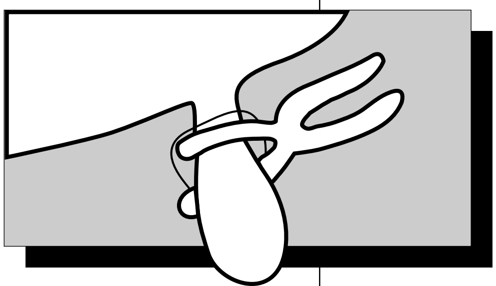


Figure E

Step No. 3 — If other management practices are to be done at this time, such as vaccination and docking, these can be done and the animal then released.

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ABORTION DISEASES OF RANGE CATTLE

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F. Lozano– Alarcon,[2]

Diagnostic success rates of only 25–30% attained by diagnostic laboratories around the world verifies the fact that determining the cause of abortion in cattle can be difficult. Abortion frequently results from an event that occurred weeks or even months earlier and the cause, if it ever was in the fetus, is probably undetectable at the time of abortion. Further, if the fetus remains in the uterus for any length of time after death, postmortem degeneration will hide lesions. Fetal membranes, which are most often first and most consistently affected are frequently unavailable for examination. Toxic and genetic factors causing fetal death and/or abortion are not discernible in the specimens available for examination and finally, many causes of bovine abortion are unknown or there are no useful diagnostic procedures for their identification.

Some of the disease entities causing bovine abortion will be briefly discussed with the idea of giving the reader an overview of abortion disease; what the veterinary practitioner would call a "differential diagnosis".

BACTERIAL DISEASES

Brucellosis

Abortions occur after the 5th month of pregnancy. Retained placenta and residual infection of the uterus are often indicators of the disease. The fetus has undergone a good deal of decomposition because it is usually retained in–utero for 1–3 days after death.

The diagnosis depends on the isolation of the Brucella bacterium from the fetal tissues and membranes, uterine exudate and blood testing of the dam.

Campylobacteriosis

Herds infected with Campylobacter fetus spp. veneralis, in which abortions occur, will have a history of infertility and repeat–breeding. If the infection has been present for several years, infertility will be more common in heifers, because many of the mature cows will have developed immunity. Abortions commonly occur between the 4th and 8th month of gestation, and expelled fetuses are usually fresh. Vaccines are available and their use has reduced the prevalence of this disease in cattle.

Corynebacterium Pyogenes

This bacterium is most frequently recovered from ruminants and is often involved in sporadic infections of the reproductive system of both sexes. It is one of the most common causes of sporadic abortion in cattle and causes abortion less commonly in sheep and swine. Abortions can occur at most any stage of gestation. Infection of the placenta is a consistent finding and is thought to result from spread of the organism by hematogenous (blood) route to the uterus. The organism can infect the fetus transplacentally and cause a septicemia.

Isolation of the organism from placental and fetal tissues as well as observing microscopic tissue lesions will provide a diagnosis.

Leptospirosis

In cattle, leptospirosis may cause fever, anemia, icterus and wine– colored urine.

However, in most cases, abortion occurs most commonly during the last trimester without any obvious symptoms in the cow. The fetus may be retained up to 3 days after death, however calves have been born alive, weak and die soon after. This is another disease where vaccination is routinely practiced and is effective.

Chlamydiosis

Chlamydial infections can produce abortion, stillbirths, or the birth of weak calves. For the most part, abortions occur very sporadically in cattle; this disease is more important as a cause of abortion in sheep. These infections can occasionally produce significant numbers of abortions in late pregnancy, particularly following inclement weather or other patterns of stress.

FUNGAL DISEASE

Mycotic Abortion

Abortions are typically sporadic, and occur from 4 months to term. The incidence, in cold climates, is highest in the winter months. Severe infection of the placenta, characterized by a leathery thickening of the areas in between the cotyledons, is a common finding. In about 25% of the cases the fungus invades the fetus and red or white ringworm–like lesions can be seen in the fetal skin.

Leathery, thickened placental tissue is observed in both Brucella and Campylobacter abortion, but in neither case is the thickening as severe as with mycotic infection.

VIRUS DISEASES

Infectious Bovine Rhinotracheitis

IBR virus can cause a number of disease manifestations in cattle including "Red Nose", Infectious Pustulo–vulvovaginitis, Conjunctivitis, Septicemia in Calves, and Abortion. Symptoms of any of these conditions may or may not be present in the herd when abortions due to the virus infection result. Abortions occur from 4 months gestation to term, and the fetuses have been dead 2 or more days prior to expulsion and can be even partially or completely mummified.

Bovine Virus Diarrhea

BVD virus infection usually results in a subclinical to mild disease, undetected in most affected herds. The mild disease is characterized by anorexia, respiratory distress, and diarrhea. The pregnant cow is seldom clinically ill with acute BVD infection but the embryo or fetus can be severely affected. In the first month of gestation, infection can result in death and resorption of the embryo. From the 2nd to 4th month, growth retardation, central nervous system malformations, alopecia, mummification and/or abortion can occur. Infections after the 6th month can result in abortion. In addition, 2–3 week premature calving, stillborn and weak calves can be a consequence of fetal BVD virus infection.

Epizootic Bovine Abortion

EBA, also called "Foothills Abortion" is a tick–borne infection of cattle that produces chronic fetal disease and abortion. The vector of this disease is the argasid tick Ornithodoros coriaceous which is known to inhabit the foothill chaparral, scrub oak, and manzanita brush areas of California, adjacent areas of Nevada, Oregon and Northern Mexico. Cattle exposed to the vector for the first time are primarily at risk. The infected cow presents no symptoms and if pregnant, passes the organism to the fetus who then becomes chronically infected; there is a 3–month or longer period between exposure of the cow to the tick and abortion of the fetus. Birth of weak calves as well as abortions happen during outbreaks of EBA. The causative agent is, at present, unknown.

PARASITIC INFECTIONS

Trichomoniasis

Trichomoniasis is a venereal disease of cattle characterized by infertility, pyometra and occasional abortion caused by a protozoan parasite, Tritrichomonas fetus. The parasite is carried asymptomatically on the epithelium of the penis and prepuce of the bull and transmitted to the cow at the time of breeding. Although abortions do occur most infected animals become, at least temporarily, infertile. The conceptus dies between 18 and 60 days of gestation. The affected cows' return to estrus is necessarily at irregular, delayed intervals greatly extending the breeding season. Thus, repeat breeding becomes an important clinical observation for Trichomoniasis as well as Campylobacteriosis.

Most infected cows are able to eliminate the infection, conceive and carry a calf to term. A small percentage of cows maintain the infection, and carry the calf to term, yet, a very small number will remain infected into the next breeding season.

Neospora-Like Abortion in Cattle

This relatively new abortion disease is caused by a coccidial parasite called Neospora caninum–like. It was named so because of its morphologic similarity to Neosporum caninum, a parasite causing disease in dogs. Sporadic abortions were described in the early reports, however more recently, papers from California and New Mexico describe abortion storms up to 10% of the herd occurring in 1–5 month periods. Abortions, as described in these reports, occurred between 5–7 and 5–6 months of gestation respectively. Affected cows show no signs of illness other than retained placentas for several days after the abortion.

A distinct pattern of lesions occurs in aborted bovine fetuses, which includes infection of the brain, heart, skeletal muscle, and evidence of inflammatory changes in other organs; a specific laboratory test has been developed for the detection of the parasite in animal tissues.

The organism has not been isolated from naturally infected cattle therefore the work necessary to fully characterize it cannot be done. The question remains as to whether the parasite demonstrated in the tissues of the aborted fetuses is Neosporum caninum or an antigenically similar protozoal parasite.

While there is no concrete information as to the source or method of transmission, the California group suspected a carnivore host, and the transmission of the parasite by fecal contamination of the feed.

ABORTION CAUSED BY PLANTS

Pine Needle Abortion

Abortions occur most often in the late fall, winter and early spring in the last trimester of pregnancy in cattle having access to pine needles (Pinus ponderosa). Predisposing factors include: sudden weather changes, starvation, changes in feed or sudden access of cows to pine needles. The abortion can begin as early as 48 hours and continue as long as 2 weeks after ingestion of the needles. The affected cow has weak uterine contractions, excessive uterine hemorrhages with incomplete dilation of the cervix. Retained placenta is a constant occurrence often followed by severe uterine infection and peritonitis.

Locoweed Abortion

Locoweeds are several species of plants of the genus Astragalus and Oxytropis. The active principle of these plants is an alkaloid called Swainsonine. This toxic substance induces a form of storage disease and continued ingestion of the plant over a period of 4–6 weeks or more results in failure to thrive, ataxia, behavioral abnormalities (locoism) and abortion. We have also seen in Arizona, Hydrops amnii, a condition in pregnant cows who have ingested locoweed and develop a large accumulation of fluid in the amnion resulting in tremendous distension of the abdomen. In the pregnant ewe both abortion and birth defects can result from ingestion of locoweed. The birth anomalies include: brachygnathia (bulldog jaw), contractures or overextensions of joints, limb rotations, osteoporosis and bone fragility.

PLANTS THAT CAUSE ABORTION IN CATTLE

Gutierrezia microcephala (Broomweed)
Gutierrezia sarothrae (Broomweed)
Conium maculatum (Poison Hemlock)
Solidago ciliosa (Golden Rod)
Sorghum almum (Johnson Grass)
Trifolium subterraneum (Cocklebur)
Claviceps sp. (Ergot)

BOVINE ABORTION DIAGNOSIS

Submission of abortion specimens to most veterinary diagnostic laboratories may be done directly or through a veterinarian. In either case, a fee is usually charged for the service.

The following procedures are preferred by the laboratory:

1. Call ahead and notify the laboratory if at all possible.

2. The preferred specimens are: the fetus; placenta, if available; blood samples from the cow or cows that aborted.

3. The fetus and placenta should be placed in a double set of heavy duty plastic bags to prevent leakage, then packed in ice (but not frozen) along with any blood samples in a good quality, leakproof picnic cooler. Most laboratories will clean and return the cooler if requested.

4. Persons handling aborted fetal and placental material for shipment should always wear disposable gloves and wash thoroughly afterwards, as some infectious causes of bovine abortion can cause serious disease in man. Pregnant women should not handle aborted fetal tissues.

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FOOTHILL ABORTION: A WESTERN STATES PROBLEM?

Michael N. Oliver[1] and
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Epizootic bovine abortion (EBA) is commonly referred to as "foothill abortion" because it was originally recognized as an abortion disease of cattle that occurred after summer grazing in the foothill regions of coastal and central California. In the early 1950s, with the advent of calving two year old heifers, it became a recognizable disease with abortion rates up 50%. EBA is also is a phenomenon of summer grazing in the Sierra Nevada Mountains and the Great Basin regions of California, and has been diagnosed in southern Oregon and western Nevada.

IT IS A TICK TRANSMITTED ABORTION DISEASE

EBA is a disease that is apparently only transmitted by the bite of a particular soft-bodied tick commonly known as the pajahuello (or pajaroello) (pronounced pa-ha-way'-lo). The scientific name of the tick is *Ornithodoros coriaceus.* Despite several decades of study, the disease agent the tick is transmitting has eluded researchers. Suspected agents have been isolated from aborted fetuses and from the tick, but none has proved to fulfill Koch's postulates for recreating the disease when put back into pregnant cows. Recently, thymus from an aborted fetus has apparently transmitted EBA to a pregnant cow under experimental conditions.

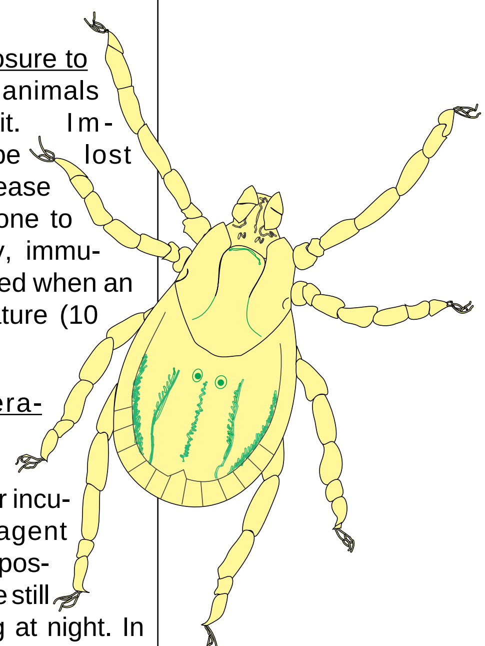
FOUR THINGS ARE NEEDED FOR EBA TO OCCUR

First: Cattle must be six months or less in pregnancy. Experimentally, cattle that were as early as 35 days pregnant when exposed have aborted.

Second: Pajahuello ticks must be present and hungry in the range the cattle are utilizing. Ticks don't refeed for about two months after exposure to cattle.

Third: No previous exposure to the disease means animals have no immunity to it. Immunity can apparently be lost if exposure to the disease has not occurred for one to two years. Apparently, immunity can only be obtained when an animal is sexually mature (10 months or older).

Fourth: Ambient temperatures must be warm and dry enough to activate the tick's metabolism or incubate the unknown agent within the tick's body (possibly in the 70s F.), while still staying above freezing at night. In coastal and central California, this weather pattern usually occurs from May through October. In the mountains and high desert regions, the warm months typically are June through October. Unusually warm, dry winters can cause EBA to occur in normally "safe" periods.



ABORTION OCCURS 3-4 MONTHS AFTER EXPOSURE TO TICK

If all of the above four factors exist at the same time, EBA abortions can be expected to occur 3 to 4 months later. To determine where disease exposure (tick exposure) happened, the producer must be able to identify where his cattle were grazing 3 to 4 months prior to the onset of abortions.

THE TICK "LIVES" IN COW AND DEER BED GROUNDS

The existence of pajahuello ticks in a pasture can be verified by collecting them. The tick resides in the soil and organic matter found in deer and cattle bedding areas; this tick does not "quest" nor climb up on brush like most of its hard-bodied cousins. Few people have seen this tick in the field. Its bite on the human is very painful and subsequent bites cause skin necrosis and very swollen areas.

TICKS DON'T LIVE IN WET AREAS OR PLACES THAT FLOOD

Don't bother looking in irrigated pastures or areas that are subject to flooding. The pajahuello doesn't survive well when submerged or damp. Look above the high water mark when in gulches and arroyos. They have been found in desert dry wash creek beds.

TRAP THESE TICKS WITH DRY ICE (FROZEN CO_2)

The pajahuello tick detects and locates its host by being extremely sensitive to increased concentrations of gaseous CO_2 in its environment; CO_2 is exhaled in animals' breath. Tick collection is accomplished by placing pieces of dry ice (frozen CO_2) on the ground or in buried pans (traps) underneath trees or brush where there is evidence of deer or cattle bedding. If ticks are present and if they haven't taken a blood meal in the last month or two, they will crawl out of the ground, locate the source of CO_2, and be picked up as they are seen moving toward the dry ice, or fall in the trap on their way to the bait. If a pasture does not yield ticks to CO_2/dry ice trapping, then you may need to repeat it several times. A pasture with any number of ticks is positive, but a pasture without ticks being trapped needs several different trapping attempts before considering it negative.

THE TICKS ONLY STAY ON THE COW ABOUT 20 MINUTES AT A TIME

Unlike hard-bodied ticks that attach to their host for 7 to 10 days, the pajahuello only requires about 20 minutes of attachment in order to completely engorge itself with blood. Once full, the tick drops off the animal and quickly buries itself back in the soil. The exception to this behavior is the larval stage tick that hatches from the egg. These very tiny creatures stay attached for a week or more while they slowly engorge and grow to several times their original size. After the larva leaves the animal, it molts and becomes a nymph. Thereafter, each time a nymph feeds, it molts and becomes a larger nymph. This process continues through 5 to 7 nymph stages (instars) before the tick becomes an adult. Adult females are unmistakably larger than adult males. Females will lay about 300 eggs following each blood meal. The life span of the pajahuello is unknown, but experimentally, <u>large females have lived</u> <u>in plastic dishes for four years without having a blood meal.</u>

NO VACCINE AVAILABLE

Until the causative agent is identified, it will be difficult to develop a vaccine to protect animals from EBA abortion. A number of research projects are underway both at UCD and in collaboration with University of Nevada/Reno. Newer molecular biology and biotechnology tools are being applied to this problem.

YOU CAN LEARN TO MANAGE AROUND THE DISEASE

Many producers have been able to avoid the disease simply by incorporating knowledge of the previously listed four EBA prerequisites into their breeding and range management programs.

CRITICAL POINTS TO REMEMBER

Exposing sexually mature heifers to known pajahuello pastures during warm weather has often established immunity in many of these animals. Females may lose their protection if removed from tick exposure areas.

Shifting breeding seasons has avoided the overlapping of susceptible gestation period with warm weather tick exposure.

Changing pasture rotation schedules has utilized tick pastures before breeding or after cattle are six months pregnant.

Don't bring pregnant cattle into a known tick area without taking into account the EBA risk and how to avoid.

HAVE YOUR VETERINARIAN LOOK AT ABORTED FETUSES

If EBA is suspected of being the cause of abortion in a herd, a veterinarian should be consulted quickly. He will establish a herd history and ask that any fetuses that are found be brought to him refrigerated (not frozen) as soon as possible. Small pieces of fresh fetal tissues placed in formalin can be used by a veterinary pathology lab to look for microscopic lesions that are particular to this disease.

DIAGNOSIS OF EBA/FOOTHILL ABORTION

With a suspicious history, EBA can be grossly diagnosed in about 1/3 of the fetuses.

The fetus will usually be at least six months old (small cat sized), and may have any combination of the following external and including:

- enlarged lymph nodes, especially the prescapular nodes which are in front of the shoulder blade at the base of neck on the side,
- a fluid-filled abdomen,
- pinpoint hemorrhages around the eyes or under the tongue,
- enlarged liver with a rough discolored surface,
- and/or pinpoint hemorrhages on the thymus.

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HAND FEEDING YOUNG CALVES

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Many individuals purchase dairy calves during the year and raise them for sale or meat. Other calves may be orphaned due to the death of the mother. In many cases, these calve do not survive the first week or two of their new environment.

Anytime a newborn calf is taken from the mother and raised separately several problems may arise. It is critical that the calf receive colostrum (the milk given during the first 5 days after calving) from a mother cow if it is to have any chance for long term survival. Colostrum contains antibodies to common diseases. When purchasing calves at auction it is important that the buyer receive an affirmation of this prior to the sale. If the calf does not receive colostrum within the first 12 to 24 hours following birth, it does no good to provide it later. The intestinal wall changes shortly after birth following the first ingestion of milk or water, and is incapable of absorbing the antibodies from the colostrum into its body after 24-hours.

The following recommendations will help ensure survival of hand raised calves:

- Place the calves in a warm, dry enclosure where they are protected from the wind.
- The calf may require assistance the first day or so until it is used to the feeding process. A nipple bottle or pail is valuable for starting calves, however they can learn to drink from a pail in a few days.
- Avoid placing a very young calf in a pen with an older animal. The older animal may harass the calf and compete for dry food.
- As a matter of course, it is a good idea to inject the new calf with vitamins A, D & E and Combiotic. Approved antibiotics in the milk replacer will help guard against respiratory problems, scours and other digestive upsets.
- Milk replacers made from dried milk are more expensive than soy based products. However, they may be better initially. Some calves may have, or develop, allergies to some of the proteins in either soy based or dried milk products. Be prepared to shift products if scours or other symptoms of product incompatibility occur.
- Ensure that there is adequate fat and protein in the milk replacer. Generally, fat content should be at least 20-25% at the onset while protein should be 18 - 20%.
- Feed the calf every three to four hours for the first two or three weeks. This a critical element in the survival of very young calves. A little bit several times a day will be one of the best scours prevention measures one can employ.

The calf can go for eight hours between feedings, two to three weeks after birth. Good alfalfa hay along with a commercial calf starter ration, available from local feed stores, should be placed in the pen. Generally, it is more economical to feed at the rate the calf will eat, rather than putting large amounts of feed out for it to waste or become stale. Once the calf is eating five to six pounds a day (about 2.5% of body weight) it can be <u>gradually</u> weaned from the milk replacer. Calves should be observed for diarrhea and/or other infections and treated accordingly.

Some calves have been successfully weaned as early as thirty days after birth. However, for the average person it is better to wean them gradually at 60 to 75 days of age. The key is to be sure of adequate consumption of the calf starter and high quality alfalfa hay before weaning.

The new calf is very delicate and needs the same type of round the clock care the human baby needs. Before going out and purchasing a calf, be prepared for the time, effort and expense required to raise it.

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TRICHOMONIASIS

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This disease is caused by a microscopic one-celled parasite Tritrichomonas fetus, which infects the cow's uterus resulting in abortion and infertility. Trichomoniasis has been recognized in all major cattle-producing countries during the past 100 years. It was first characterized in Europe at the turn of the century as a bovine infertility problem.

With the widespread use of artificial insemination there was an apparent disappearance of the disease in parts of the world where cattle are intensively managed. However, it persisted where cattle graze regions considered unsuitable for intensive agriculture.

Few economic analyses have been made to assess the disease's cost to the rancher. But, one study done in the late 1950's suggested the overall loss associated with this infection could be as high as $800 per bull per year. In another more recent estimation a loss of anticipated revenue loss of $43,000 developed in a 360 cow herd the year trichomonas infection occurred. The pregnancy rate had dropped from 95 to 64.5% and almost 10% were cycling late.

The bull is the important link in the transmission of the disease in the herd. The parasite is present on the mucosa of the penis and in the crypts of the prepuce of the bull. These crypts are downfoldings of the epithelium which forms the lining of the prepuce and they offer an environment that is conducive to the proliferation of the trichomonas organisms. An important fact in the prevention and control of the disease is the poor development of prepucial crypts in bulls less than four years of age.

Trichomoniasis causes a very mild inflammation of the affected tissues in the bull with virtually no clinical signs of disease. Transmission then occurs from sexual contact between animals. Bulls can passively transmit the organism when a non-infected bull serves an infected cow and, soon after, serves a non-infected cow, however infection rates by this means of transmission are low. A more common scenario occurs with the introduction of a mature bull in the herd, who is infected by a cow who actively transmits the organism which establishes itself in the prepucial crypts where it evidently stimulates little immune response on the part of the bull. This animal can then infect many cows in the herd and subsequently other herd bulls.

The organism can be found in the cervix, vagina and uterus of cows after both experimental and natural infection. The part of the tract where long-lasting infections occur has not yet been identified. As with the bulls, clinical signs of the disease are not usually apparent; although infrequently a cow may show a slight vulvar discharge.

An infected cow will abort between 18 days and five months of gestation; losses most commonly occur at 40-60 days. The infection results in the development of an intrauterine environment not conducive to the maintenance of pregnancy. For the most part, the infection is rather short lived in the cow; researchers report a duration of 90-100 days. Following the initial infection, a period of temporary immunity exists during which a cow can conceive and carry a calf to term.

There have been reports that the carrier condition occurs with this disease. In this case, the infected cow conceives and carries the organism through gestation, calves and maintains the infection for at least six to nine weeks following calving. It is believed that this does not occur often, and thus, we can be encouraged that the majority of cows that have calved normally are uninfected.

In herds with short breeding periods, the disease can result in a high number of non-pregnant cows. With a longer breeding season, there may be more pregnant cows since there is adequate time for immunity to develop. In the latter case, cows become infected, abort, develop immunity and go on to conceive again and carry the calf to term. It is entirely possible that a given cow can go through this cycle more than once before carrying a calf to term; in this instance the rancher will observe a significant measure of repeat breeding in his herd. In either case, there are also an increased number of late calves.

The definitive diagnosis of Trichomoniasis depends on the cultivation and identification of the organism from cervical mucus or prepucial smegma. In most cases the sampling of the bull battery for the organism is recommended and it is important that the sample be properly and adequately collected. For best results, an insemination pipette to which a 10cc syringe is attached, is inserted into and as far back in the prepuce as possible. The prepucial lining is scraped by a backward-forward movement of the pipette, the tip against the lining, done in a vigorous manner for 30 seconds to 1 minute. The pipette is withdrawn from the back of the prepuce while pulling back the plunger of the syringe. There should be 4-8 inches of pink to red mucus in the pipette. If this mucus recovery is not achieved the lining of the prepuce was inadequately scraped and the process should be repeated. This is important as it increases the chance of recovering the organisms that lie in the deep parts of the prepucial crypts. If the sample is not satisfactorily taken, and there are false negative results, the disease will continue to cause production loss unabated.

A plastic 2-chambered pouch ("In Pouch") containing an improved trichomonas culture media is available, that can be used for the collection and transporting of cervical and smegma samples. The material in the insemination pipette is transferred directly into the upper chamber of the pouch. The mixture is then squeezed into the lower chamber by rolling down and sealing the top chamber. The pouches can be sent to the diagnostic laboratory where they are incubated and subsequently examined under the microscope. These pouches make sample inoculation, shipping and the laboratory examination much easier with better results than the previous methods employed. The pouch held at room temperature has a shelf life of six months and is reasonable in price.

Treatment for infected animals is not, for the most part, effective or practical. Prevention is the only satisfactory approach to this disease. A vaccine is commercially available but there is a good deal of controversy as to its efficacy. A number of management recommendations can be offered which will help to prevent introduction of the disease in the herd. Replacements should be only virgin bulls and heifers and use, as much as possible, home raised heifers. Ideally bulls should be replaced after 4 years of service. A mature bull introduced in the herd should be tested for trichomonas at least 3 times on successive weeks with a negative test, before exposure to cows. Surveillance of breeding behavior of the animals, in particular the observation of excessive repeat breeding, may give a warning of possible infection.

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PINE NEEDLE ABORTION

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INTRODUCTION

Pine Needle Abortion (PNA) is a problem for cattle ranchers who raise cattle in areas where ponderosa pine trees grow. Abortions caused by pine needles are most common on grazing lands throughout the western United States (James et al., 1977). Pine needles have been known to cause abortions in cattle since 1920 (James et al., 1989). PNA can cause severe financial losses to the cattle industry. Abortion rates can range from 0% to 100% (James et al., 1989).

Abortions are caused when cows eat green pine needles off trees, from windfalls, and dead needles off the ground around pine trees (James et al., 1977). Cows in feedlots have been seen eating pine needles due to boredom (James et al., 1977). Weather influences consumption of pine needles by cows, due to the availability of feed, snow cover, and grazing time (Pfister et al., 1993).

Calves aborted due to PNA are born weak but viable, meaning pine needles cause a premature parturition (Ford et al., 1992). Abortions may occur as early as twenty-four hours to as long as three weeks following ingestion of pine needles (Pfister et al., 1993). Cows usually retain the placenta after abortions caused by PNA (Stuart et al., 1989). There are also other problems associated with PNA such as metritis, peritonitis, and death to the cow (Stuart et al., 1989).

PNA interrupts the stage of development when cell division and growth are occurring rapidly (Chow et al., 1972). The stage affected is the last trimester of pregnancy during late fall, winter, or early spring. Various studies indicate that blood flow to the calf is reduced during late pregnancy by up to 60% (Ford et al., 1992; Panter et al., 1992). The reduced blood flow stresses the calf, causing a premature parturition (Short et al., 1997). The chemical in pine needles responsible for the reduced blood flow to the calf and the cause of PNA is called Isocupressic acid (Smith 1996).

DIFFERENTIAL DIAGNOSIS

PNA should not be confused with abortions caused by Foothill Abortion. PNA generally occurs later in gestation than does Foothill Abortion. PNA calves have a short hair coat, lack teeth, and are very susceptible to respiratory infections. Pine needle aborted calves may be viable if they are spotted early enough because they are born prematurely but not dead. Foothill aborted calves are typically born dead, with no chance of survival. They generally have lesions around their lips and no hair on the body with the exception of a little hair above the eyes.

SUSCEPTIBILITY

Cows are susceptible to PNA even when there are very few pine trees in the area they are grazing. The only way to prevent PNA is to keep cows away from pine trees and pine needles (Short et al., 1994). One rancher has observed that one pine tree per three acres is enough to cause PNA. Cows having access to pine needles are at risk, no matter how few pine trees they have access to.

Cows will eat pine needles off the ground or while they are still on the tree. The pine needles that are eaten off the ground are eaten because the cows are trying to eat the grass coming up underneath the pine needle cover.

Often in snowy country, the area under pine trees does not have much snow cover. Grass can easily grow in this area under the fallen pine needles.

Cows try to move the pine needles away so they can get to the grass. However, by trying to clear the pine needles away they still may ingest enough pine needles to cause PNA. This usually occurs under trees that are all by themselves with no other trees nearby. The area under these trees is not trampled on by cows trying to stay out of harsh weather conditions and provides a good environment for grass to grow.

Pine needles eaten off trees are due to snow or wind pushing branches down to a level where cows can easily reach them. Once the snow or wind has pushed the branches down, cows are able to reach up and grab a mouthful of pine needles. The reason cows eat pine needles off branches is unknown, but may be due to boredom or a diet high in protein. Upon inspection of pine trees it is easy to see that cows do eat pine needles from the branches.

MANAGEMENT STRATEGIES

Cattle ranchers have a variety of methods from which to choose to combat PNA. These may include pruning trees higher so snow and wind cannot push branches down to a level that cows can reach. All fallen pine needles around trees must be raked up as well. Other strategies include logging the trees, fencing cattle away from trees, or simply avoiding grazing areas that contain pine trees during cows' third trimester of pregnancy. The pine needle cover can be abundant under trees.

Each of these strategies carries considerable additional costs to ranchers. Also, not all of these strategies have the same effectiveness. In selecting a preventative strategy ranchers must determine what they can afford to do. They should account for the cost of the strategy they choose and also the amount of time required to implement the preventative strategy.

Calves born after day 250 of gestation have a greater chance of survival than calves born prior to day 250 (Panter et al., 1992). These calves need to be warmed up quickly since they have been born prematurely and lack the ability to keep themselves warm. Also, some calves will need to be bottle fed since some cows have not been stimulated to produce milk (Stuart et al., 1989).

The amount of money cattle ranchers lose due to PNA depends on what costs the rancher has in the cows. Total costs including feed, pasture, veterinarian, supplements, etc., may be as high as $421. This is just an example; actual figures will vary depending on size, and location of operation. Ranchers may also need to include other expenses to determine the actual amount lost per calf due to PNA.

At $421 per calf, the amount a rancher can lose due to PNA can be very large. Cattle ranchers need to be aware of PNA and of the substantial costs that come with it. There are ways to deal with PNA that may cost cattle ranchers a lot of money in the short run but will save them money in the long run.

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FROM:

Arizona Ranchers' Management Guide
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NUTRITIONAL VALUE OF RANGE FORAGE FOR LIVESTOCK

George Ruyle [1]

Grazing is the base of the nutritional program for range cow outfits. On some ranches, range forage is the only feed source cattle have except for salt and water. During periods of initial plant growth in the spring and summer all forage species are high in nutrient content although moisture content may also be high and limit dry matter intake. However, as plant growth stages advance, the nutritional differences among forages becomes more evident, especially during the fall and winter periods.

The nutrient value of range forages is best tested by their ability to provide for the nutritional requirements of the grazing animal during the various seasons of production. Plant nutritional values should be compared with the corresponding animal requirements during the year.

The nutrient evaluation of range forage can be based on how much protein, phosphorus and energy the plants contain. These, along with carotene (vitamin A) are the four principle nutrients that may be limiting on rangelands. These can best be discussed by dividing the plants into three common forage classes, grasses, forbs (broad-leaved, herbaceous plants, often called weeds), and shrubs.

Protein is calculated from the amount of nitrogen contained in plants. Grasses decline in digestible protein rapidly as they mature. Nitrogen is moved by the grass plant from above-ground parts available to the grazing animal to storage organs below the ground as the current years grass growth matures. Shrubs, on the other hand, are good sources of protein even after they reach full maturity because nutrients remain in branches and leaves as well as below ground. Forbs, in general, are intermediate between shrubs and grasses with respect to protein content during most seasons.

Phosphorus, a macro-mineral, is often limiting in range forage plants. Grasses are low in phosphorus soon after they form seed. Shrubs are generally considered good sources of phosphorus for general animal maintenance and gestation, even when mature. Most forbs have a phosphorus content only slightly lower than that of shrubs. Phosphorus content of plants can fluctuate depending on the soil status. Soils high in phosphorus will allow plants to contain more phosphorus than where soils are limiting in phosphorus content.

Energy values of forage are commonly reported as Total Digestible Nutrients (TDN) or Digestible Energy (DE). Grasses are generally considered good sources of energy primarily because of their high content of cellulose. In very rank grasses however, digestibility will be so low as to reduce intake and thereby reduce total energy intake. Digestibility is the proportion of a dietary nutrient available for animal metabolism and indirectly tells us something about intake (as digestibility goes down, intake may go down). Shrubs are not considered good sources of energy after they reach fruit development. Again, forbs are intermediate between grasses and shrubs in furnishing energy. In my opinion, energy is more frequently a limiting factor to livestock production on rangelands than is crude protein. The single biggest problem however, especially when forage plants are mature, is getting enough total nutrients into the animal each day.

Other factors may also affect the nutritive value of range plants. Range condition, for example, may alter total forage intake of grazing cattle. Research shows that protein and phosphorus are about the same in plants growing on good versus poor condition range. However, plant species on poor condition range may be less digestible than plant species on good condition range which can reduce total forage intake by livestock. The animals either can't or won't eat enough. An appropriate mix of grasses, shrubs, and forbs, is necessary to provide nutritious forage to livestock on a year-long basis.

Management factors such as stocking rate and specialized grazing systems can also influence grazing animal nutrition. Heavy stocking reduces individual animal performance and can result in damage to the forage resource. Although the influence of animal numbers can be altered by controlling the time the plants are exposed to grazing and allowing for adequate recovery periods, proper stocking rates are essential to long-term range livestock production levels.

Grazing systems may reduce or improve forage nutritive value. Although forage reserves are a necessary part of ranch planning, and some amount of plant material should be left for resource protection, if pastures are allowed to accumulate a lot of old plant growth animal production may suffer. This can be offset by adjustments in stocking rates or changes in range condition. Carefully planned grazing can help increase diet quality. In grazing cells for example, the longer animals stay in a particular paddock the further diet quality is reduced. If grazing periods are shortened, be sure to consider the implications of the subsequently shorter rest periods.

Supplementation will probably be necessary to achieve high levels of livestock performance from rangelands although economic analysis should consider the bottom line before any decision on supplementing cattle diets is made. Even though total production may be reduced, profits may be maximized at lower input and offtake levels. When determining whether or not to supplement, cow as well as forage conditions should be considered, but remember, it is the nutrients provided by the range forage that are supplemented. Over-supplementation, especially of protein, or supplementing too late in the season to improve production are not uncommon practices.

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RANGE COW NUTRITION MANAGEMENT EVALUATOR

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INTRODUCTION

Many of the important decisions ranchers make involve the management of the nutritive intake of their cows. Decisions such as levels and timing of supplemental feeding directly impact the level of nutritive intake of cows. Decisions such as choice of breeding date indirectly impact the level of nutrition by changing the timing between the periods of the pregnancy—calving cycle with high nutritive needs and periods of forage availability. This linkage between ranchers decisions and the nutritive intake of range cows is complex and involves many factors. Further, the linkage between the nutritive intake of range cows and their production is also complex. This complexity makes the analysis of decisions impacting nutritive intake of cows a very difficult task.

In order to provide ranchers a tool to analyze decisions which impact range cow nutritive intake, a computer simulation of the range cow nutrition—production process has been developed. This program allows ranchers to predict the results of alternative strategies of managing the nutritional intake of their cows and evaluates the results in economic terms.

The purpose of the range cow nutrition—production simulation is to predict the results of rancher decisions given an observed or predicted diet of the range cow. The simulation tracks the input to the cow and calf on a daily basis, and predicts their weight daily and predicts the calving rate for the cows. The simulation is run for a period of seven years and a summary measure of the present value of the cows production over the seven year period is produced to be used as a yardstick to economically compare different alternatives or conditions.

To use the evaluator, information on the diets of the cows and the nutritive content of the forage they are eating is necessary. The diet data is obtained by microscopic analysis of fecal samples to identify undigested plant cells. The nutrition data is obtained from laboratory analysis of forage samples. Since both diets and the nutritive value of the forage change as the seasons change these analyses must be repeated on a monthly basis. For ranches which have not developed this information the program can still be used by inputting data from nearby ranches or even from ranches in other areas with similar conditions.

Once the diet and forage data are collected and entered into the computer, information on the beginning condition of the cow and on the current management practices, such as breeding dates and supplementation, must be input into the computer. The computer then predicts the performance of the cow for a period of seven years and produces a series of graphs, which are useful in analyzing the results and formulating alternative strategies for the computer to evaluate.

The following is an example of how a rancher might use the program. First the rancher, working with technical help from an extension agent, would develop an estimate of the composition of the diet and the nutritional composition of the forage species in the diet. An example of such information in a graphical form is displayed in Figure 1. The line labelled “1” is the percent of the cow's intake made up of this particular plant species over a complete season. The line labelled "2" is an estimate of the percent phosphorus contained in this particular forage over the season while the lines labelled "3" and "4" are estimates of the protein and TDN percentages. As can be seen in the example, both the percentage of the diet and the nutritional value of the forage vary greatly over the season.

Next the rancher would specify the particular management scheme to be used for the base run. For our example, this is a breeding date of May 15th, an initial weight of 900 pounds for a bred cow, a weaning date of October 15th, and no supplement. The model is then run on the computer with the results as shown in Figures 2 and 3. Figure 2 shows the life production of the cow under the base conditions. As can be seen in the figure, the cow loses weight and the calving rate declines until in the forth year she skips a calf and regains some of the lost weight. After this she again declines in weight and skips another calf in year seven. Figure 3 shows detail of the nutritional situation over the season. The line labelled "1" is the predicted gain per day given the diet and forage nutrition. Line "2" is the gain which would be predicted based only upon the phosphorus content of the forage under the assumption that the other components of nutrition protein and energy were readily available. Line "3" is the predicted gain based on the protein level and line "4" is the predicted gain based on the energy level, again assuming the other components of nutrition are available. The graph demonstrates the fact that energy must be available for gain and that the other components of gain combine with energy to result in gain. At the start of the year energy is very low with the result that the cow loses from one to two pounds a day for the first three months of the year. For the next three months the energy availability improves but the cow continues to lose weight at about one quarter pound per day. After six months the summer rains result in new forage and the cow gains weight until winter. During this four month time of weight gain, it is clear from the graph that while the cow has an excess of energy, protein levels and particularly phosphorus levels are limiting factors in keeping the cow gain below the gain possible if the energy were fully utilized.

The economic results depend upon both calf weights, which are simply a function of the forage available between calving and weaning, and upon the calving percentage of the cow over her lifetime. For the base run the lifetime value of the cow's production expressed in present dollars is 777 dollars under conservative estimates of calf prices. This value will be used as a yardstick to judge alternative management strategies.

One possible reaction to the base results would be to check on the correspondence between forage availability and nutritional needs of the cow. Figure 4 displays how the cow's nutritional requirements change over the annual cycle. Requirements are high during the last trimester of pregnancy and during the time the cow is nursing her calf. After the calf is weaned the requirements drop considerably. Comparing the requirements to the results of the potential and actual gain chart result in the discovery that gain is highest at the time of the year where nutritional requirements are lowest. Since the requirements are tied to breeding date, one possible alternative to evaluate would be changing the breeding date to September 1st in order to better match up requirements and forage availability. Figures 5 and 6 display these results. The most obvious result is that the cow maintains her weight for the seven years and does not skip any calves. The gain graph shows that weight losses are moderated for the winter months caused by reducing the nutritive requirements of the cow during this period. The economic yardstick for this alternative is $1,128. This is improvement over the base case of over 350 dollars all without any additional cost to the rancher.

Another possibility suggested by analysis of the base run is to remove the limitations on phosphorus during the period where it is limiting gain, by supplementing from July 15th through December 31st with a 6% phosphorus block at the rate of .2 pound per day and a cost of 20 cents per pound for the supplement. The results of this simulation are displayed in Figures 7 and 8. A definite improvement in performance over the base run can be observed. The limitation of gain by phosphorus is significantly reduced resulting in higher gains and the economic yardstick adjusted for the costs of the supplement, increases to 964, over a 150 dollar improvement.

What about a more traditional program of supplementation? What happens if we feed 1.5 pounds per day for 95 days beginning on November 1st of a 2% phosphorus, 25% protein and 65% TDN supplement. The results are displayed in Figures 9 and 10. The cows get fat. The calving rate therefore increases. The gains increase dramatically over the base run for the period the cows are being supplemented. The graph suggests that good use of the forage energy is being made with the addition of the limiting factors of phosphorus and protein to the cows diet. Most importantly the economic yardstick increases to 1,283 dollars, even after subtracting out the feed costs, over a 500 dollar increase compared to the base situation.

What about changing both the breeding date and supplementing? What about changing the timing of the supplementation? What about ....? The rancher can continue the process of evaluating alternatives quickly and cheaply by use of the computer simulation. Hopefully the computer results would lead to the selection of alternatives to further evaluate by real world testing and monitoring.

Conclusions

Ranchers in Arizona now have a new tool to help them evaluate decisions involving changes in range cow nutrition. As data bases on diets and forage nutritive values are expanded, ranchers throughout the state will be able to quickly and efficiently evaluate alternative nutrition management strategies. For further information on the Range Cow Nutrition Evaluator contact your County Extension Agent.

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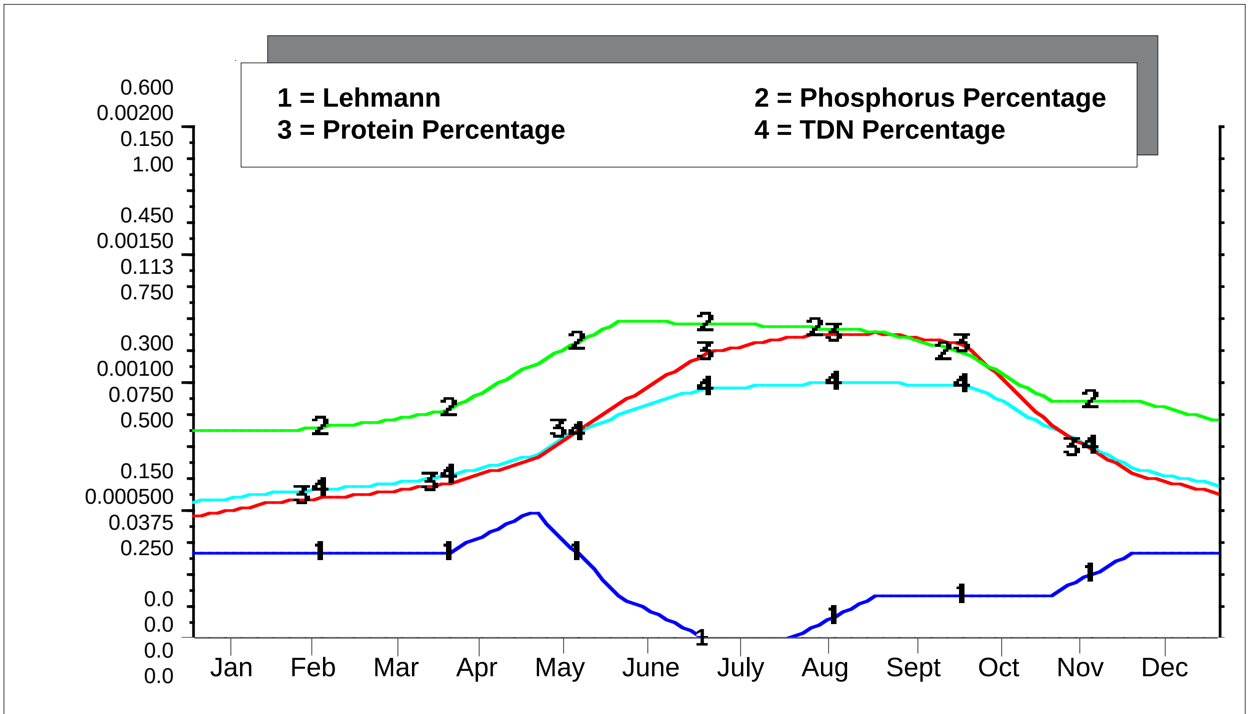
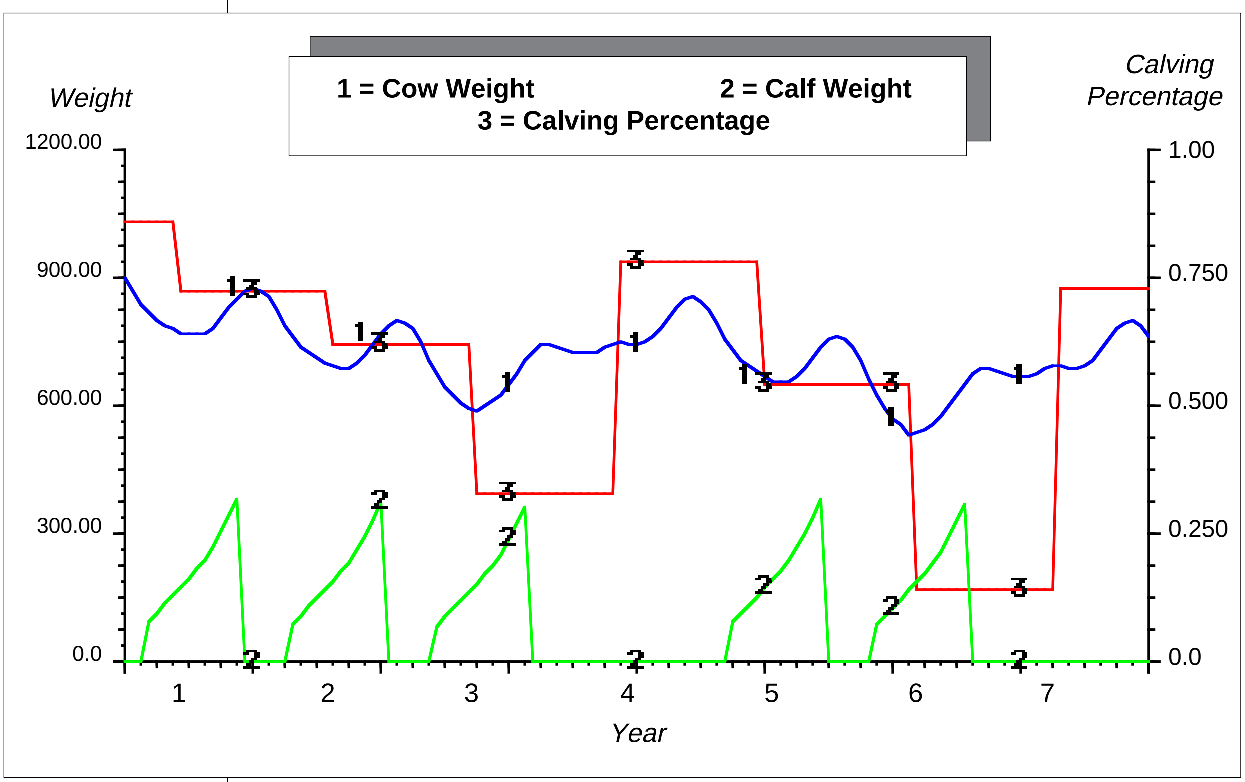


Figure 1



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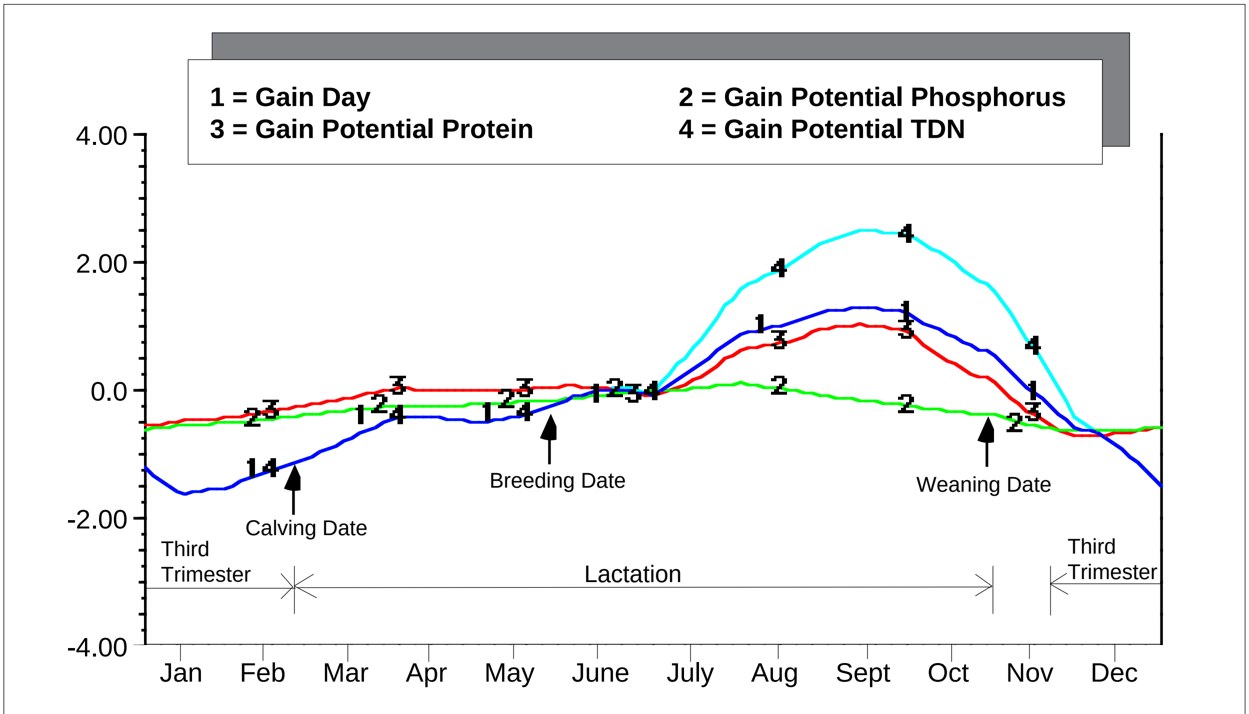

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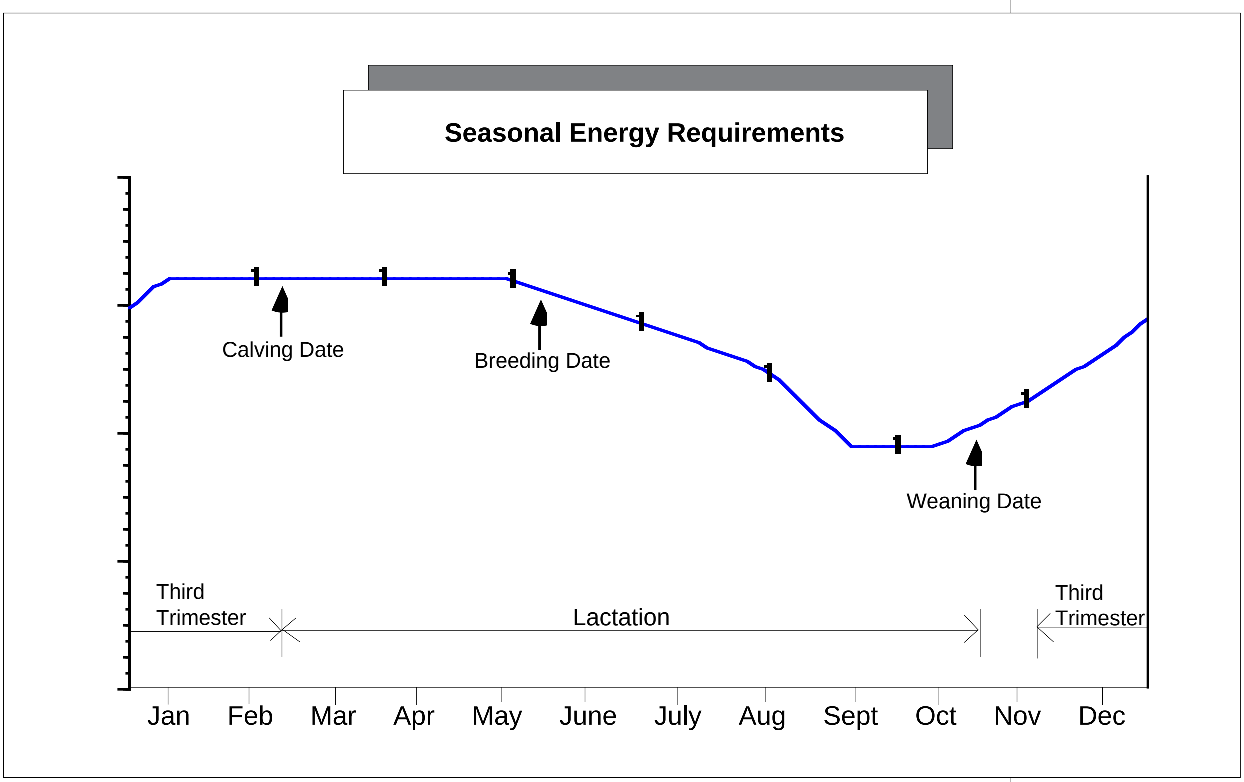

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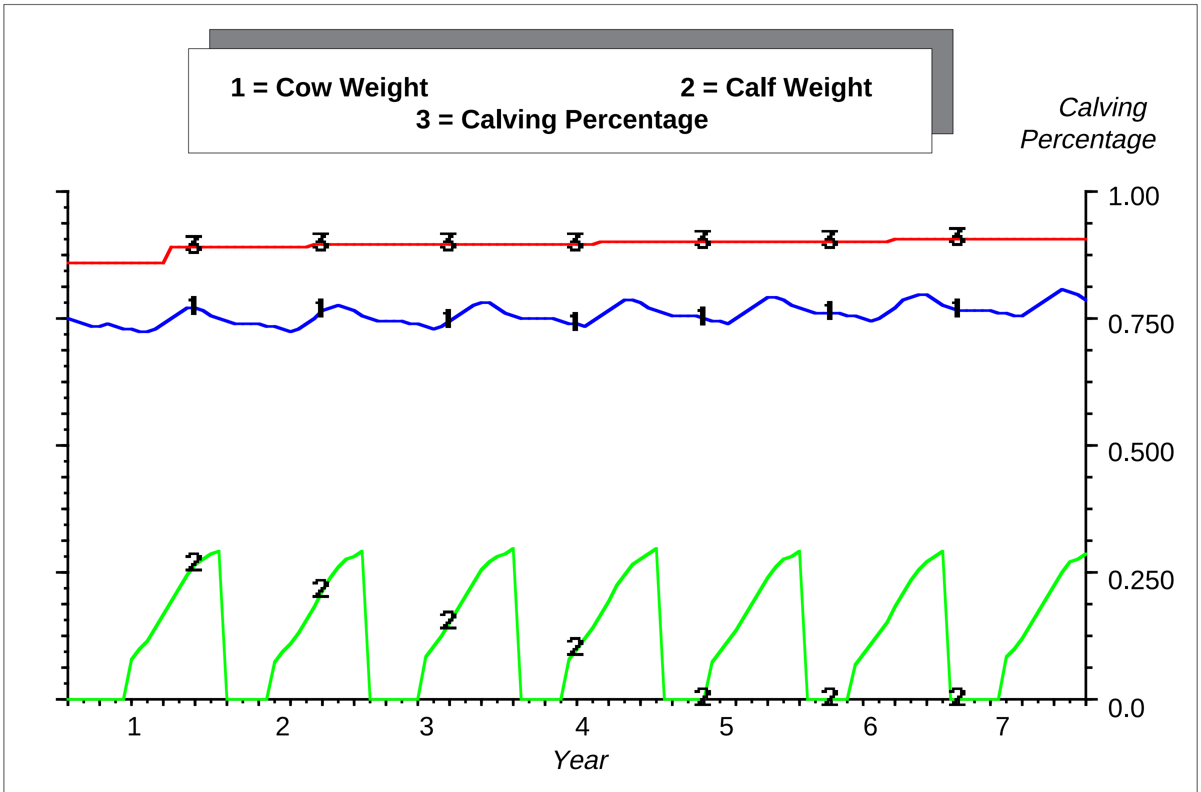

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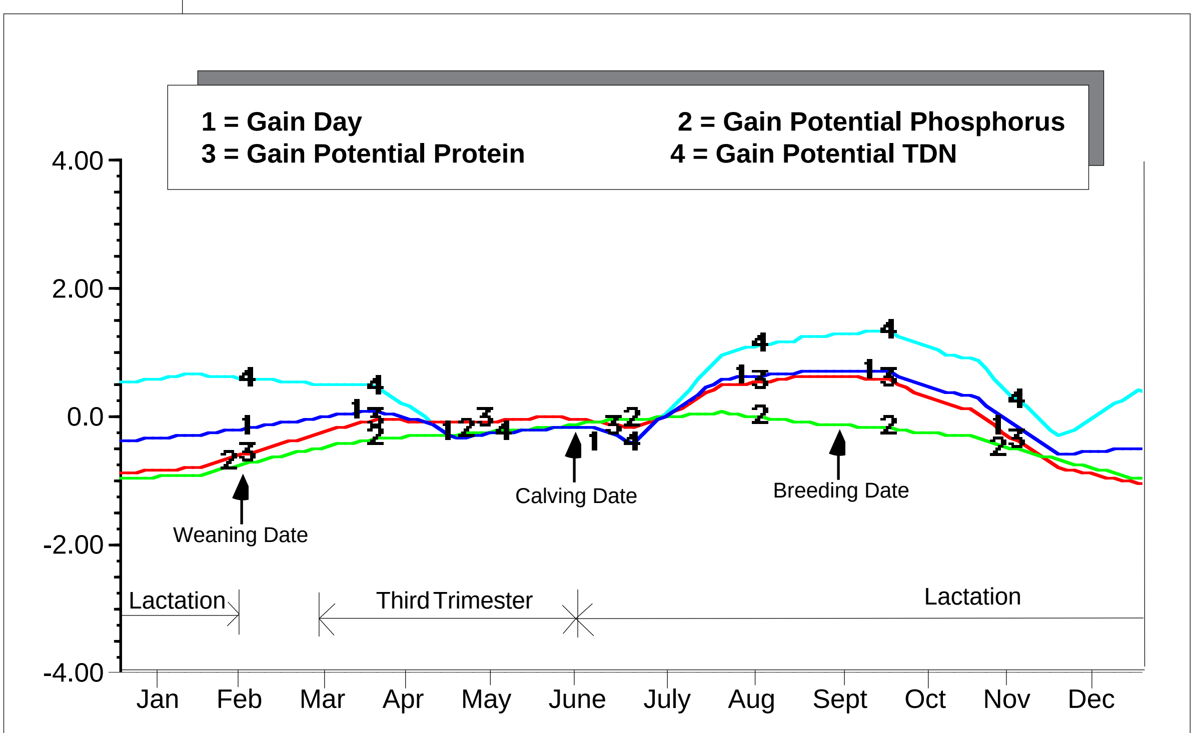

Figure 6

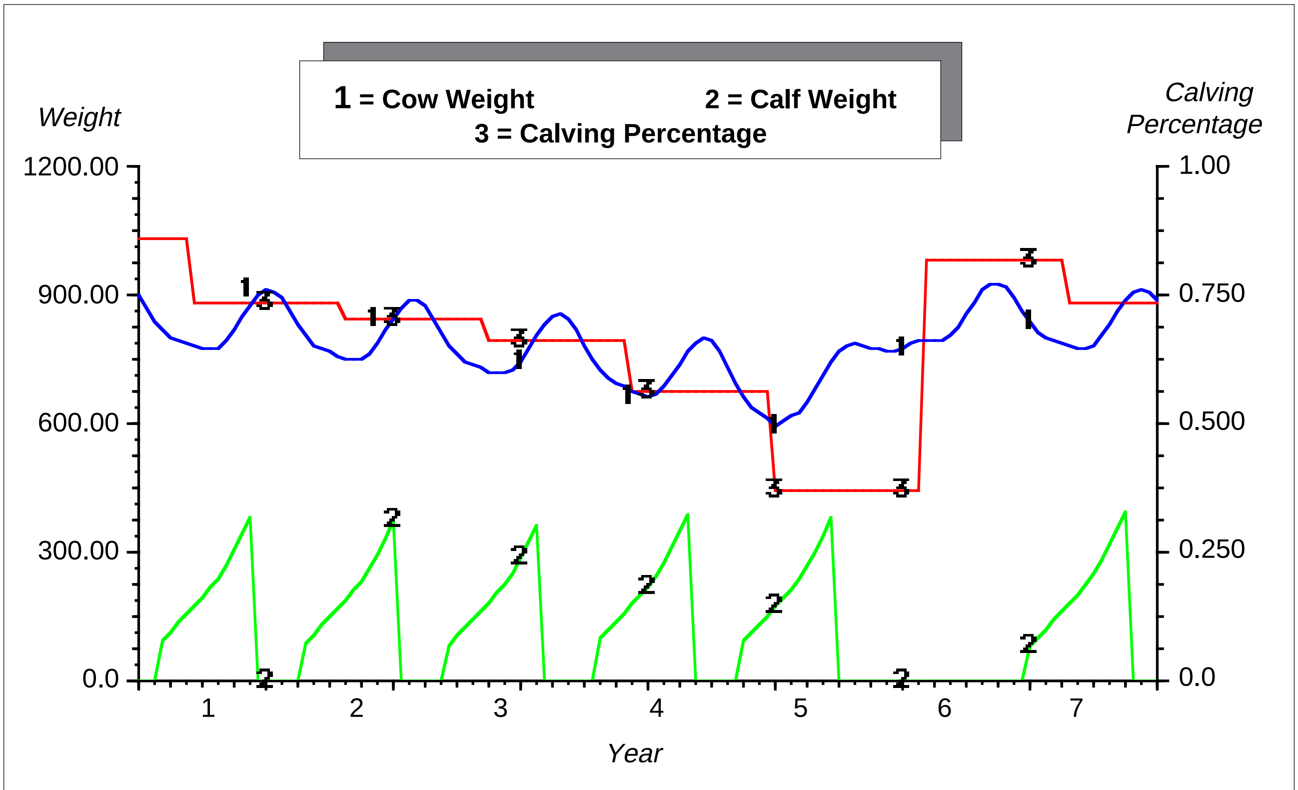

Figure 7

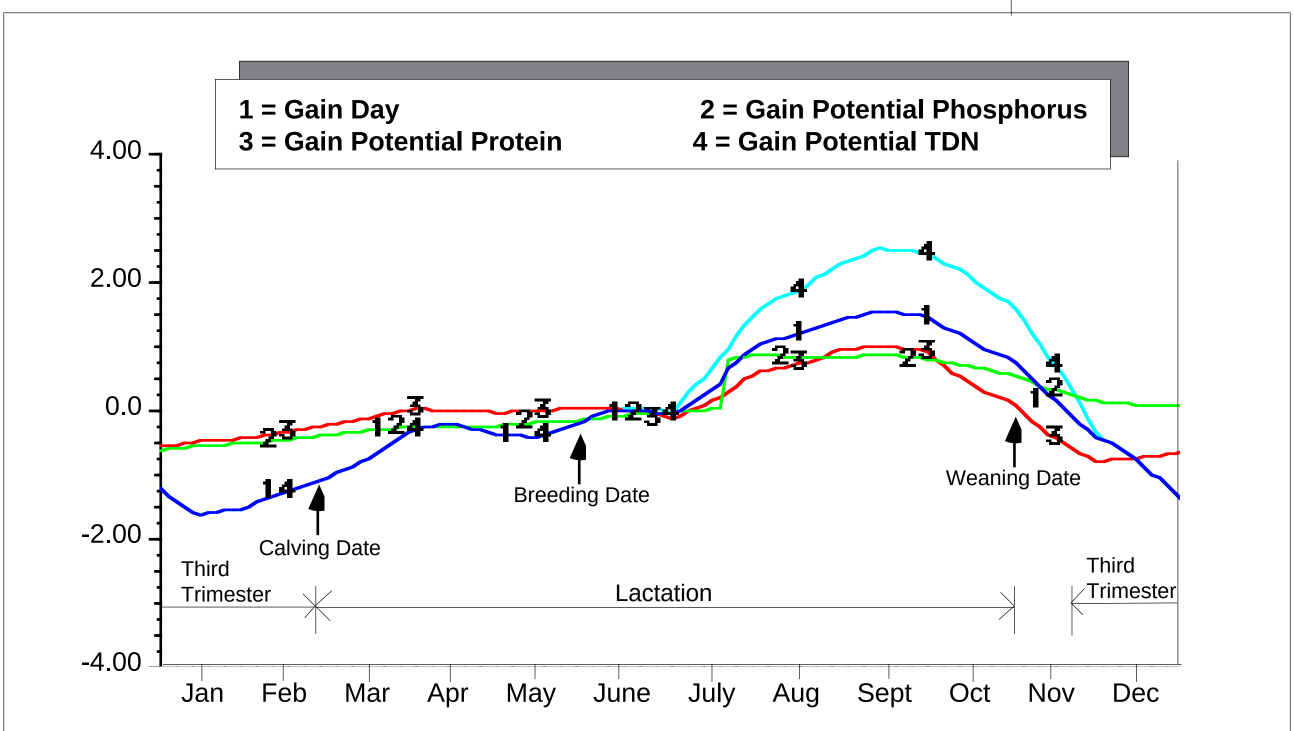

Figure 8

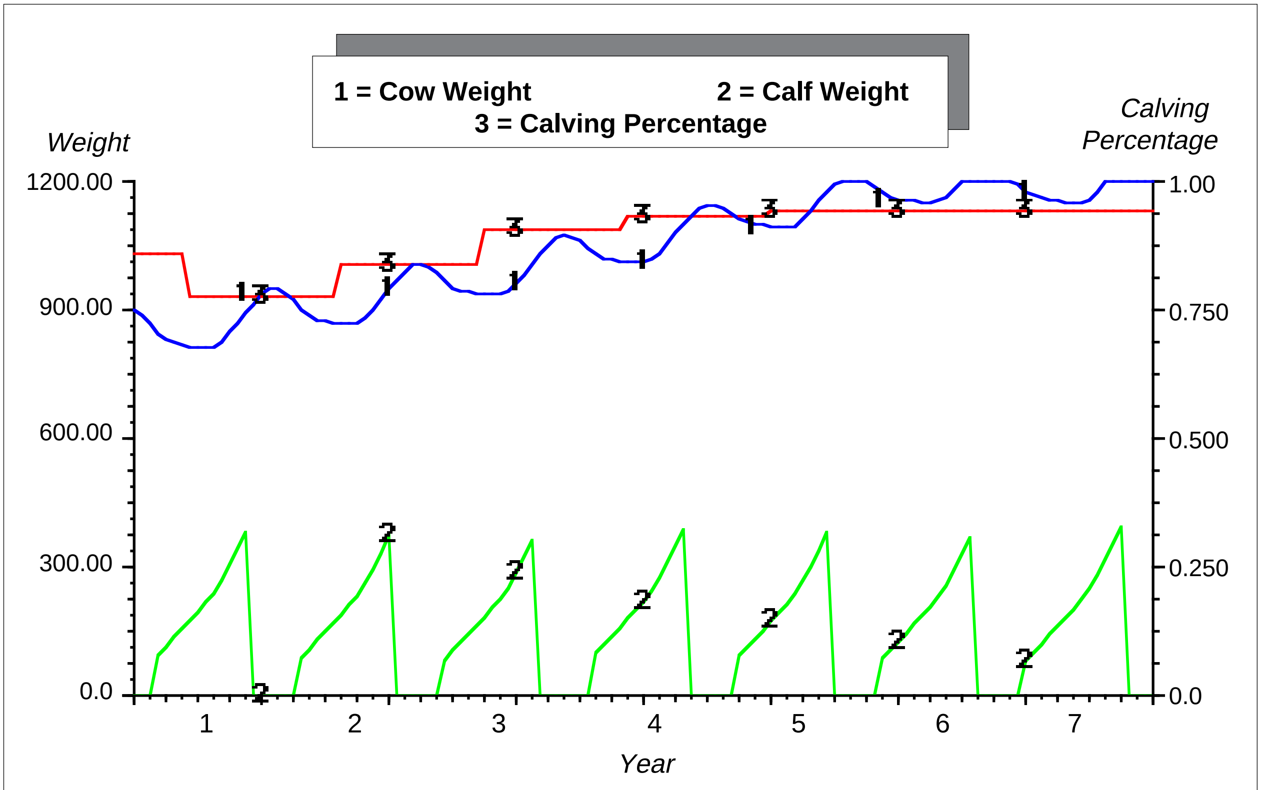

Figure 9

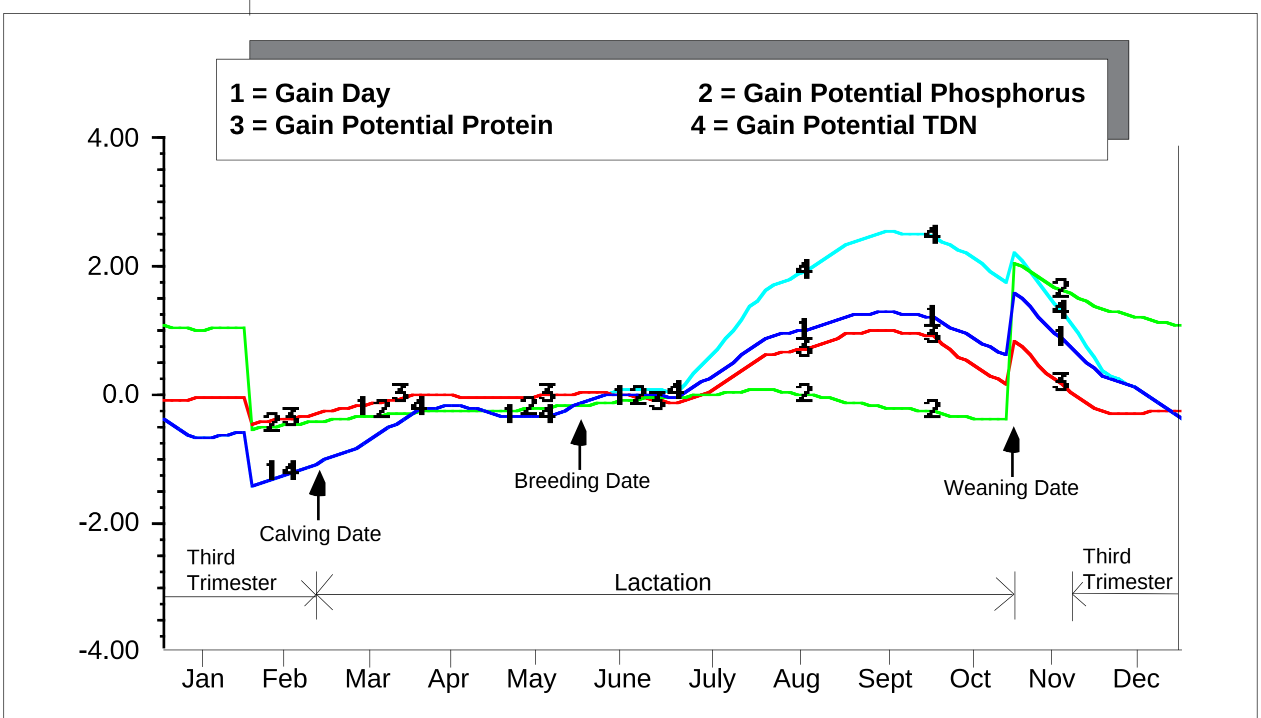

Figure 10

FROM:

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Russell Gum, George Ruyle, and Richard Rice, Editors.
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RANGE COW NUTRITION IN LATE PREGNANCY

Edward LeViness [1]

The success or failure of a cow-calf operation depends on how well the cow's nutritional requirements are met during the last three months of pregnancy.

In Arizona, the majority of cow-calf producers manage their breeding herds for spring calving and the sale of weaner calves in the fall. This is a traditional practice. It is logical and reflects experience gained from generations of cattle ranching in the southwest.

The practice of spring calving, like nearly everything else in the cow business, creates its own share of management problems. One of these concerns deals with the nutritional requirements of the breeding herd during the winter months.

For the cow that has been bred to calve in February or March, or perhaps even earlier, one of the most critical periods in her yearlong productive cycle is the interval between late December through March. This time represents the 7th, 8th and 9th months of pregnancy or what is often referred to as the third trimester of gestation. Unfortunately, however, this is the season when most forages reach their lowest nutrition. This is particularly true with protein and carbohydrate levels and the problem occurs with both grass and browse.

The graphs illustrate the relative nutritive values of grass and browse species found in the southwest:

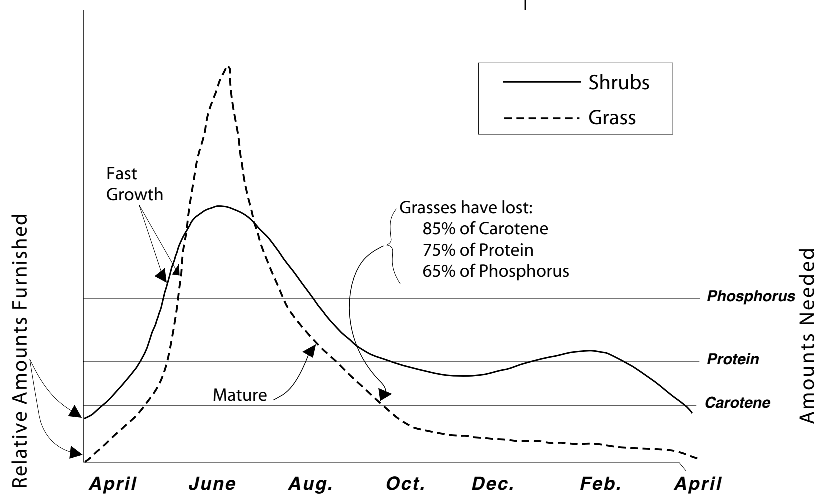

Figure 1. Seasonal Trends in Protein, Phosphorus, and Carotene Content of Range Forage.

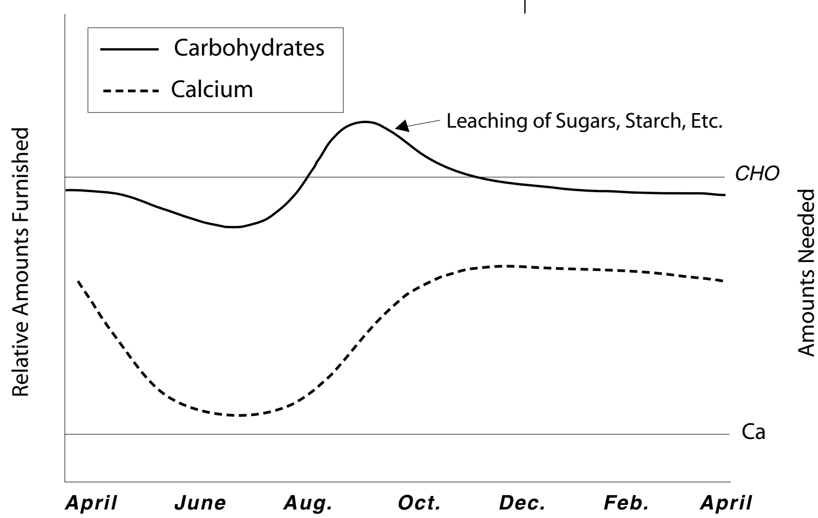

Figure 2. Seasonal Trends in Calcium and Carbohydrates in Range Grass.

It can be seen that grass and browse vary considerably in nutritive levels throughout the year. More important however, from the standpoint of the pregnant cow, is the fact that the nutritive levels of these forages are usually lowest during plant dormancy. This also happens to be a critical time for the cow in the latter stages of pregnancy.

To emphasize the importance of nutrition in the cow and why this 80-90 day period is so vital to her performance, consider a few of the duties expected of the cow that are affected by nutritional intake during this time:

a) she must adequately nourish the developing unborn calf because it triples in weight during the last 3 months of gestation,

b) her thriftiness and body condition must be maintained in order to promote normal calving (weak cows produce weak calves or no calves at all),

c) the cow must insure an adequate supply of milk for the newborn calf,

d) she needs to maintain good health to minimize the interval between calving and first heat after calving,

e) she should stay in good condition to increase the likelihood of conception during the first or second heat period after calving.

With these thoughts in mind, it might be good for the producer whose breeding program is aimed at weaning a marketable calf from as many cows as possible every 365 days, to check the arithmetic involved. The length of gestation in most cows is between 275-290 days. Thus, a beef cow is pregnant for most of the year! So, if the objective is for the cow to calve every 12 months, she has only 75-90 days after calving before she is pregnant again. It is obvious there is little time to waste.

Consider then, the work the cow is expected to complete, the time span she has to work in and the generally inadequate nutritive levels of forages she grazes. It is evident that she will need help.

One logical way to help the animal during this important 80-90 day period is to increase the nutrient level or quality of feed available. It is important to understand this goal. Even under proper grazing management where animal numbers and their daily dry matter requirements are in balance with forage production, there are times when forages will not provide the quality of nutrition necessary to attain the livestock performance level desired.

One of the most common and economical methods of providing the cow with extra nutrition during her critical period is by supplying what the industry refers to as a supplemental feed. The word supplement means something that completes or makes an addition. This is what a supplemental feed is, a nutritional additive that lends balance and helps "round-out" the nutrients provided by range forages.

Supplemental feeds are not designed nor should they be expected to substantially replace dry matter, roughage of range forages or both. (This does not consider true range feed emergencies, wherein the role of supplemental feeds may be altered temporarily.) Most supplemental feeds contain varying quantities of the nutrients protein, carbohydrate, minerals and vitamins.

The questions and details concerning the what, where and when of supplemental feeding represent subjects in themselves and are not dealt with here.

The purpose of this material is to remind stockmen of the vital functions that must take place in the cow during the latter stages of her pregnancy and the part adequate nutrition plays in these functions. It's up to the rancher to insure that the nutritional needs of the cow during this critical time are met.

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LEAST COST SUPPLEMENTATION

Russell Gum[1]

Supplementation decisions are one of the critical tasks in managing a range cow herd. Should I supplement? When should I supplement? What should I supplement? These are all common and important questions that a rancher must answer. The purpose of this report is to describe a decision aid that can help in answering these questions. A copy of the decision aid in Excel spreadsheet format can be obtained from the author.

The question answered by this decision aid is given:

1) a current weight for a mother cow and a target weight for that cow 12 months in the future

2) expected nutrient analysis for range forages over the year

3) nutrient analyses and costs for possible supplements **what is the least cost supplement plan to insure that the mother cow meets or exceeds her target weight?**

This is an extension of the least cost ration problem described earlier and uses the same basic spreadsheet techniques to solve the problem. The major difference is that instead of constraints on nutrients in the ration we now have constraints on cow weight. To do this we need a way of predicting cow weights. The method used is a modified net energy method. The modifications were to add minerals and protein to the gain formula and to vary the energy requirements as a func-

Figure 1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1														
2	Month		1	2	3	4	5	6	7	8	9	10	11	12
3	cow weight	lbs	800	790	781	774	773	798	824	835	832	821	811	800
4	pg_energy_req	ratio	1.32	1.6	1.6	1.6	1.6	1.6	1.49	1.38	1.25	0.95	0.95	1.12
5				Calve				Breed						
6	lbs energy	lbs/day	6.00	5.92	5.86	5.82	5.87	6.07	6.23	6.28	6.24	6.16	6.08	6.00
7	pounds_protein	lbs/day	0.75	0.74	0.73	0.73	0.77	0.80	0.80	0.79	0.78	0.77	0.76	0.75
8	pounds minerals	lbs/day	0.00	0.00	0.00	0.01	0.04	0.04	0.03	0.01	0.00	0.00	0.00	0.00
9														
10	net energy for maintenance	lbs/day	6.24	5.76	5.29	4.76	3.61	3.70	4.47	5.32	6.43	6.37	6.30	6.24
11	net energy for gain	lbs/day	-0.24	0.17	0.57	1.06	2.26	2.37	1.76	0.96	-0.19	-0.21	-0.23	-0.24
12														
13	gain-energy	lbs/day	-0.12	0.09	0.31	0.62	1.63	1.66	1.06	0.51	-0.09	-0.10	-0.11	-0.12
14	gain-minerals	lbs/day	-0.99	-1.05	-1.12	-0.89	1.77	2.02	0.46	-0.74	-1.04	-1.02	-1.01	-0.99
15	gain-protein	lbs/day	-0.22	-0.23	-0.23	-0.24	-0.23	-0.27	-0.30	-0.30	-0.25	-0.24	-0.23	-0.22
16														
17	expected gain	lbs/day	-0.35	-0.29	-0.22	-0.06	0.84	0.87	0.36	-0.09	-0.36	-0.36	-0.35	-0.35
18														
19	cost	$/month	2.00	2.00	2.00	2.15	3.15	3.25	2.77	2.25	2.00	2.00	2.00	2.00
20														
21	cost per year	27.56												
22														
23														
24	range forage	lbs consumed	15.00	14.80	14.64	14.52	14.49	14.96	15.45	15.65	15.60	15.40	15.20	15.00
25	hay	lbs fed/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	cottonseed	lbs fed/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	block	lbs fed/day	0.00	0.00	0.00	0.02	0.15	0.17	0.10	0.03	0.00	0.00	0.00	0.00
28	mineral supplement	lbs fed/day	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

tion of the pregnancy and lactation state of the cow.

Because of the added complexity of this model compared to the simpler ration formulation model, not all spreadsheet solvers will solve this problem. You may have to experiment with the solver option in your spreadsheet to check if it works. The template is available in Excel format and the Excel solver does solve this problem albeit slowly. If you would like current information on what spreadsheets can solve this problem you might consider posting a question to the IRM electronic highway mailing list. (See the Ranchers' Management Guide article on the electronic highway information sources for details on how to do this.)

The basic spreadsheet is displayed in Figures 1 and 2.

How to use the supplement decision guide.

1. Input the starting weight of your cows in cell C3.
2. Input the expected nutrient values and costs for your range forage in rows 30 through 33. This is not a trivial task as the species composition of the diet as well as the nutrient values of the components of the diet vary over the year. However, insight can be gained into the supplement problem by inputting a reasonable estimate of these values based on your experience or perhaps information from extension, blm, forest service or soil conservation service range management professionals.
3. Input the nutrient values and costs for the possible supplements you would like to consider. Commercial supplements have this information on their tags. Values for other feeds such as hay and cottonseed can be obtained for your local extension agent.

Set all of the supplement fed cells (C25:N28) to zero. At this point the

Figure 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
29														
30	range forage	% protein	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
31		% energy	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
32		% phosphorus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33		$/au day	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
34														
35	hay	% protein	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
36		% energy	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
37		% phosphorus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
38		$/lb	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
39														
40	cottonseed	% protein	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
41		% energy	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
42		% phosphorus	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
43		$/lb	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
44														
45	block	% protein	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
46		% energy	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
47		% phosphorus	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
48		$/lb	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
49														
50	mineral supplement	% protein	0	0	0	0	0	0	0	0	0	0	0	0
51		% energy	0	0	0	0	0	0	0	0	0	0	0	0
52		% phosphorus	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185
53		$/lb	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
54														

spreadsheet will calculate the expected results for the scenario where no supplement is fed. You must analyze this result by inspection and common sense to see if the result is what you would expect to happen if you did not feed any supplement to your cows. If the results are about what your experience and common sense would expect to happen if no supplement were fed then you can proceed to the next step. If not, this problem needs to be fixed before you proceed. The most likely cause for the spreadsheet model and reality to be different is the intake of range forage amount. This value is initially set at 1.875% of the cows weight. This value varies as a function of the quality and availability of forage on your range. If your judgment indicates your cows should not gain as much as the original spreadsheet model indicates for a particular month you need to lower the intake percentage in the appropriate cell. For example if you expect that the November weight gain indicated is too high edit cell M24 and replace the .01875 in the formula with a lower number. The spreadsheet will now recalculate and the new results can be inspected. When you are satisfied that the results reflect what would happen on your ranch you are ready for the next step.

4. Check to see if the December weight meets your target weight. If it does then the problem is solved without any supplement. If not you need to follow the next steps to calculate a least cost supplement plan.

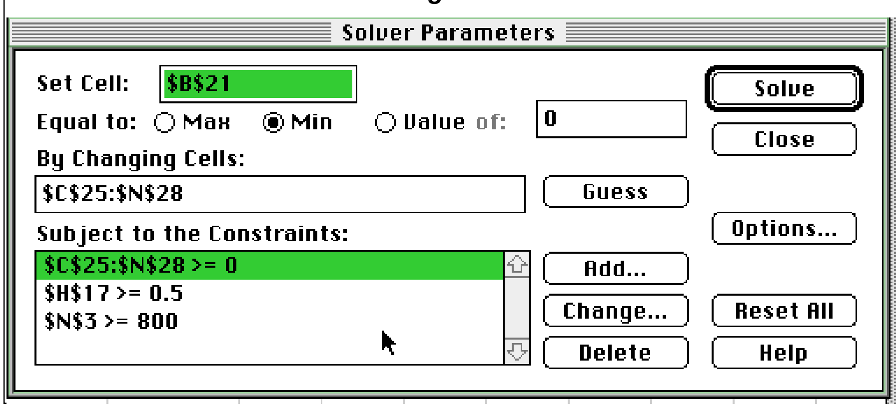
   Choose **Solver** from the formula menu. The following dialog box should appear (Figure 3). If solver does not appear in your menu open the solver add-in the Solver sub-directory of the Macro Library directory.

   Set cell is the cell the solver will attempt to minimize (or maximize depending on which check box is checked) subject to the constraints. In our case B21 is the cell that contains the total feed cost for the cow for the year.

   By changing cells contains all of the things the program can manipulate in its search for an optimum solution. In our case it is the area where the timing and amounts of supplement will be reported. i.e., C25 TO N28.

   Subject to the constraints contains all of the restrictions placed on the solution of the problem. In our case there are three basic constraints. First it is not possible to feed negative amounts of supplement so cells C25 to N27 must be equal to or greater than zero. Second we want to meet the target weight for the cow N3. Finally we want to insure that the cows are gaining at least .5 pounds per day in the period just before and during the breeding season. To do this we constrain H17 to be greater than or equal to .5. If you have a different breeding schedule than the example you will have to adjust this constraint and adjust the pregnancy energy requirements (row 4).

Figure 3



After checking to be sure the set cell, by changing cells and subject to constraints settings are correct click on the solve button. It will take a while for the problem to solve. In fact, it may indicate you have reached the time limit. If this happens just click on continue and let it run a few more minutes. When it finishes click on the option to display the results on the original spreadsheet. Now you should save the results and then analyze what the computer suggested as a supplement plan. Below is the recommendations from the sample problem. The optimal results are displayed in Figure 1, rows 25, 26, 27, and 28.

The computer's suggestions meet all of the constraints, and are the least cost manner of doing so. But you will probably want to use a bit of common sense to modify the computers suggestions. For example, the sample results suggest feeding .02 pounds of block per day per cow in April (cell F27 - Figure 1). Common sense would suggest that this would be more trouble than it was worth. One practical solution would be to feed .17 pounds of block per day per cow in May and none in April instead of the recommended amounts. If you enter this into the spreadsheet you can check to see that you still meet constraints. Other minor modifications in the computer's recommendations may slightly raise costs or cause the constraints to be not quite met. By putting these practical modifications into the spreadsheet and observing their impact on costs and constraints a practical supplement plan can be generated.

SUMMARY

The supplement recommendation spreadsheet can produce useful information to help you develop a sound supplement plan. The computer model is only a tool to help you think about supplement management. It is not an exact answer to be followed no matter what. The functional relationships between nutritional intake and gain are statistically derived approximations. The nutritional values for your range forage will be subject to weather and other random influences. The intake of range forage is an approximation. However, even with the uncertainties involved in the model it can serve as a reasonable starting point for your supplement decisions As with any other ranching decision monitoring is necessary. If you happen to get great weather and the grass is much taller and greener on your range than it was depicted in the spreadsheet you will need to reevaluate your supplement planning. The spreadsheet model can, and should be used throughout the year. Adjustments to the intake function and the nutritional values of the range forage can be made to reflect actual conditions. The model can then be run allowing the remaining months supplement plan to vary to provide information on possible revisions in your supplement plan. To do this you would need to change the **By changing cells** selection under the Solver menu.

While it will take effort to set up the model and get it initially running it will get easier with time. As you use the model and develop information on the nutritional values obtained by your cows from the range forage on your ranch you will be able to fine tune it to your specific ranching conditions.

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FROM:

Arizona Ranchers' Management Guide
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Arizona Cooperative Extension

HOW DO DOMESTIC UNGULATES SELECT NUTRITIOUS DIETS ON RANGELANDS?

Larry D. Howery[1], Frederick D. Provenza[2], and George B. Ruyle[3]

INTRODUCTION

Animal learning has been shown to play a major role in the development of diet selection by domestic ungulates. Dr. Frederick Provenza and his associates at Utah State University have conducted a series of experiments over the past 15 years to learn how physiological and behavioral mechanisms govern diet selection. In this paper, we synthesize several key diet selection concepts presented in 4 recent articles (i.e., Provenza et al. 1992; Provenza 1995, 1996, 1997).

PALATABILITY AND PREFERENCE

Palatability is traditionally defined as "the relish an animal shows for a particular plant as forage…which varies with succulence, fiber content, nutrient and chemical content, and morphological features such as spines and thorns" (see Frost and Ruyle, this Guide). Because palatability is defined in terms of plant attributes, it is often called a "plant characteristic." ***Preference*** is traditionally defined as "relative consumption of one plant over another by a specific class of animal when given free choice at a particular time and place" (Frost and Ruyle, this Guide). Because preference is defined in terms of free choice by an animal, it is often called an "animal characteristic." Collectively, these two definitions evoke range animals' well-documented ability to somehow assess the nutritional value of range forages (i.e., palatability), and invariably select a more nutritious diet than is available on average within their particular environment (i.e., preference). In

GLOSSARY OF TERMS

Affective Processes – Involuntary processes that do not require conscious thought. For example, breathing, digestion, and hedonic shifts are affective (involuntary) processes that occur even while an animal sleeps or is anesthetized. *See cognitive processes and hedonic shift.*

Cognitive Processes – Voluntary processes that require conscious thought. For example, walking, running, or seeking/selecting a particular food are cognitive (voluntary) processes. *See affective processes.*

Emetic System – System responsible for nausea, vomiting, and malaise in animals. It is a critical component of the affective (involuntary) system and plays a key role in the formation of conditioned taste aversions to forages that cause malaise. *See affective processes, malaise.*

Hedonic Shift – A shift in preference (i.e., either increased or decreased intake) for a food following positive or negative postingestive feedback. *See affective processes and postingestive feedback.*

Malaise – Negative postingestive feedback. Feeling of malaise (i.e., nausea or unpleasant feelings of physical discomfort) after ingesting a food or foods. *See postingestive feedback, satiety.*

Postingestive feedback (PIF) – Feedback from the gut to the brain that allows animals to sense the nutritional or toxicological effects of food ingestion (positive or negative) and accordingly adjust their preference (increase or decrease intake) for the food. *See hedonic shift, malaise, satiety.*

Satiety – Positive postingestive feedback. Feeling of satisfaction after ingesting a food or foods. *See malaise, postingestive feedback.*

addition to selecting nutritious diets, range animals generally avoid plants that cause toxicosis, inhibit digestion, or cause malnutrition. This is remarkable given that nutrients, toxins, and digestion inhibitors vary seasonally and by location, both among and within plant species. Animals do occasionally over-ingest plant nutrients and toxins (discussed later), but generally speaking, range herbivores commonly select forages that meet their nutritional needs and avoid forages that do not. Although this observation has been often reported in the literature, Dr. Provenza's research is the first to offer both theoretical and experimental evidence that explains how this important process occurs. His work suggests that animal preference for foods (and hence their palatability) are best understood as the interrelationship between a food's taste and its postingestive effects, which is determined by a food's chemical (and physical) characteristics, and by an animal's age, morphology, and physiological condition.

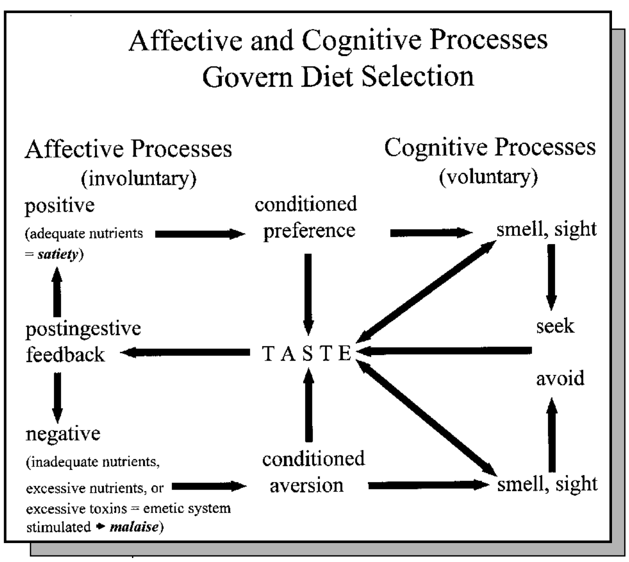

Figure 1. Schematic representation of affective and cognitive processes in diet selection. The affective system links the taste of food with its postingestive feedback (PIF). The cognitive system integrates the senses of taste, smell, and sight which animals use to seek or avoid foods in accord with positive or negative PIF. There is an iterative exchange of information between these systems which allows animals to modify their foraging behavior in response to changing environmental conditions, and in response to changing nutritional needs (adpated from Provenza et al., 1992).[4]

POSTINGESTIVE FEEDBACK (PIF) AND HEDONIC SHIFTS

Animals regulate their intake of forages according to whether ***postingestive feedback (PIF)*** that results from forage ingestion is positive or negative. Animals change their "preference" for various forages (i.e., forages become more or less "palatable" and relatively more or less "preferred") in accord with PIF. This process is know as a ***hedonic shift***. For example:

- Lambs develop strong preferences even for poorly nutritious foods such as straw (i.e., increased intake, a positive hedonic shift) when it is eaten during stomach tubings of energy (starch or glucose) or nitrogen (urea, casein, gluten).

- Conversely, lambs quickly learn to avoid a previously palatable food (i.e., decreased intake, a negative hedonic shift) after receiving one dose of lithium chloride (LiCl), a compound that causes nausea.

These results demonstrate that palatability and preference can be manipulated experimentally. However, palatability and preference are also altered in nature when chemical composition of rangeland plants (i.e., forage quality) changes across space (e.g., range sites differing in kind and amount of available forage) and time (e.g., decline in forage quality as plants mature).

AFFECTIVE AND COGNITIVE SYSTEMS

Two interrelated systems mediate hedonic shifts via PIF from the gut to the brain: ***affective systems*** and ***cognitive systems***. Affective involuntary processes are mediated subconsciously; cognitive processes are mediated consciously. The senses of taste, smell, and sight are linked with PIF across the two systems, but are functionally different (Figure 1). We will discuss affective and cognitive systems (and their affiliated senses) separately in order to highlight their primary functions, but this does not mean they operate independently of one another. Animals readily exchange information between these two systems through their senses of taste, smell, and sight.

Affective (involuntary) processes allow animals to associate the taste of forages with their positive or negative PIF and respectively form either conditioned preferences or conditioned aversions. If a forage causes malaise (i.e., nausea), animals acquire conditioned taste aversions (mild to strong). Malaise may occur when the forage ingested contains excess nutrients (e.g., energy, protein, minerals), excess toxins (e.g., tannins, alkaloids), or inadequate nutrients (Figure 2). What constitutes excesses and deficits in nutrients or toxins depends on the animal's age, morphology (e.g., small vs. large animal, ruminant vs. cecal digestive system), and physiological condition (Figure 3). On the other hand, if a forage causes satiety (the sensation of being satisfied to the full), animals acquire conditioned taste preferences (mild to strong). Satiety results when an animal ingests the kinds and amounts of forages necessary to meet its nutritional requirements, again depending on age, morphology, and physiology.

Cognitive (voluntary) processes allow animals to integrate the senses of taste, smell, and sight to discriminate among forages and make "conscious" choices (i.e., behavioral modification) to select or avoid a food based on previous experience with the food's PIF (Figure 1). If a food previously resulted in malaise (i.e., negative PIF), its taste becomes undesirable and the animal uses its senses of smell and sight to

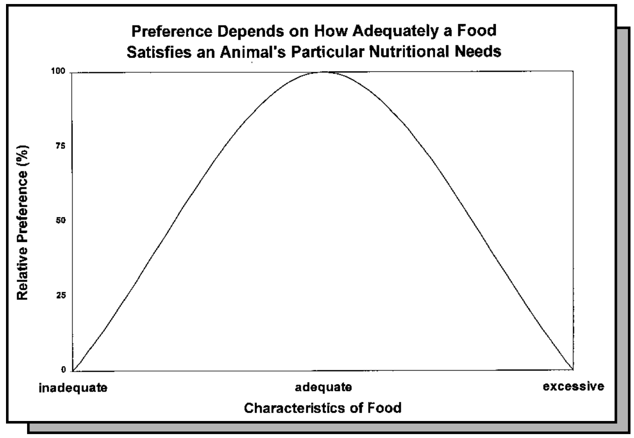

Figure 2. Preference is dependent on how adequately a food satisfies an animal's particular nutritional requirements. Preference resides along a continuum, wherein foods with low or excessive concentrations of nutrients (or excessive concentrations of toxins) cause preference to decline, and foods with adequate amounts of nutrients cause preference to increase (adapted from Provenza 1995).[4]

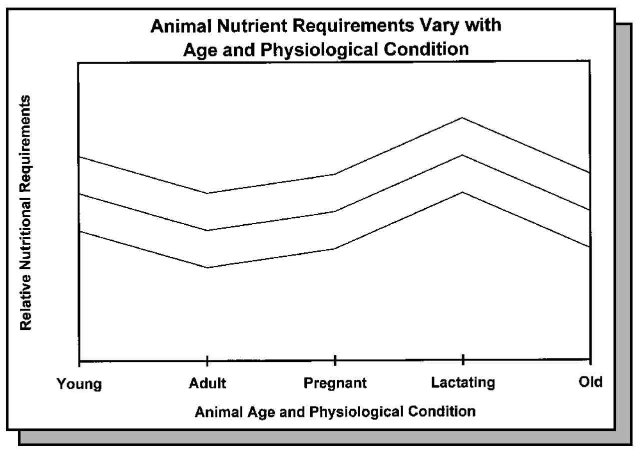

Figure 3. Animal nutrient requirements vary with age and physiological condition. The ideal nutritional state (center line) occurs when all nutrients are obtained simultaneously. It is dynamic and multidimensional, with as many dimensions as there are functionally relevant nutrients. However, animals need not maximize (optimize) intake of any particular nutrient or mix of nutrients within each meal or even on a daily basis, because they can withstand departures from the normal average intake of nutrients (i.e., energy-rich substances, nitrogen, various minerals, and vitamins). Rather, homeostatic regulation needs only some increasing tendency, as a result of a gradually worsening deficit of some nutrient (lower line) or of an excess of toxins or nutrients (upper line), to generate conditions (i.e., malaise) to correct the disorder (i.e., cause the animals to change food selection). Malaise causes animals to increase diet breadth, to acquire preferences for foods that rectify states of malaise, and to exhibit state-dependent food selection (adapted from Provenza 1995).[4]

avoid the forage in the future; the converse would occur if a food previously resulted in satiation (i.e., positive PIF).

To summarize, animals use the affective system to evaluate the postingestive consequences of ingesting a forage, and the cognitive system to modify their foraging behavior according to whether PIF was positive or negative. Although animals integrate the senses of taste, smell, and sight to seek or avoid foods that have respectively caused positive or negative PIF, taste is most strongly linked with PIF. Animals first relate the taste of a food with its PIF through the affective (involuntary) system before smell and sight become functional in the cognitive (voluntary) system (Figure 1). Hence, foraging behavior entails a never-ending exchange of information systems whereby animals sample forages, associate positive or negative PIF from the digestive tract with a forage's taste, integrate forage taste with smell and sight, and then seek or avoid forages accordingly. Together, these two systems give animals flexibility to learn and modify their foraging behavior in response to changing environmental conditions (e.g., variation in plant nutrients and toxins across space and time), and in response to changing nutritional needs (old vs. young, lactating vs. non-lactating, etc.).

CONDITIONED TASTE AVERSIONS

Conditioned taste aversions have evolved as a survival mechanism to help animals limit their intake of otherwise nutritious plants that contain toxins, or plants that fail to meet nutritional requirements. Supporting this notion is the fact that conditioned taste aversions have been demonstrated in many different animal species (e.g., snakes and tiger salamanders; quail, blackbirds, blue jays, and crows; rats, opossums, and mongooses; coyotes and timber wolves; goats, sheep, and cattle; olive baboons and humans) using a variety of compounds. The ***emetic system*** is a critical component of the affective system (see previous section), and plays a key role in the formation of conditioned taste aversions to forages that cause malaise. The emetic system mediates interactions between the brain and the digestive tract and is the same system responsible for nausea and vomiting in humans.

Because the emetic system is a subset of the affective system, it involves non-cognitive or involuntary processes. Accordingly, aversive PIF may occur even as an animal sleeps, is anesthetized, or with short (i.e., less than 1 hour) or long delays (i.e., up to 12 hours) between food ingestion and PIF. This is critical because digestion and absorption rates (i.e., PIF) vary from fast to slow depending on animal species and forage characteristics. Although conditioned taste aversions (and preferences, discussed next section) are non-cognitive, this information is clearly integrated with the cognitive system through the senses of sight and smell. After animals relate a forage's taste with negative PIF (malaise), smell and sight become powerful predictors of anticipated negative PIF and the cognitive response is to avoid the forage when encountered in the future (Figure 1). The emetic system may be stimulated (resulting in malaise and conditioned taste aversions) when animals ingest forages containing excess nutrients or toxins. There is also limited evidence that the emetic system may be stimulated when forages ingested contain inadequate nutrients (Figure 2). Some experimental and anecdotal examples of conditioned taste aversions follow.

EXCESS NUTRIENTS

- Ruminants prefer high-energy foods like grains, but limit grain intake and increase intake of alternative foods once grain is over-ingested, evidently because negative PIF caused by excess by-products from microbial fermentation (i.e., volatile fatty acids such as lactate, acetate, and propionate) produces a negative hedonic shift within a meal.

- Sheep given a high dose of propionate during a meal (i.e., high energy) acquire a persistent aversion to the food.

- Ruminants eating foods high in rumen-degradable protein (through microbial fermentation) experience toxic levels of ruminal ammonia which cause declines in intake.

- Goats learn to limit intake of various sources of non-protein nitrogen within minutes of ingestion. For instance, urea is quickly converted into ammonia, which explains why intake rapidly declines as urea is added to foods.

- Sheep fed an oat hay-lupine mixture containing either 0, 1.7, 3.3, 6.3, 12, or 21% of a mineral mix ate less as the mineral concentration was increased. Most of the sheep consuming the highest mineral concentrations eventually refused to eat the food.

EXCESS TOXINS

- Goats prefer old-growth to current-season growth blackbrush *(Coleogyne ramosissima*) twigs, even though current-season growth contains more nitrogen (2.3 vs. 1.7%) and is more digestible (48 vs. 38%) than old-growth. This is because current-season growth contains a condensed tannin that causes aversive PIF.

- Toxic compounds in larkspur (*Delphinium barbeyi*) and tall fescue (*Festuca arundinacea*) (alkaloids), brassica crops (glucosinolates), and sacahuista (*Nolina microcarpa*) (saponins, coumarins, furocoumarins, and anthraquinones) cause decreased intake in cattle, sheep, and goats.

- Various toxic compounds in leafy spurge (*Euphorbia esula*), bitterweed (*Hymenoxys odorata*), poor quality silage, and sagebrush (*Artemisia* spp.) contain compounds that decrease intake in range herbivores.

- Sheep quickly acquire aversions to foods containing the toxin lithium chloride (LiCl).

INADEQUATE NUTRIENTS

- Deficits or imbalances of energy, nitrogen, and amino acids cause lambs and rats to decrease intake.

- Phosphorus deficient diets cause cattle, sheep, and goats to decrease intake; the decline in intake is directly related to the degree of the deficit.

CONDITIONED TASTE PREFERENCES

Conditioned taste preferences, like conditioned taste aversions, are mediated through the affective and cognitive systems, except of course, the cognitive response of animals is to seek forages that have previously caused positive PIF (Figure 1). Animals may form preferences and seek forages when their taste has been paired with adequate: 1) energy, 2) nitrogen, or 3) recovery from nutritional deficiencies or malaise. Some experimental and anecdotal examples of conditioned taste preferences follow.

ENERGY AND PROTEIN

- Lambs acquire strong preferences for non-nutritive foods (e.g., straw or grape pomace) or flavors (e.g., maple, apple, coconut, onion) paired with energy sources (e.g., starch or glucose) or with volatile fatty acids (e.g., propionate or acetate) that are energy sources.

- Lambs also acquire strong preferences for flavored straw paired with protein (e.g., casein, gluten) or non-protein (e.g., urea) sources of nitrogen.

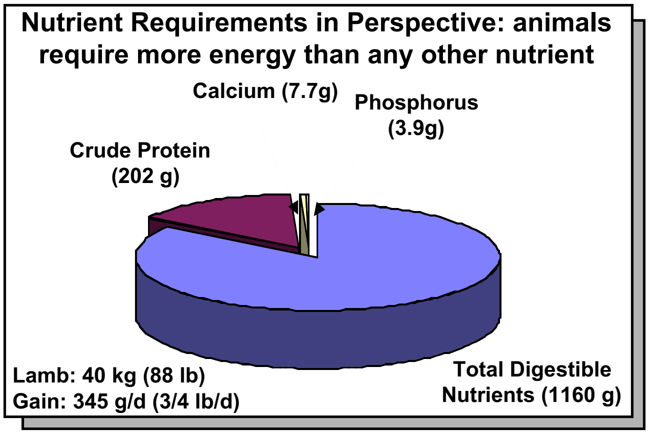

Figure 4. Animals require more energy daily than any other nutrient. For example, a 40 kg lamb requires 1160 g of total digestible nutrients (TDN), but only 202 g of crude protein (CP), 7.7 g of calcium (Ca), and 3.9 g of phosphorus (P) to gain 345 g/d (3/4 lb/d) (NRC 1985).

Meal to Meal Preference for Energy and Protein Depends on Whether Energy and Protein Requirements Were Satisfied during Previous Meals

	Preference for:				
Animal previously consumed:	energy		protein		water
water	energy	>	protein	>	water
energy	↓		↑		no change
protein	↑		↓		no change

Figure 5. Animals typically acquire stronger preferences for non-nutritive foods paired with energy than with protein. However, meal to meal preference for energy and protein depends on whether energy and protein requirements were satisfied during previous meals. After a high-energy meal, lamb preference for energy declines and preference for protein increases; the converse is also true.

- Lambs acquire the strongest preferences when the sources of energy and nitrogen ferment at similar rates and in similar amounts in the rumen. Conversely, when the balance of energy and protein is skewed in rate or amount, animals tend to form aversions to the food.

- Energy and protein can both readily change preferences, but animals require much more energy than protein each day (Figure 4). Accordingly, animals typically acquire stronger preferences for non-nutritive foods paired with energy than with protein. However, meal to meal preference for energy and protein depends on whether energy and protein requirements were satisfied during previous meals. After a high-energy meal, lamb preference for energy declines and preference for protein increases; the converse is also true (Figure 5).

RECOVERY FROM NUTRITIONAL DEFICIENCIES

- Lambs suffering from acidosis (excess energy) drink more of a sodium bicarbonate solution; lambs not suffering from acidosis prefer plain water.

- Cattle readily consume supplemental protein blocks when ingesting forages low in protein.

- When browsing a low-protein blackbrush diet (1.5% nitrogen), goats consume woodrat houses soaked in urine (nitrogen).

- Sheep increase intake of a protein-deficient diet following infusions of protein into the duodenum.

- Rats prefer flavors associated with their recovery from threonine (an amino acid) deficiency.

- Sheep apparently rectify mineral deficits (e.g., P, S, and Se) by ingesting mineral supplements; cattle consume non-food items, apparently to rectify P deficiencies. Deer and other ungulates experiencing mineral deficits eat antlers. Bighorn sheep that use rodent middens as mineral licks may do so to rectify nutrient deficiencies.

- Cattle ingesting mineral deficient forages lick urine patches of rabbits and man, chew wood, consume soil, eat fecal pellets of rabbits, and ingest non-food items such as plastic, feathers, bones, cinders, sacks, and tins. Mineral deficient cattle also eat rabbit flesh and bones, whereas non-deficient animals may sniff or lick the flesh, but never eat it, and they ignore the bones.

- Other ruminants experiencing various nutrient deficiencies have been known to eat the following: live and dead lemmings, rabbits, birds (caribou, red deer, sheep), ptarmigan eggs (caribou), arctic terns (sheep), and fish (white-tailed deer).

SAMPLING FAMILIAR VS. NOVEL FORAGES

Animals may frequently change intake of familiar foods in familiar environments because the nutrient and toxin content of familiar plants can change dramatically within a matter of hours or even minutes depending on previous herbivory and/or environmental conditions. If toxicity decreases (or nutrient content increases), the food is no longer paired with negative PIF and intake may increase. Conversely, forage intake may decrease as forage toxicity increases or as nutrient content decreases. Thus, forage sampling and PIF provide animals with a means of tracking and adapting to changes in nutrients and toxins in familiar foraging environments.

Animals sample new (novel) forages even more cautiously than familiar forages evidently because the postingestive consequence of ingesting a new forage is unknown. Animals are apt to “blame” a novel food for negative PIF even when it is not responsible for the malaise. For instance, young animals that were given LiCl (i.e., negative PIF) avoided a novel food when fed a combination of one nutritious-novel and four nutritious-familiar foods even though one of the familiar foods actually contained the LiCl. “Blaming” novel rather than familiar forages for aversive postingestive consequences likely evolved as a means of protecting herbivores from over-ingesting potentially harmful new foods before confirming their PIF (i.e., positive or negative) by careful sampling as described above.

Thus, range herbivores routinely sample both nutritious and toxic forages (both familiar and novel) and regulate forage intake according to whether PIF is positive or negative. In addition to sampling and PIF, different animal species have evolved specialized physiological mechanisms that bind, metabolize, or detoxify certain thresholds of harmful plant compounds. However, the capacity of these mechanisms is seldom exceeded because animals quickly acquire taste aversions and limit intake before toxicosis ensues. Physiological mechanisms work in concert with PIF, and provide animals flexibility to regulate their intake and ingest adequate diets in ever-changing foraging environments. This is impressive considering the millions of bites that range herbivores take each day across rangelands that contain a diverse array of nutritious and harmful plant compounds.

WHY DO ANIMALS SOMETIMES OVERINGEST NUTRIENTS AND/OR TOXINS?

Animals occasionally over-ingest plant nutrients and toxins that may cause declines in intake, production, and even death. This probably occurs whenever an animal fails to properly relate the taste or smell of a particular forage with its PIF, and the animal's physiological means for binding, metabolizing, or detoxifying toxic compounds is exceeded. Any of the following scenarios (or combinations thereof) involving both the affective and cognitive systems could be responsible for such a breakdown.

EMETIC SYSTEM NOT STIMULATED

The emetic system apparently must be stimulated (i.e., malaise must be experienced by animals) to produce a conditioned taste aversion. However, over-ingestion of certain nutrients and toxins may not stimulate the emetic system.

- Animals that over-ingest alfalfa experience bloat and decrease short-term intake, apparently because tension receptors in the rumen and reticulum are stimulated which may cause short-term physical discomfort. However, bloat apparently does not stimulate the emetic system or cause a long-term negative hedonic shift because animals will ingest alfalfa soon after bloat subsides. In contrast, forages that stimulate the emetic system (cause malaise) have been avoided for at least 3 years.

- Some toxic compounds (e.g., tannins) stimulate the emetic system and cause conditioned taste aversions. Other compounds (e.g., gallamine, naloxone) may not stimulate the emetic system but instead cause aversions to physical locations or other external stimuli.

INTERACTIONS BETWEEN AVERSIVE AND POSITIVE PIF

Animals are more likely to be poisoned when PIF from a toxin is not experienced for more than 12 hours. Beyond 12 hours, animals may not be able to distinguish which foods cause positive or negative PIF. The longer the delay between food ingestion and aversive feedback, and the higher proportion of positive to negative PIF during that time, the more likely it is that livestock will continue to ingest the food.

- Some animals may die from over-ingesting larkspur *(D. barbeyi)* because there is immediate positive PIF but delayed aversive PIF. For instance, cattle ingest larkspur because it initially enhances ruminal fermentation and digestion (i.e., it is high in energy and protein). Consumption generally increases over a 2 to 4 day period before declining dramatically when alkaloids have their maximum aversive effects. A somewhat similar scenario may occur when animals over-ingest alfalfa and become bloated. Positive PIF from nutrients may cause a strong liking for a nutritious food like alfalfa (i.e., a positive hedonic shift) that overrides any short-term physical discomfort (i.e., stimulation of tension receptors in the rumen and reticulum) due to bloat.

- Poisoning is delayed when animals consume various locoweed species *(Astragalus* and *Oxytropis spp.)* that contain indolizidine alkaloids. Cellular damage does not occur for 8 days and there are no clinical signs of poisoning for 3 weeks. Animals acquire aversions to such foods only after vital organs (e.g., the liver) have been damaged.

- Liver damage caused by pyrrolozidine alkaloids in species such as groundsel *(Senecio* spp.) is progressive and death may not occur for months or even years.

DIFFERENTIATING NUTRITIOUS FROM TOXIC PLANTS IN UNFAMILIAR ENVIRONMENTS

It is probably more difficult for herbivores to differentiate nutritious from toxic foods in unfamiliar environments because all foods may be novel.

- Ninety percent of naïve goats introduced into pastures containing white snakeroot *(Eupatorium rugosum)* died during the first 2 weeks of grazing. Survivors apparently learned to avoid the plant.

- Sheep in South Africa eat groundsel for the first 3 days in an unfamiliar pasture but then refuse to eat the plant even if starving.

- Cattle ranchers in South Africa stomach-tube a sublethal preparation of tulips *(Homeria pallida)* to prevent deaths, and report that only naïve or extremely hungry animals eat the plant. Naïve animals given the preparation, or untreated animals that survive beyond 4 days of grazing pastures containing the plant learn to avoid tulips.

- Many cattle deaths caused by larkspur *(D. barbeyi)* occur within 10 to 14 days after cattle enter a new pasture. Survivors may learn to avoid ingesting a lethal dose.

- When foraging in a familiar environment, sheep ate less of a familiar-aversive food than in an unfamiliar environment. Conversely, when foraging in an unfamiliar environment, sheep ate less of a novel-harmless food than when in a familiar environment. These results suggest that animals generally perform better when foraging on familiar foods in familiar environments.

CHANGES IN ENVIRONMENTAL CONTEXT MAY ALTER ANIMAL PHYSIOLOGY

Even when familiar plants are available in unfamiliar environments, changes in an animal's environmental context may render its physiological mechanisms (e.g., binding, metabolizing, and detoxifying) less effective and cause animals to be more susceptible to toxicosis. In this case, the same dose of a familiar toxin may be more harmful in an unfamiliar than in a familiar environment. Work in this area has mainly involved drug research on humans and rats, but there are important implications concerning how range animals may respond to familiar toxic plants after being moved to an unfamiliar environment.

- A cancer patient died when injected with morphine in a different room; the patient had tolerated the same dose when injected every 6 hours for 4 weeks in a familiar room.

- Social drinkers become more impaired when they drink at unusual times or in different settings.

- Rats with or without previous experience with heroin were given a strong dose either in a familiar or a unfamiliar environment. The dose was lethal for:

    - **32%** of the **experienced** rats in a **familiar** environment.

    - **64%** of the **experienced** rats in an **unfamiliar** environment.

    - **96%** of the **inexperienced** rats in an **unfamiliar** environment.

- Cows raised in Gila county Arizona and moved 100 miles east to Apache county suffered severe lupine and locoweed poisoning. Sister cows that remained in Gila county did not experience lupine or locoweed poisoning even though these species were available in small to moderate stands.

SOCIAL FACILITATION

Animals can also influence what one another eat.

- A group of heifers that were averted to larkspur (with LiCl) avoided the plant over a 3-year period until they were placed in a pasture with nonaverted heifers, at which point they began eating larkspur at similar levels to the nonaverted heifers.

SUBTLE MOLECULAR CHANGES INCREASE PLANT TOXICITY

Animals may be unable to readily detect subtle molecular changes that increase plant toxicity.

- Lambs were unable to detect that LiCl had been added to a previously "safe" familiar food (barley) when it was fed in combination with a novel food (milo). The lambs instead avoided milo and continued to eat the familiar barley, even though barley actually contained the toxin.

- Cattle typically increase intake of larkspur *(D. barbeyi)* after a drop in barometric pressure and mortality increases, probably because changes in plant chemistry simultaneously increase both the palatability *and* toxicity of the plant. Such changes likely increase susceptibility to poisoning.

- Bitterbrush *(Purshia tridentata)* is more palatable than blackbrush both for goats and snowshoe hares, even though both shrubs contain condensed tannins. Slight chemical differences render condensed tannins in blackbrush more aversive to herbivores.

TOXINS IN MORE THAN ONE PLANT

It may be difficult for herbivores to associate toxicity with a specific food when the same toxin exists in more than one food, or when two or more compounds in different foods interact to cause toxicity.

- Goats and deer ingest many different browse species that are high in tannins. It may be difficult for them to distinguish PIF among several different plant species that contain the same (or nearly the same) compound.

- Sheep that consume hemlock (*Cicuta spp.)* may then be more susceptible to compounds in crown beard *(Verbesina enceliodes)*.

- Sheep that consume black sagebrush *(Artemesia nova)* before horsebrush *(Tetradymia glabrata)* are predisposed to photosensitization. Photosensitization by itself is not likely to cause a food aversion because the emetic system is not directly stimulated, but liver dysfunction associated with ingesting these two plant species might indirectly stimulate the emetic system and ultimately cause a conditioned food aversion.

- Various locoweed species contain toxic nitrogen compounds and selenium, which when combined increases their toxicity.

SUMMARY

Animals continually sample and evaluate the nutritional value (i.e., PIF) of forages using their senses of taste, smell, and sight. Postingestive feedback adjusts a forage's hedonic value (i.e., preference and palatability) commensurate with its utility to the animal (i.e., animal age, morphology, and physiology) enabling survival when both the animal's foraging environment and nutritional needs are constantly changing. Plant species that cause positive hedonic shifts are usually highly correlated with nutritional well-being, while plant species that cause negative hedonic shifts are typically highly correlated with nutrient deficiencies and toxicosis. Hence, what makes a forage taste "good or bad" (and thus, sought or avoided) is not taste *per se*, but rather nutritional benefits or deficits received from forage ingestion, which are sensed by animals through PIF and linked with a forage's taste. Animals integrate and use their senses of taste, smell, and sight to seek foods that cause positive PIF (i.e., nutritional well-being) and avoid foods that cause negative PIF (i.e., nutrient deficiencies and toxicosis), and can thus be described as possessing a high degree of "nutritional wisdom." This process occasionally breaks down when animals fail to properly link the PIF of a particular food with its taste, smell, or sight, and their physiological means for binding, metabolizing, or detoxifying toxic compounds is exceeded.

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[4]Figures 1-3 were originally published in similar form in the Journal of Range Management. They are reproduced here by permission of the Journal.

FROM:

Arizona Ranchers' Management Guide
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Arizona Cooperative Extension

MATCHING FORAGE RESOURCES WITH COW HERD SUPPLEMENTATION

Jim Sprinkle[1]

INTRODUCTION

In any supplementation program, it is essential that forage resources be stocked such that there is adequate forage quantity available per animal unit. If forage quantity is insufficient, then the supplementation program will be ineffective. The object of supplementation programs (usually protein supplements) is to make-up deficiencies in forage quality to increase passage rate of forage and thus increase forage intake of the cow.

Forage intake of the cow declines with decreased forage quality. Cellulose content in mature forage increases and requires increased rumen residence time for rumen microbes to break down chemical bonds. Also, protein content of mature forage decreases, allowing less protein to be available for making new rumen microbes. The net effect is for the passage rate of forage and forage intake to decline (Table 1).

A general rule is for daily protein supplementation to be limited to around 2 lbs. a day in order to avoid forage substitution effects. If energy supplements are fed, then it is generally expected that negative forage substitution effects will occur.

COW NUTRITIONAL REQUIREMENTS

An animal unit day (AUD) is defined as 26 lbs. of forage per day for a 1000 lb. cow and her calf. If the forage is not green and actively growing, protein, phosphorus, and sometimes energy content of the forage may be deficient. In order to meet the dietary protein requirements of the cow herd, the forage needs to contain 7% protein or 1.6 lbs. per day for a nonlactating and 9.6% or 2.0 lbs. per day for a 1000 lb. lactating cow milking 10 lbs. a day. Calcium and phosphorus requirements for a nonlactating 1000 lb. cow in the last trimester of pregnancy are .26% calcium or .81 oz. per day and .20% phosphorus or .63 oz. per day. For a lactating 1000 lb. cow, .28% calcium or .88 oz. per day and .22% phosphorus or .70 oz. per day are required.

As mentioned above, protein requirements increase with lactation. For early lactation (18 lbs. of milk), protein requirements are 2.14 to 2.24 lbs for a 1000 lb. cow. For late lactation (7 lbs. of milk), protein requirements are 1.8 to 1.9 lbs. for a 1000 lb. cow. Protein requirements are lowest for non-lactating cattle during mid-pregnancy, or only 1.4 lbs.

Table 1. Forage Intake of Lactating Cattle at Different Forage Digestibilities[a]

Forage Digestibility or TDN %	Amount Required to Eat to Meet Maintenance Requirements, % of Body Weight[b]	Amount Can Eat at the Forage Digestibility Listed, % of Body Weight[c]
43	3.2	1.2 to 1.3
45	3.1	1.7 to 2.0
50	2.8	1.9 to 2.1
55	2.6	1.7 to 2.1
58	2.4	1.9 to 2.5
60	2.3	2.0 to 2.5
62	2.3	2.3 to 2.8
64	2.2	2.6 to 3.2
Greater then 64		2.6 to 3.2

[a]For a 1000 lb. cow milking 10 lbs. / day.
[b]The point of intersect for mainintenance requirements and what the animal can eat is around 56% digestibility for lactating animals and about 52% digestibility for nonlactating animals.
[c]Research from various sources including Kronberg et al., 1986. *J. Range Manage.* 39:421; Wagner et al., 1986. *J. Anim. Sci.* 63:1484; Havstad and Doornbos, 1987. Proc. West. Sec. Amer. Soc. Anim Sci. p. 9; Sprinkle, 1992. M.S. Thesis, Montana State University.

Table 2. Maintenance Requirements for Range Cattle

Cow weight, lbs.	Protein required, lbs., nonlactating range cow	Mcal of ME required, nonlactating range cow[a]
800	1.4	15.1
900	1.5	16.5
1000	1.6	18.0
1100	1.6	19.2
1200	1.7	20.5
1300	1.8	21.8
1400	1.9	23.0
1500	2.0	24.2
1600	2.1	25.4
1700	2.2	26.6
1800	2.3	27.8
Additional requirements for milk production: Add to the above maintenance requirements if cow is lactating.		
Estimated lbs. of milk production/day	**Additional lbs. of protein required/day**	**Mcal of ME required for milk**
5	.15	2.4
8	.24	3.8
10 (late lactation; 100 days or more)	.30	4.8
12	.36	5.8
14	.42	6.7
16	.48	7.7
18 (peak lactation; 60 to 70 days; most beef breeds)	.54	8.6
20	.60	9.6
22 (peak lactation; more typical of breeds such as Simmental)	.66	10.6

[a]ME = metabolizable energy; Mcal = megacalories (1,000,000 calories). Increase maintenance requirements by 10% if Charolais, Simmental, or other large framed breed crosses; increase by 15% for dairy crosses; reduce by 10% for Brahman crosses. If daytime temperatures exceed 95˚ F, increase maintenance requirements 25%.

Human energy needs are specified in calories. Human calories are actually equal to 1000 calories, so an average male diet of 3000 calories per day is equal to 3,000,000 calories. Since cattle are much larger than humans, energy needs for cattle are listed in megacalories of metabolizable energy. A megacalorie (Mcal) is equal to 1,000,000 calories. Metabolizable energy (ME) is that amount of energy in feed or forage thatis available to be metabolized or used by the body for maintenance, production, work, and heat regulation. The energy requirement for a 1000 lb. nonlactating cow is 18,000,000 calories or 18 Mcal of ME per day. To maintain a 1000 lb. range cow milking 10 lbs. per day requires approximately 23,000,000 calories or 23 Mcal of ME per day. Energy requirements for cows with greater milk production are increased by .48 Mcal of ME per lb. of milk (1 gallon of milk = 8.62 lbs.). Table 2 lists maintenance requirements for different sizes of cattle.

Energy is used to produce milk with about the same efficiency as energy is used to maintain essential body functions. Energy for body weight gain is used less efficiently than energy for milk production with a greater portion of the metabolizable energy being lost as heat as body tissue is formed. Poor quality forages promote very little body weight gains while the energy density of grain for body weight gain can be up to 7 times greater than that of inferior quality forage. Because of the variability in available energy for body weight gain among different feedstuffs and the accompanying inefficiency of gain, a different system of specifying energy requirements for gain (net energy for gain or NE_g) is recommended by the National Research Council. Net energy for gain or NE_g in a particular feed or forage is always less than ME (see Table 3). Table 3 lists ME and NE_g values for known digestiblities or total digestible nutrients (TDN) of forages or feeds.

The energy costs of NE_g required for body weight gain has been determined by research. Energy costs are dependent upon fat content of the gain, but for most range cows, each 1 lb. of live weight gain requires approximately 2.1 Mcal of NE_g. Live weight gain can only occur after the cow's maintenance and lactation requirements are met. If a 1000 lb. lactating cow milking 10 lbs. per day consumed 24 lbs. of forage with a digestibility of 60%, then 23.5 lbs. of the forage would satisfy her maintenance requirements of 23 Mcal (see calculation below).

23 Mcal ME required per day for maintenance and lactation

$$\div \frac{.98 \text{ Mcal ME}}{\text{lb. forage}} = 23.5 \text{ lbs. forage}$$

This would leave .5 lbs. of forage for gain, which would supply .17 Mcal of NE_g. The cow should be able to gain .08 lbs. per day with this level of milk production and forage quality.

.5 lbs. of forage remaining

$$\bullet \frac{.34 \text{ Mcal } NE_g}{\text{lb. of forage}} = .17 \text{ Mcal } NE_g$$

$$.17 \text{ Mcal } NE_g \div \frac{2.1 \text{ Mcal } NE_g}{\text{lb. of gain}}$$

= .08 lbs. average daily gain

COW HERD ASSESSMENT

The easiest way to monitor cattle is to use the body condition scoring system displayed in Table 4. Briefly, if the transverse processes of the lumbar vertebrae (between hip bones [hooks] and the ribs) are readily visible, the cow is probably a body condition score (BCS) of 3 and may not rebreed. Research has shown that reproduction will suffer when cows have a body condition score less than 4. Each 1 unit increase in body condition is approximately 80 pounds, so to increase a cow from a BCS of 3 to 4 would require a live weight gain of 80 lbs. Before a cow can gain weight, maintenance and lactation energy requirements must be met. It is practically impossible and very costly for cows to gain weight during early lactation. Most cows will mobilize fat to support milk production for the first 40 to 60 days of lactation. A good management practice is to monitor body condition 3 months before calving and supplement accordingly to maintain desired body condition. If possible, cattle should be at a BCS of 5 or greater at calving to allow for weight loss during the first 60 days of lactation. Young growing cattle that will be producing their first calf at calving, large frame size cows, and cows with greater milk production potential are all at risk for becoming thin and failing to rebreed. If the grazing management plan will allow it, young or thin cattle should be separated from the rest of the herd into a different pasture and supplemented as necessary to maintain body condition

Table 3. Energy Content of Forages or Feeds at Different Digestibilities

	Dry Matter Basis	
Digestibility	Mcal ME/lb. of feed or forage	Mcal NE_g/lb. of feed or forage
40	.66	.04
42	.69	.07
44	.72	.10
46	.75	.13
48	.79	.16
50	.82	.19
52	.85	.22
54	.88	.25
56	.92	.28
58	.95	.31
60	.98	.34
62	1.02	.37
64	1.05	.40

TDN = Total Digestible Nutrients; ME = metabolizable energy; NE_g = net energy for gain; Mcal = megacalories or 1,000,000 calories.

Table 4. System of Body Condition Scoring (BCS) for Beef Cattle

Group	BCS	Description
Thin Condition	1	EMACIATED - Cow is extremely emaciated with no palpable fat detectable over spinous processes, transverse processes, hip bones or ribs. Tail-head and ribs project quite prominently, as do shoulders, hooks, backbone, and pins. Looks like C.M. Russell's "Waiting for a Chinook" or "Last of the 5000."
	2	POOR - Cow still appears somewhat emaciated, but tail-head and ribs are less prominent. Individual spinous processes are visible and sharply defined and are still rather sharp to the touch, but some tissue cover exists along the spine. Spaces between spinous processes are visible.
	3	THIN - Ribs are still individually identifiable but not quite as sharp to the touch. There is obvious palpable fat along spine and over tail-head with some tissue cover over ribs, transverse processes, and hip bones. Backbone is still visible but not so sharp in appearance. Transverse processes of lumbar vertebrae (between hooks and ribs) are readily visible. Hindquarters are angular in appearance and not fleshy.
Borderline Condition	4	BORDERLINE - Individual ribs are no longer visually obvious. Foreribs are not visible, but 12th and 13th ribs (last ribs) are. The spinous processes can be identified individually on palpation, but feel rounded rather than sharp. Some fat cover over ribs, transverse processes, and hip bones. Transverse processes are no longer obvious. Spine is covered with some fat, but it is still possible to detect individual vertebrae. Full, but straight, muscling in hindquarters.
Optimum Moderate Condition	5	MODERATE - Cow has generally good overall appearance. Upon palpation, fat cover over ribs feels spongy and areas on either side of tail-head now have palpable fat cover. The 12th and 13th ribs not visible unless the animal has been shrunk. Areas on each side of tailhead are beginning to fill with fat, but are not mounded.
	6	HIGH MODERATE - Firm pressure now needs to be applied to feel spinous processes. A high degree of fat is palpable over ribs and around tail-head. Back appears rounded. Hindquarters are plump and full. Noticeable sponginess over foreribs and small mounds of fat are beginning to appear beside tailhead.
	7	GOOD - Cow appears fleshy and obviously carries considerable fat. Very spongy fat cover over ribs and around tail-head. In fact, "rounds" or "pones" or "love handles" beginning to be obvious. Some fat around vulva and in crotch. Brisket is full. Spine is covered with fat and spinous processes can barely be distinguished. Back has a square appearance.
Fat Condition	8	FAT - Cow very fleshy and over-conditioned. Spinous processes almost impossible to palpate. Cow has large fat deposits over ribs, around tail-head, and below vulva. "Rounds" or "pones" are obvious. Very full brisket.
	9	EXTREMELY FAT - Cow obviously extremely wasty and patchy and looks blocky. Tail-head and hips buried in fatty tissue and "rounds" or "pones" of fat are protruding. Bone structure no longer visible and barely palpable. Animal's motility may even be impaired by large fatty deposits. Heavy deposits of udder fat.

Adapted from Richards et al., 1986; *Journal of Animal Science* Vol. 62:300.

at a score of 4 or greater prior to calving. Many producers also breed heifers to calve 30 days before the cow herd to allow them additional time to recover from the stresses of lactation prior to rebreeding. A producer should consider implementing a supplementation program if the forage is such that cattle are consistently at less than a BCS of 4 at breeding and conception rates are 10 to 15% lower than desired.

EXAMPLE OF COST OF BODY WEIGHT GAIN BEFORE CALVING

It is determined that several cattle are at a body condition score of 3, ninety days before calving. The grazing management plan does not allow separation of thin cattle into a separate pasture. The permittee desires to evaluate the economics of supplementing all 100 cattle. To increase body weight 80 lbs. (1 condition score) over 90 days requires an average daily gain of .88 lbs. It is assumed that at 55% digestibility, the forage is currently meeting maintenance requirements if cattle have daily forage intakes equal to 2% of their body weight. The NE_g content of the cottonseed meal supplement to be fed is .50 Mcal of NE_g per lb. If cottonseed meal was $180 per ton and 90% dry matter (DM), to gain .88 lbs. per day would require feeding 4.11 lbs. of protein supplement per day at a cost of $0.37 a day.

$$\frac{.88 \text{ lbs gain}}{\text{day}} \bullet \frac{2.1 \text{ Mcal } NE_g}{\text{lb. gain}}$$

$$= \frac{1.85 \text{ Mcal } NE_g \text{ required}}{\text{day}}$$

$$\frac{1.85 \text{ Mcal } NE_g}{\text{day}} \div \frac{.50 \text{ Mcal } NE_g}{\text{lb. cottonseed meal}}$$

= 3.7 lbs DM cottonseed meal

3.7 lbs. DM cottonseed meal

$$\div \frac{.90 \text{ dry matter}}{\text{lb. as fed cottonseed meal}}$$

= 4.11 lbs. as fed cottonseed meal

$$\bullet \frac{\$0.09}{\text{lb.}} = \$ .37 \text{ per day}$$

The 90 day cost per cow would be $33.30, or $3330 for 100 cows. If conception rates increased only 10% by increasing body condition by 1 unit, the value added for calves would be $3000 if calves weighed 400 lbs. at weaning and sold for $0.75 per lb. If labor is factored in at $20 per day to feed the supplement and supplement was fed three times per week (9.59 lbs. per cow per feeding), net loss would be $930.

[$3330 supplement cost + $600 labor and gas (3 times/ week feeding)] - ($3000 value from calves) = $930 loss

In order to break even on the cost of supplement + labor and gas in the above scenario, two-thirds of the cow herd would need to be at a body condition of 3.

$3930 total cost of supplementation ÷ $300 per calf = 13.1 calves

13.1 calves ÷ 20% conservative estimate of increased conception with cow BCS of 4 vs. 3 during breeding = 65.5 cows

It is much more cost effective to separate thin cows from fat cows 3 to 4 months before calving, and to supplement them to be at a BCS of 5 or greater at calving. Ideally, cattle should go into winter with a BCS of 5 or greater. This allows for a cushion for weight loss when forage quality and availability decline. Thin cows, especially first calf heifers, could possibly benefit from weaning calves 1 or 2 months early to take advantage of lower cow maintenance requirements and the opportunity for gain before forage quality and availability drop in late fall. If first calf heifers have calved two weeks to a month before the cow herd, this can offset some of the reduced weaning weight. Also, late summer calf prices are often slightly higher than autumn calf prices. Producers can benefit by evaluating forage as described below in order to match cow nutritional requirements to forage quality. This will allow for forward planning of weight loss in the cow herd and enable designing a cost effective supplementation program.

FORAGE ASSESSMENT

*Forage Quality***.** In order to match cow requirements to the available forage, lab analyses of forage samples representative of the cow herd diet are encouraged. By matching cow nutritional requirements with forage contributions, a cost effective supplement program can be developed. When forage is green and actively growing, forage quality should be sufficient to meet a cow's nutritional requirements. As forage matures, forage quality is reduced substantially. At a minimum, the forage should be analyzed for protein and TDN, and, if possible, calcium and phosphorus. Local Cooperative Extension offices can furnish addresses and phone numbers of laboratories which can provide this service.

Another option to plant testing is to analyze fecal samples from a cross section of the herd (approximately 10 cows) using a new technique called near infrared spectroscopy (NIRS). This technique uses reflected infrared light to estimate digestibility, protein, and phosphorus content of the forage diet. Unless the cow's diet contains 30% or greater brush content, NIRS can be a rapid and easy method to determine nutrient content of the diet. Currently, Texas A & M University (Department of Rangeland Ecology and Management, Grazingland Animal Nutrition Lab, College Station, TX 77843-2126) is doing this procedure. The phone number for more information is (409) 845-5838.

Currently, the cost for protein and TDN plant analyses is approximately $18, and the cost for NIRS is around $24 with shipping costs included. The NIRS procedure may more accurately estimate energy and protein content of the selected diet, but is not recommended when diets consist of large quantities of brush. If plant analysis is practiced, it is important to select a representative sample similar to what the cows are actually eating by plant species and percentage.

Benefits are not usually realized in nonlactating cattle for protein supplementation unless the forage has less than 6.25% protein. Protein supplementation when protein content of the forage is below this level will increase microbial synthesis of protein in the rumen and also increase passage rate and intake of poor quality forage. If forage has less than .28% calcium and .22% phosphorus as a percentage of dry matter, then lactating cattle (1000 lbs.) should have a free choice calcium and phosphorus mineral mix provided in addition to trace mineral salt. The TDN or digestibility content of the forage for lactating cattle is marginal at around 56%. For nonlactating cattle, TDN is marginal at around 52%. As digestibility of the forage drops, residence time in the rumen increases and forage intake decreases to levels inadequate to maintain production and reproductive success.

*Additional Considerations for Forage Quality***.** Let us assume a cow herd consists of 1200 lb. cows milking 16 lbs. per day and that forage quantity is no problem. The cows' maintenance and lactation energy requirements would be equal to 20.5 + 7.7 Mcal or 28.2 Mcal of ME per day (Table 2). If the forage digestibility is 60% (green and actively growing), then the energy concentration for maintenance would be .98 Mcal of ME per lb. of forage (Table 3). This would equal 29 lbs. of forage per day that needs to be eaten to maintain body weight, or 2.4% of body weight. This level of intake is possible with forage quality this good. If forage quality dropped to 54% digestibility, then forage intake would need to be 2.7% of body weight, which is probably not possible with forage of this quality. In this instance, the cow would need to reduce milk production or lose body weight, or both. If the cow had a body condition score of 6, then weight loss would probably not be a problem. However, if the cow had a body condition score of 4, then potential problems could exist for rebreeding.

Because minimal cheap harvested feed or crop aftermath exists in Arizona, it is probably advantageous to match yearly forage resources to the calving season to reduce supplemental feeding. If a sufficient quantity of nutritious green spring forage is available, then traditional spring calving is practical. On the other hand, if forage quantity is limiting and often of poor quality during early spring, then it may be advantageous to move the calving season forward to synchronize with summer monsoon rains. Nonlactating cattle will consume about 30% less forage than lactating cattle and forage quality of dormant forage will more closely match nutrient requirements for nonlactating cattle.

SUPPLEMENTATION DECISIONS

Once the cow requirements are defined and forage quality determined, a decision can be made to supplement protein or energy or both. Usually, the best practice is to satisfy protein requirements first. This gives the best chance for increasing forage intake and increasing energy intake. After protein requirements are met, additional protein and energy may need to be supplemented in order to meet energy requirements or for weight gain. If the allotment is accessible, supplementation may have positive economic benefits in subsequent calving percentages. Supplemented cattle should be monitored frequently for body condition to evaluate the success of the supplementation program.

*Energy Supplementation***.** If the energy content of the forage is deficient, supplementation of energy will decrease forage intake and possibly forage digestibility. This may sometimes be an advantage in stretching forage supplies. Some of the negative forage substitution effects of energy supplementation upon forage intake can be overcome by including greater proportions of feed byproducts high in fiber such as corn gluten feed in the energy supplement. Energy supplements also have the disadvantage of needing to be supplemented at least every other day, and preferably every day. This may be impractical for many range operations. Boss cows may overload with energy when supplemented at less frequent intervals. Salt-limited supplements are also an option, but oftentimes cost discounts are not applied to the commercial supplement for the 20% salt included. Another solution may be to feed molasses based blocks, but an economic analysis should be conducted to determine costs and benefits of this type of energy supplement.

Protein Supplementation. Due to its positive effects upon forage intake, protein supplementation is the most frequently practiced of all supplementation regimes. Research in west Texas has shown that cattle may be effectively supplemented with protein as infrequently as once a week (seven times daily rate of supplementation of 2 lbs. per day). As mentioned earlier, protein supplementation may increase forage intake, allowing for greater intake of nutrients. Since protein supplements are costly, forage evaluation is recommended to determine if protein supplementation is necessary. For nonlactating cattle, the forage should contain less than 6.25% protein. Lactating cattle may benefit from protein supplementation if forage is below their requirements (9.6% for 1000 lb. cow), but they should be able to tolerate a slight deficiency since they can select a diet higher in protein than random pasture clippings. If forage availability is inadequate, protein supplementation may be inefficient. If forage utilization in a pasture is already at 50%, then don't expect protein supplementation to enhance forage intake. Managers who use protein supplementation effectively with dormant forages often do so by establishing ungrazed forage "banks" or pastures to use in conjunction with protein supplementation. By doing so, the manager ensures adequate forage availability. If forage availability is inadequate, feeding larger quantities of a protein-energy supplement would be a better choice to attempt to minimize weight loss.

*Bypass Protein Supplementation***.** If the cow herd has been experiencing pronounced loss of body condition and the energy content of the forage is adequate, supplementation with a ruminally undegradeable protein supplement or bypass protein may be advantageous. Research in Montana on dormant winter range has shown that the feeding of bypass protein supplements may reduce weight loss in stressed cows. Also, earlier estrus activity following calving may exist in cows fed bypass protein. Feedstuffs high in bypass protein include feather meal, blood meal, corn gluten meal, and fish meal. Due to palatability problems, rendered animal products are usually limited to 25 to 30% of the total supplement and are combined with grain products to increase palatability. The effectiveness of bypass protein is influenced by the type of forage. For instance, research in Texas reported that cottonseed meal contains 50% bypass protein when fed with cool season forages, but only 23% with warm season forages. The disadvantage with feeding bypass protein is cost. Bypass protein supplements may cost twice as much as normal protein supplements.

*Supplement of Indecision***.** Sometimes a producer is unsure whether to supplement protein or energy. Usually, when forages are low in energy, they are also low in protein. Cool season forages tend to have greater digestibility than warm season grasses. Dormant Tobosa grass can be very low in both digestibility and protein. The "supplement of indecision" combines both protein and energy. An example supplement would contain 40% natural protein, 50% grain products, trace mineral salt, vitamins A and D, dicalcium phosphate, and potassium chloride. Fed at a rate of 2 pounds a day the 90 days preceding calving, there would probably be a slight decrease in BCS if the forage was low in protein and forage availability was adequate.

Table 5. Protein and Energy Content of Some Supplements

	Dry Matter Basis		
Feedstuff	% Protein	ME, Mcal/ lb.[a]	NE_g, Mcal/ lb.[a]
Corn	10.0	1.49	.67
Milo	12.4	1.30	.58
Cottonseed Meal	44.8	1.23	.50
Alfalfa Hay, full bloom	15.9	.85	.22

[a]ME = metabolizable energy; Mcal = megacalories (1,000,000 calories); NE_g = net energy for gain.

EXAMPLE CASE STUDIES OF SUPPLEMENTATION

As mentioned previously, supplementation of cattle should occur before calving. Minimal results will be achieved through supplementation the first 45 to 60 days after calving, and attempting to restore body condition after this time will be twice as costly as supplementing for weight gains before calving.

Two examples are presented at the end of this section: I. Maintaining a cow at a BCS of 5, ninety days before calving when forage quality is inadequate; and, II. Increasing BCS from 4 to 5, seventy days before calving when forage quality is adequate.

Table 5 provides nutrient content of some feedstuffs. Other values can be obtained from National Research Council tables for feedstuffs or from your feed company. Least cost computer programs are also available to calculate the least expensive supplements to feed.

SUMMARY

Ideally, body condition of cattle should be 5 or greater for maximum reproductive success. If BCS drops below a score of 4 at breeding, calving percentages will decrease sharply.

Producers should manage their herds through supplementation regimes to obtain at least a BCS of 5 at calving. The least costly and most effective time to supplement is before calving. If cattle are still thin at calving, they should be placed on a higher plane of nutrition at least 60 to 90 days to increase conception rates. This may be accomplished with higher quality pastures if available or supplementation or both. Forage which is not green and actively growing should be analyzed to determine what type of supplementation to practice and at what level.

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University of Arizona

Example I. Maintaining a Cow at BCS of 5 with Inadequate Forage Quality

1. **Determine Forage Quality.**
   Forage digestibility is 50% and protein is 6.2%.

2. **Determine Cow Maintenance Requirements (Table 2).**
   For a 1000 lb. nonlactating cow in the last trimester of pregnancy, 18 Mcal of ME and 1.6 lbs. protein are required.

3. **Estimate Forage Intake (Table 1).**
   Forage intake is estimated at 1.8% of body weight (a little less since cow is nonlactating).

4. **Determine if Maintenance Requirements are Being Met.**
   Protein: 18 lbs. forage intake • .062 protein in forage = 1.116 lbs. The forage is deficient in protein by .484 lbs. (1.6 - 1.116 = .484 lbs.) Using cottonseed meal as a supplement would require 1.08 lbs. of cottonseed meal per day (Table 5, dry matter basis). (.484 ÷ .448 protein/ lb. cottonseed meal = 1.08 lbs.)

   Energy: 18 lbs. forage intake • .82 Mcal ME per lb. (see Table 3 to convert TDN to ME) = 14.76 Mcal. The forage is deficient by 3.24 Mcal. (18 - 14.76 = 3.24 Mcal). Using cottonseed meal as supplement would require 2.63 lbs. of cottonseed meal per day (Table 5, dry matter basis). (3.24 ÷ 1.23 Mcal ME/lb. cottonseed meal = 2.63 lbs.)

   So, to satisfy the maintenance requirements of this cow would require about 2.9 lbs. of cottonseed meal per day. (Must convert dry matter to as fed basis: 2.63 ÷ .90 dry matter = 2.9 lbs.)

5. **Supplement for Maintenance if Necessary.**
   To supplement this cow at this level for 90 days preceding calving would require 2.9 lbs. of protein supplement per day for a cost of $ .25 per day or $22.50 for 3 months ($9.00 per cwt. for cottonseed meal).

6. **Determine if Body Condition is Adequate.**
   Adequate.

7. **Supplement for Weight Gain if Needed.**
   Not needed.

8. **Financial Analysis.**
   If a 10% increase in conception occurs as a result of supplementation and calves are born on an average 20 days earlier, then the net profit excluding labor and gas is $19.50 (400 lb. weaning weights; 1.5 lbs. average daily gain on calves).

20 days • 1.5 ADG • .60/lb. =	$ 18.00
10% increase in conception: (400 lbs. • .60/lb • .10)	24.00
	42.00
less supplement cost	- 22.50
profit exc. labor and gas	$ 19.50

Example II. Increasing Cow Condition from 4 to 5 with Adequate Forage Quality

1. **Determine Forage Quality.**
Forage digestibility is 55% and protein is 8.5%.

2. **Determine Cow Maintenance Requirements (Table 2).**
For a 1000 lb. nonlactating cow in the last trimester of pregnancy, 18 Mcal of ME and 1.6 lbs. protein are required.

3. **Estimate Forage Intake (Table 1).**
Forage intake is estimated at 2.0 % of body weight.

4. **Determine if Maintenance Requirements are Being Met.**
Protein: 20 lbs. forage intake • .085 protein in forage = 1.7 lbs. The forage is adequate in protein.

   Energy: 20 lbs. forage intake • .90 Mcal ME per lb. (see Table 3 to convert TDN to ME) = 18 Mcal. The forage is adequate in energy.

5. **Supplement for Maintenance if Necessary.**
Not necessary.

6. **Determine if Body Condition is Adequate.**
Inadequate. Needs to increase by 1 condition score before calving, or by 80 lbs.

7. **Supplement for Weight Gain if Needed.**
Average daily gain needed over 70 days is 1.14 lbs. (80 lbs. ÷ 70 days = 1.14 lbs.) This requires 5.3 lbs. of cottonseed meal per day (as fed basis). (1.14 lbs. ADG • 2.1 Mcal NE_g required per lb. of gain = 2.394 Mcal NE_g; 2.394 Mcal NE_g required ÷ .50 Mcal NE_g per lb. of cottonseed meal (Table 5) = 4.788 lbs. cottonseed meal (dry matter basis); 4.788 lbs. ÷ .90 dry matter = 5.3 lbs. cottonseed meal per day.

8. **Financial Analysis.**
In this example, weight gain is expensive using a protein supplement. If a cheaper protein supplement could be obtained with a higher NE_g concentration per lb. of supplement, then it would cheapen things somewhat. Also, a judgment call is required here. In most years, the substitution of grain products could cheapen the cost of gain by about 1/2. There may be some decline in forage intake (possibly up to 15%), but this can be alleviated somewhat by feeding the grain supplement during the early afternoon (around 1 PM). Unless the weather is cold, cattle should not be grazing as actively during this time period, so there will be less substitution of energy obtained from the grain for energy obtained from grazing. If the protein supplement was fed, then the gross profit before discounting labor and gas would only be $8.50 per cow. This may be marginal in profitability. If corn were fed, 4 lbs. of corn would be required per day to achieve the same weight gains. At a corn price of $7.50/cwt, the cost per day for corn would be around $0.25 to $0.30 per day or $17.50 to $21.00 for the feeding period.

For Protein Supplement		**For Grain Supplement**	
20 days • 1.5 ADG • .60/lb. =	$ 18.00	20 days • 1.5 ADG • .60/lb. =	$ 18.00
10% increase in conception:	24.00	10% increase in conception:	24.00
(400 lbs. • .60/lb • .10)		(400 lbs. • .60/lb • .10)	
	42.00		42.00
less protein supplement cost	- 33.60	less grain supplement cost	- 21.00
profit exc. labor and gas	$ 8.40	profit exc. labor and gas	$ 21.00

FROM:

Arizona Ranchers' Management Guide
Russell Tronstad, George Ruyle, and Jim Sprinkle, Editors.
Arizona Cooperative Extension

PROTEIN SUPPLEMENTATION

Jim Sprinkle[1]

INTRODUCTION

Arizona can be characterized as having a bimodal (occurring twice a year) pattern of forage production which accompanies the seasonal summer monsoons and winter rains or snows. Forage quantity and quality decrease during the winter dormant season and the "summer slump" preceding summer rains (Figure 1). However, forage quality during any given month can be quite variable, depending upon the timing, frequency, and amount of moisture. This is illustrated in Table 1.

DETERMINING WHEN TO SUPPLEMENT PROTEIN

Generally speaking, crude protein content required in the forage to meet the requirements of rumen microbes that digest fiber is around 7%. When crude protein in forage is below 6.25%, forage intake for the nonlactating cow drops sharply (Figure 2).

Providing supplemental protein when crude protein is less than 6.25% can increase forage intake and sometimes forage digestibility, reduce weight loss before calving, and ultimately increase conception rate and profitability.

If the Total Digestible Nutrients (TDN) of forage is around 52 to 55%, forage intake required to maintain a nonlactating cow is around 1.8 to 2.1% of body weight or around 18 to 20 lbs. This is true if protein requirements are being met by the forage or by feeding supplemental protein. If protein is deficient in the diet, severe weight loss can occur since the cow must break down body tissue to supply the necessary protein. It takes 6.7 lbs. of lean tissue to supply 1 lb. of protein (Berg and Butterfield, 1976). Conversely, if the diet is deficient in energy (TDN), this only requires 1 lb. of body weight loss for each 1 lb. of TDN (NRC, 1989).

As shown in Figure 2, when forage fails to meet protein requirements of the microbes in the rumen, intake decreases. This is because microbe numbers and (or) microbe activity decrease, reducing forage digestibility and increasing exit time from the rumen for fiber. When the forage only contains 4% crude protein, Figure 2 projects forage intake of only 1.2% of body weight. Forage intake at this level would cause extreme weight loss. Ignoring

Figure 1. Forage Production in Arizona

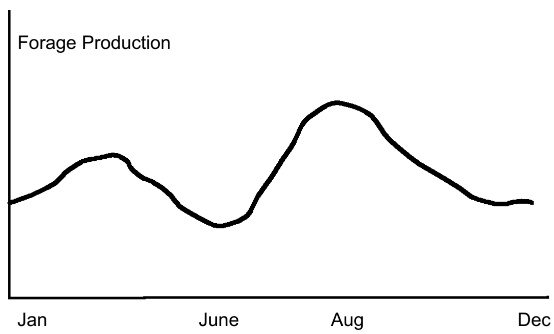
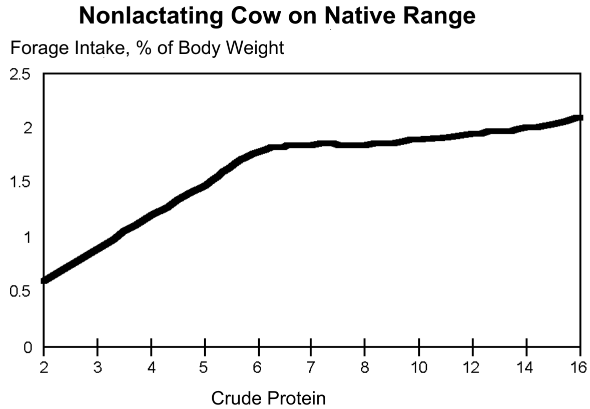


Table 1. Range In Crude Protein by Month
Blue Gamma in Arizona

Month of Year	Number of Observations	Crude Protein, %
January	2	3.94 - 7.55
February	5	1.58 - 6.9
March	3	2.57 - 7.3
April	3	4.55 - 7.9
May	5	1.92 - 9.3
June	3	5.59 - 9.0
July	4	4.45 - 8.6
August	6	4.42 - 9.43
September	4	4.76 - 12.5
October	2	6.0 - 7.4
November	7	3.03 - 6.7
December	2	4.5 - 7.13

1979, 1980-81,1995-96

Figure 2. Effect of Crude Protein on Forage Intake



Adapted from: Cochran, 1995 KSU Range Field Day.

Table 2.Cottonseed Meal Supplementation

Steers Fed 6% Crude Protein in Prairie Hay

Environmental Group	Rumen Digestibility	Forage Intake Increase	Net Effect
Supplemented	57.5%	+ 27%	+ 27% increase in nutrient intake
Control	56.6%		

McCollum and Galyean, 1985 *Journal Anim. Sci.* 60:570–577.

Table 3. Protein Supplementation with Cottonseed Meal

Steers Grazing Tobosa

Amount CSM, lbs.	Cost/Day (.114¢/lb.)	ADG	Extra Gain with CSM	Profit/Day (.70/lb. calf)
1985*	*(Crude protein below 7% in July)			
0	0	0.84		
0.75	0.09	0.97	0.13	0
1.5	0.17	1.48	0.64	0.28
1986				
0	0	1.43		
0.75	0.09	1.45	0.02	-0.07
1.5	0.17	1.57	0.14	-0.07
1987				
0	0	2.16		
0.75	0.09	2.38	0.22	0.07
1.5	0.17	2.36	0.20	-0.03

Adapted from Pitts et al., 1992: *Journal Range Mgmt.* 45:226-231

deficient protein and only considering the energy deficit, weight loss in the above example could exceed 4 lbs. per day.

As a general rule, do not supplement protein when the forage contains greater than 6.25% crude protein (Caton et al., 1988). However, benefits will be gained by protein supplementation when crude protein in forage is low. This principle is illustrated by Tables 2 and 3. In the first example (Table 2), forage intake and overall nutrient intake increased by 27% when steers on a 6% crude protein hay diet received additional protein. In the second example (Table 3), supplementing steers grazing tobosa grass was only beneficial when the forage contained less than 7% crude protein.

Obviously, the only way to decide if you need to supplement crude protein or not is to test forage for protein content. Your local Extension office can provide a list of commercial labs which perform this service. The cost for crude protein and TDN analyses totals around $18. Alternatively, near infrared spectroscopy (NIRS) analyses can be performed on fecal samples provided the cow's diet does not exceed 30% brush. This service is provided by Texas A & M University Grazingland Animal Nutrition Lab at College Station, TX (phone 409-845-5838).

It should be mentioned that protein supplementation is only effective when an adequate quantity of forage is available. The strategy with supplementing protein is to feed the microbes enough protein to enable the cow to more effectively process and harvest cheap, low quality forage. When forage utilization (removal of available quantity by livestock, wildlife, and insects) exceeds 50% of the total mass, protein supplementation may be ineffective and expensive. In this scenario, it would be more advantageous to feed a combination protein/energy supplement. The next two graphs support this point. In the first graph,

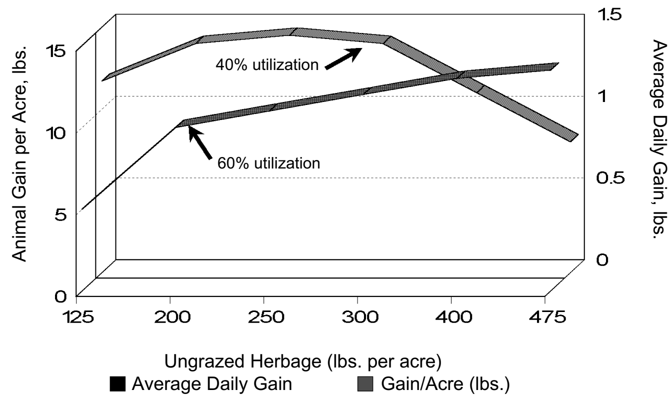
(Figure 3) researchers found that maximum animal gain per acre was achieved when forage utilization was 40 to 50%. Animal performance dropped sharply when forage utilization reached the 60% level. The standard rule of range management for plant health is “to take half and leave half.” This is also good animal management. In the second graph (Figure 4), an experiment was conducted with protein supplementation on mid-grass prairie at two different stocking rates. In the heavy stocking rate regime, protein supplementation was not economically sound.

The ideal time to supplement protein in terms of a cow’s physiological cycle is 60 to 90 days before calving. This is the time period when maintenance requirements are low and you receive the biggest “bang for your buck” in preventing weight loss and increasing conception rate. In most of Arizona with traditional spring calving, this accompanies the forage winter dormancy period. It is an expensive proposition to try to put on weight after calving, as Mother Nature is working against you. The demands of early lactation induce weight loss which is almost impossible to reverse until after about day 45 to 60 of lactation. It is a more cost effective practice to have the cow maintain or put on weight before calving to provide a safety cushion for weight loss. Table 4 illustrates the importance of having cattle in good body condition at calving.

This research was done with two-year-old cows in LA, OK, and SC, but the results are similar to those in other states. If in spite of your best efforts, cattle are thin at calving, opportunities may exist to “flush” British and Continental cross cattle with better quality pastures and (or) supplements following peak lactation (around 60 to 70 days). This stage of lactation would accompany the forage “summer slump” time period for many Arizona ranching operations. If cattle have sufficient body fat reserves at calving they may safely coast through the summer slump and

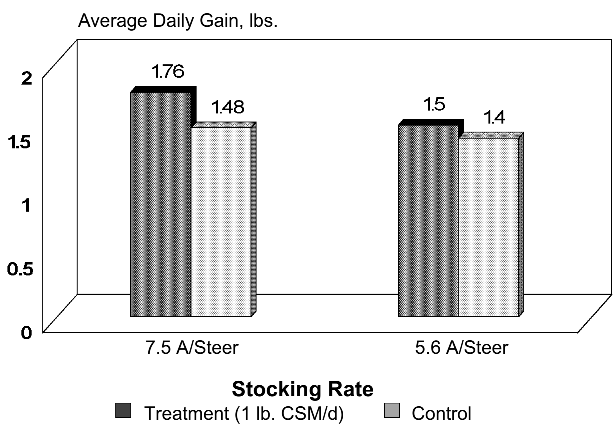
Figure 3. Animal Performance and Stocking Rate

Upland Blue Grama Range in Colorado



Adapted from: Bement, 1969 *Journal of Range Mgmt.* 22:83-86.

Figure 4. Effect of Stocking Rate Upon Cottonseed Meal Supplementation



McCollum et al., 1992 Marvin Klemme Range Res. Sta. Report, OK

Table 4. Pregnancy % by Body Condition Score

Body Condition at Calving	Day 40 of Breeding Season	Day 60 of Breeding Season
4	43 ± 5	56 ± 5
5	65 ± 4	80 ± 4
6	90 ± 9	96 ± 8

Spitzer et al., 1995 *Journal of Animal Science* 73:1251–1257 maintain acceptable conception rates. However, if cattle are below a body condition score of 4 at breeding time, it may be time to consider using a protein supplement if forage quality is low. Unfortunately, flushing thin cattle following peak lactation does not seem to work for Brahman cross cattle. Research in Australia has shown that lactating Brahman cattle often put the energy obtained from supplements into milk production instead of body fat (Hunter, 1991). This would suggest that the only opportunity one has for increasing fat stores for grazing Brahman cross cattle is before calving.

HOW MUCH SUPPLEMENT TO FEED

The most cost effective method in feeding protein supplements is to supplement what is deficient in the forage (amount of protein required by animal – amount contained in forage). Guidelines for doing this are contained in another article in this guide entitled, *Matching Forage Resources with Cow Herd Supplementation*. I have listed the maintenance requirements for a 1000 lb. cow in Table 5, but requirements will differ for different size cows. As an example in calculating the amount of protein to supplement, forage crude protein was tested and found to be 4%. For a 1000 lb. nonlactating cow, the amount of protein which needs to be fed was 2.32 lbs. per day and is calculated as follows:

1. Find the daily requirement, which is 1.6 lbs.
2. Determine the amount contained in forage. If we estimate forage intake to increase to 1.7% of body weight for the supplemented cow, then crude protein in the forage is .68 lbs. (1000 x .017= 17 lbs; 17 x .04 crude protein in forage = .68 lbs. protein)
3. Subtract the amount contained in forage from the daily requirement, which gives .92 lbs. of protein which needs to be supplemented. (1.6 – .68 = .92 lbs. of protein needed)
4. Determine the amount of supplement to feed by dividing the amount of protein needed by the protein content of the supplement. If we feed cottonseed meal (44% crude protein), then we need to feed 2.09 lbs. of cottonseed meal on a dry matter basis. (.92 lbs. protein needed ÷ .44 lbs. protein/lb. cottonseed meal = 2.09 lbs. cottonseed meal)
5. Since most protein supplements contain about 10% water, convert feed on a dry matter basis to an "as fed" basis. This would require the feeding of 2.32 lbs. of cottonseed meal per day to meet protein requirements. (2.09 ÷ .9 = 2.32 lbs. cottonseed meal)

Table 5. Maintenance Requirements of Range Cattle

	Energy TDN	Protein % in diet or lbs.
Nonlactating, Mid-Pregnancy	9.1 lbs.	7.0 or 1.40
Nonlactating, Last Trimester	11.0 lbs.	7.9 or 1.60
Early Lactation, 18 lbs. milk	16.5 lbs.	11.0 or 2.24
Mid-Lactation, 10 lbs. milk	14.0 lbs.	9.6 or 2.00
Late Lactation, 7 lbs. milk	12.8 lbs.	9.5 or 1.90

(1000 lb. cow)

The protein could be fed once a week (7 times the daily rate) without harming the cow (Huston et al., 1999). Ruminant animals have an ability to recycle some of the excess nitrogen contained in protein back into the rumen after it is consumed the first time (Owens and Zinn, 1988). **Do not feed energy (high grain, protein less than 22%) supplements with less than daily feeding or problems like acidosis and founder can occur.**

WHAT KIND OF PROTEIN SUPPLEMENT TO USE

The greatest benefits for protein supplements are usually obtained with high protein of a natural origin (no protein from urea). These type of supplements are also the most expensive to use. A portion of the protein can be obtained from urea in order to cheapen the protein supplement. Too much urea in the supplement can result in reduced intake of the supplement due to palatability problems or urea toxicity if cattle consume too much of the supplement. Recommendations for urea substitution of natural protein will be discussed later.

It is important to know the ideal composition of protein supplements to feed. Although we know very little concerning the ideal amino acid profiles, research has identified the advantage of using supplements with greater crude protein. When five trials in Kansas were summarized, researchers found that increasing crude protein of the supplement from 15 to 22 to 28% resulted in 49% greater forage intake and 22% greater forage digestion (as cited in Paterson et al., 1996). Kansas researchers also found that cattle fed a 13% crude protein supplement lost 193 lbs. over the winter and cattle fed a 39% crude protein ration lost 97 lbs. over the winter (DelCurto et al., 1990).

In stressful situations in which cattle are losing weight, some benefits have been demonstrated by feeding supplements with approximately 40 to 60% of the protein being ruminally undegradable or bypass protein. Feedstuffs high in bypass protein include feather meal, blood meal, corn gluten meal, and fish meal. Due to palatability problems, rendered animal products are usually limited to 25 to 30% of the total supplement and are combined with grain products to increase palatability. Petersen et al. (1996) reported that weight loss has been reduced and conception rates increased in several experiments by feeding bypass protein. However, they reported that bypass protein supplementation only seems to be effective when animals are losing weight. The additional cost per ton for adding bypass protein is around $50 to $80.

When urea is substituted for natural protein in the supplement, it is recommended that no more than 30% of the crude protein in the supplement come from urea (Köster et al., 1996). Table 6 presents research data from Kansas showing a slight decrease in cow performance when the percentage of crude protein derived from urea was 30%. If forage quality is very low and the supply of forage limited (as in drought) avoid the feeding of any urea at all.

Table 6. Substitution of Urea for Natural Protein

Cows Grazing Winter Tallgrass Prairie

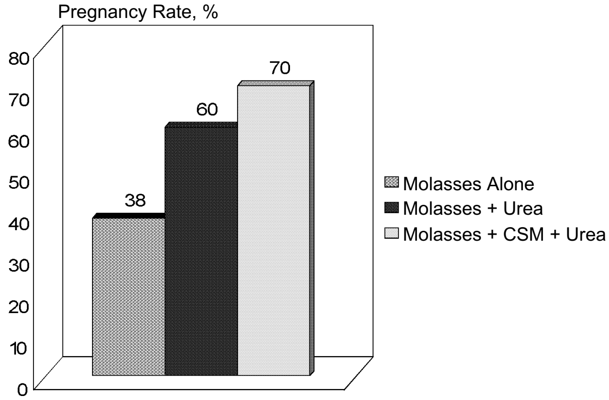
Item	0% CP from urea	15% CP from urea	30% CP from urea
Supplement Intake, lbs.	4.8	4.8	4.8
Wt. gain [28 Nov - 7 Feb]	48	42	14
Wt. gain [28 Nov - 21 Mar (Calving)]	-97	-107	-130
Wt. gain [28 Nov - 27 Apr (Breeding)]	-152	-152	-172
Wt. gain [28 Nov - 5 Oct (Weaning)]	52	62	27
Pregnancy Rate, %	92.6	100	86.2

Koster et al., 1996 KSU Cattemen's Day

Liquid feed supplements can be expected to have similar results to dry supplements. If the supplement does not contain sufficient protein (less than 22% crude protein) it can be expected to perform as an energy supplement. Usually, energy supplements result in substitution of forage by the supplement and can decrease both forage intake and forage digestibility (Caton and Dhuyvetter, 1997). Urea is often added to liquid supplements to increase crude protein. Modern technology has devised an urea molecule that breaks down more slowly than the urea molecule used in past formulations. This has reduced the danger of urea toxicity for liquid feeds. Assumptions made above for dry feeds on the percentage of urea included in feeds and their effect upon performance are probably valid for liquid feeds also. This is illustrated in Figure 5. Incremental increases in pregnancy rate were achieved by increasing protein of the molasses supplement by urea and then by cottonseed meal plus urea.

Figure 5. Molasses Supplements

3-Year-Old Cows Fed Stargrass Hay (4-6% CP)



Pate et al., 1990 *Journal Anim. Sci.* 68:618-623

Example 1: Deciding Which Supplement to Buy

Supplement A: Fed once/wk (2 lbs./d x 7 = 14 lbs/feeding)
Supplement B: Self fed (2.5 lbs/day)

1. Determine protein content of supplements:
   Supp. A: 44% CP x 2000 lb. = 880 lb. protein
   Supp. B: 36% CP x 2000 lb. = 720 lb. protein

2. Determine the cost/lb. protein:
   Supp. A: $228/T or 228 ÷ 880 lb. = $ .26/lb. protein
   Supp. B: $260/T or 260 ÷ 720 lb. = $ .36/lb. protein

3. Determine the cost of dispensing supplements:
   Supp. A: $70/T or 70 ÷ 880 = $ .08/lb. protein
   Supp. B: $20/T or 20 ÷ 720 = $ .03/lb. protein

4. Determine protein each cow eats each day:
   Supp. A: 2 lbs. x .44 = .88 lb. protein
   Supp. B: 2.5 lbs. x .36 = .90 lb. protein

5. Determine the cost/cow/day:
   Supp. A: .88 lbs. protein x (.26 + .08) = $ .34/day
   Supp. B: .90 lbs. protein x (.36 + .03) = $ .35/day

6. Determine the cost for the herd:
   Supp. A: $ .34 x 60 d x 100 cows = $ 2040
   Supp. B: $ .35 x 60 d x 100 cows = $ 2100

In a presentation given to the American Feed Industry Association in 1995, J.E. Moore made the following conclusions concerning the use of liquid feeds:

1. When forage quality was low, forage intake and average daily gain (ADG) increased, but ADG could still be low or negative.
2. When forage quality was high, forage intake decreased, but ADG increased if supplement contained meal + urea or meal.
3. Forage intake decreased if forage intake was greater than 1.75% of body weight.
4. Forage intake increased if forage intake was less than 1.75% of body weight.
5. Forage intake decreased if supplement intake exceeded .8% of body weight (about 8 lbs. for a 1000 lb. cow).
6. Forage intake increased when crude protein of the supplement was greater than 22%.
7. Liquid feeds acted similarly to dry supplements for forage intake.

DECIDING WHICH SUPPLEMENT TO BUY

The way to evaluate protein supplement purchases is to calculate the cost of each lb. of protein dispensed. Example 1 illustrates this for one supplement fed once a week at seven times the daily rate vs. another supplement that is self fed.

In Example 1, costs are similar, so a management decision needs to be made. If the producer desired to look at his herd more often, then he might opt for Supplement A. Otherwise, he may wish to use the self-fed supplement.

CONCLUSIONS

1. The purpose of protein supplementation is to feed microbes so the cow can harvest more cheap forage.
2. Adequate available forage is required for protein supplementation to be effective.
3. Forage should be tested to determine if supplementation is needed.
4. Young cows respond more favorably to protein supplementation than do older cows.
5. If forage is less than 6.25% crude protein (CP), protein supplementation typically increases forage intake, decreases weight loss, and increases conception.

6. The optimum time to supplement is 60 to 90 days before calving.
7. As a general rule, forage with 4% CP requires about 2 lbs. of cottonseed meal or soybean oil meal per cow per day.
8. To avoid hurting animal performance, keep CP by urea less than 30% of the total CP of the supplement.
9. Liquid feed functions much like dry protein supplements.
10. It is advisable to keep CP in supplements greater than 22% with low quality forage.

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FROM:

Arizona Ranchers' Management Guide
Russell Tronstad, George Ruyle, and Jim Sprinkle, Editors.
Arizona Cooperative Extension

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SUPPLEMENTATION DURING DROUGHT

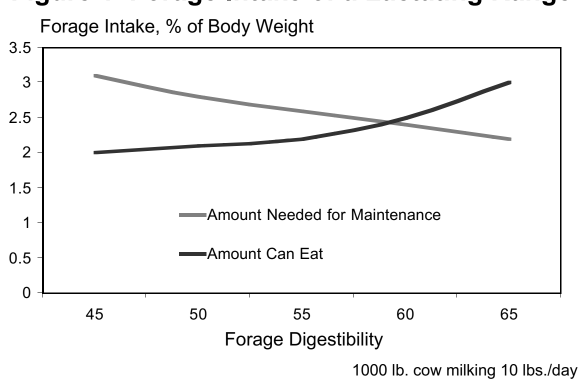
Jim Sprinkle[1]

INTRODUCTION

Breeding failure is the most important adverse consequence to the cow herd during drought. This is due to reduced forage quality and availability, resulting in nutritional stress. As forage quality decreases, lignin and other more slowly digestible components of forage increase. This lower quality forage remains longer in the rumen before exiting, reducing forage intake. Thus, the cow may be unable to eat enough forage to maintain body weight (Figure 1).

During early to mid-lactation, a beef cow will consume from 2.5 to 3.0% of her body weight in forage daily. During drought, stocking rates may be adjusted to increase forage for each animal unit, but forage quality may drop thereby preventing adequate digestible nutrient intake. As forage digestibility drops, passage rate of undigested dry matter decreases and forage intake declines. In Montana, when forage digestibility was 61%, lactating cattle consumed 2.2 to 2.8% of body weight in forage. During a drought year, forage digestibility dropped to 43% and the same lactating cattle consumed 1.2 to 1.3% of body weight in forage (Havstad and Doornbos, 1987). Forage intake at this level is inadequate to furnish the necessary nutrients for milk production and maintenance of cow body condition. To survive drought and maintain acceptable rebreeding percentages and economic viability, the cow herd should be managed for acceptable body condition. Forage should also be monitored for total production and

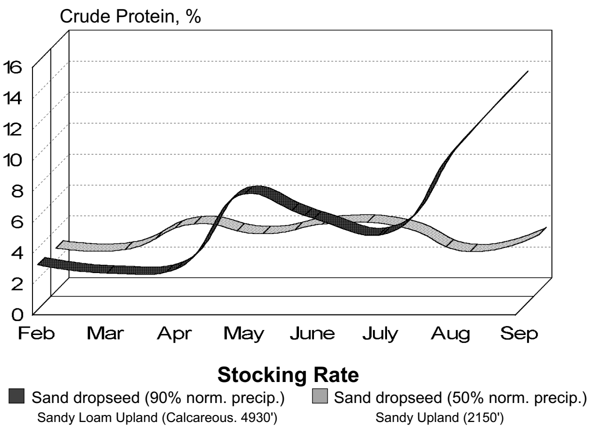
Figure 1. Forage Intake of a Lactating Range Cow



GENERAL RECOMMENDATIONS

1. Evaluate range to determine forage supply.
2. Analyze forage to determine nutrient deficiencies.
3. Start supplementation regime at least 60 days before calving to prevent accelerated weight loss following calving.
4. If forage supply is adequate (less than 50% utilization of forage), supplement natural protein (22% crude protein or greater) to meet forage deficiencies (generally 1 to 2 lbs. of supplement per day for nonlactating cattle). Protein supplements can be given as infrequently as once a week.
5. If forage supply is limited, use a protein/energy or energy supplement. Energy supplements need to be fed daily.
6. Use urea supplements with extreme caution.
7. Use water to help distribute livestock to underutilized areas of the grazing allotment.
8. Cull cows to match animal units to forage available. Cull in this order: open cows, old cows (9 years or older), 2-year-old producing cows, 3-year-old producing cows, replacement heifers.
9. Monitor use of toxic plants by cattle and move cattle if necessary to avoid over- consumption of toxic plants.

Figure 2. Crude Protein in Arizona During Drought



Arizona Strip Range Forage Quality Analysis Study (1996)

Table 1. Production from Cows During Drought

	No Supplement		1 lb./day cottonseed meal	
Cow Age (Years)	**Weaning Weight (Lbs.)**	**Conception Rate (%)**	**Weaning Weight (Lbs.)**	**Conception Rate (%)**
3	306	45	372	90
4	341	62	376	88
5	366	63	410	92
6	356	73	396	85

Foster, 1996

quality to determine if the cow's nutritional requirements are being met. It may be a cost effective practice to analyze forage or fecal samples for total digestible nutrients (TDN) and crude protein during dormancy or drought and match supplementation strategies to the nutritional deficits in the forage. Your local Cooperative Extension office can provide addresses of laboratories which offer this service.

PROTEIN SUPPLEMENTATION

Figure 2 illustrates crude protein content of sand dropseed (*sporobolus cryptandrus* (Torr.) Gray; warm season grass) at two different range sites in Arizona during the 1996 drought. At one site, precipitation was 90% of normal and protein content increased to 14.92% by September following 2.32 inches of moisture from July through September. At the lower elevation site with 50% of normal moisture, crude protein of the forage never got above 4.4%. At the same low elevation sandy upland range site, even winterfat had only crude protein above 6% for one month (April 96; 7.23% crude protein). Conversely, the crude protein of winterfat at the site with 90% moisture never fell below 6% and was above 11% during April and May. Protein required for a 1000 lb. nonlactating cow is around 1.6 lbs./ day or 7% crude protein in the diet. When the cow is lactating, 2.0 lbs. or 9.6% dietary crude protein is required. Drought accentuates the need for protein supplementation.

Protein supplementation during drought can yield dividends. In a study at Fort Stanton, NM over several years of drought, weaning weights and conception rates for cattle of different ages were compared (Table 1). The supplemented cows in this study were fed 1 lb. of cottonseed meal per day from just prior to calving until grass was green. The effects of the drought were most severe for younger cows, but supplementation increased weaning weights and conception rates in cows of all ages. Other cattle at risk during drought are heavier milking cattle and larger framed cattle. It is well to remember that during drought we are not only supplementing to meet deficits in this year's forage, we are also supplementing next year's calf crop.

When forage contains less than 6% protein, protein supplementation can be effective in enhancing forage intake (Caton et al., 1988). When additional protein is made available, this increases the number and activity of microorganisms in the rumen which are ultimately responsible for fiber digestion. As the microbial population of fiber digesting bacteria increases, passage rate of forage increases, ultimately allowing for greater intake of low quality forage. In some cases, greater digestibility of forage has also been observed. Figures 3 and 4 illustrate how both forage intake and forage digestibility were increased by protein supplementation for cattle eating poor quality (2% crude protein) prairie hay.

Steers fed the greatest amount of the 33% protein supplement increased forage intake 49% and had 39% greater digestibility of forage than control steers. The amount of TDN required to maintain body weight for nonlactating cattle is around 52%, so steers supplemented the highest level of protein should not have experienced weight loss (although these data were not reported).

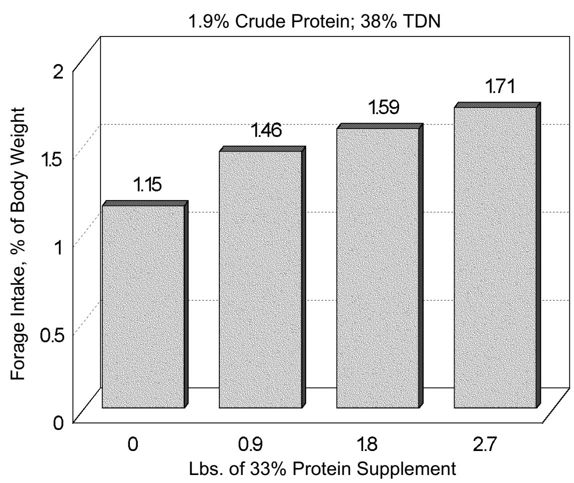
When a lower protein supplement (18%) was fed on an equal protein basis (1.7, 3.5, and 5.3 lbs. of supplement per day), forage intake was 1.34, 1.48, and 1.33% of body weight for each increasing supplementation level. Total ration digestibility was 41, 43, and 50%, respectively. Cattle in this study appeared to be limited in protein intake with the low quality forage, and substitution of forage by supplement did not appear to occur with the higher protein supplement. In this same study, some substitution of forage by supplement resulted when alfalfa hay was fed at the same rates as for the medium protein supplement. However, no substitution occurred when alfalfa pellets were fed, presumably because of a positive effect on rate of passage.

An advantage with protein supplementation is that cattle can be supplemented as infrequently as once a week without detrimental effect (Huston et al., 1997). This is not the case for energy supplements (e.g., corn, milo) which need to be supplemented daily.

ENERGY SUPPLEMENTATION

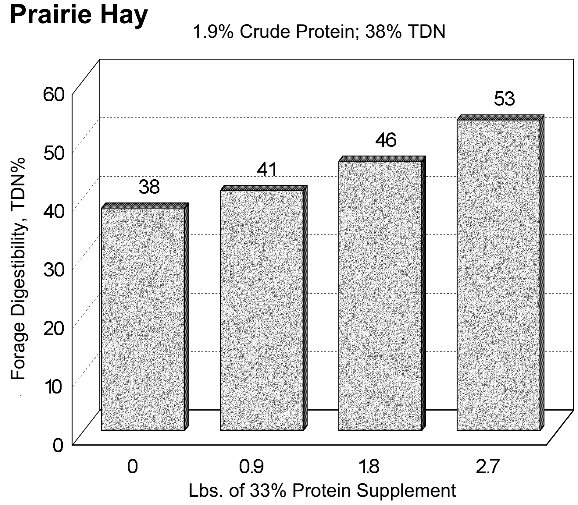
It is generally acknowledged that forage intake and digestibility of the forage will decrease with energy (grain) supplementation. However, sometimes the value of the grain to the animal offers a greater advantage than the disadvantage of lowering the forage value. Also, grain can be advantageous for stretching the forage supply. If forage quantity is insufficient, it is probably more economical to supplement with a combination protein/energy ration (20 to 25% protein; 40 to 50% grain) than a high protein ration. **Cattle will be unable to capitalize on the benefits of a high protein supplement when the forage supply is insufficient.** As a general rule, if utilization of available forage is less than 50%, use a high protein ration, but if forage utilization is

Figure 3. Forage Intake on Dormant Tallgrass Prairie Hay



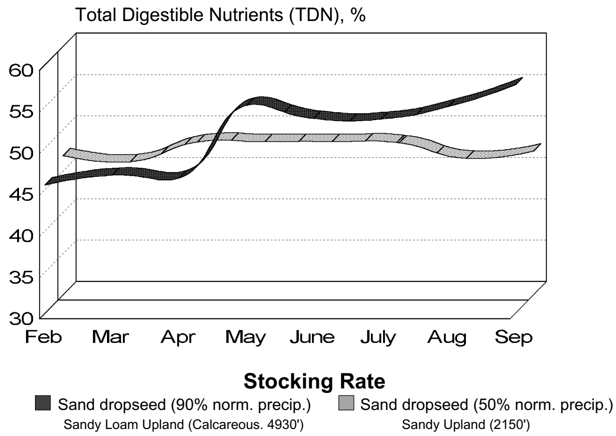
Stafford et. al., March 1996 *Journal of Animal Science*

Figure 4. Forage Digestibility on Dormant Tallgrass Prairie Hay



Stafford et. al., March 1996 *Journal of Animal Science*

Figure 5. Energy Content in Arizona During Drought



Arizona Strip Range Forage Quality Analysis Study (1996)

equal to or greater than 50%, use a protein/energy or energy supplement.

Figure 5 shows the energy content (TDN) of the same grass from the same sites as shown in Figure 2. The energy required for maintenance of lactating cattle is supplied by forage at around 56% TDN and for nonlactating around 52% TDN. At no time during 1996 was TDN above 49% for the low elevation range site with 50% of normal precipitation. Assuming forage availability was adequate, protein supplementation at the low elevation range site could possibly have increased both forage digestibility and intake to more optimal levels.

OTHER SUPPLEMENTS

In stressful situations in which cattle are losing weight, some benefits have been demonstrated by feeding supplements with approximately 40 to 60% of the protein being ruminally undegradable or bypass protein. Feedstuffs high in bypass protein include feather meal, blood meal, corn gluten meal, and fish meal. Due to palatability problems, rendered animal products are usually limited to 25 to 30% of the total supplement and are combined with grain products to increase palatability. Petersen et al. (1996) reported that weight loss has been reduced and conception rates increased in several experiments by feeding bypass protein. However, they reported that bypass protein supplementation only seems to be effective when animals are losing weight. The additional cost per ton for adding bypass protein is around $50 to $80.

Another form of supplementation during drought to increase harvestable forage is the hauling of water to seldom used areas of pastures. Granted, this is labor intensive and requires acreage which is easily accessible. However, in large pastures with few water developments, this can help in grazing distribution. In areas which are not excessively rugged, it is estimated that cattle will use 80% of the allowed harvestable forage up to 1 mile from a water source, but only 40% at 1.5 miles, and 20% at 2 miles from the water source. If there are areas in pastures exceeding 1 mile from water, then in effect you have a “forage bank” which can be utilized.

In order to avoid harming the range resource for subsequent years, maximum utilization of forage should not exceed 60% (Lacey, 1995). Exceptions are crested wheatgrass (Lacey, 1995) and annuals. Annuals should be grazed early and heavily during a drought year while they are still green and have greater nutritive values. Pastures should be rotated frequently and include longer rest periods due to reduced growth during drought. In some instances, it may be advantageous to open up pastures into larger pastures to allow for more selectivity by cattle. This will also help prevent cattle from “bogging down” in earthen water tanks with dropping water levels.

UREA SUPPLEMENTS

When forage quality is low and the TDN or energy value of forage is low (less than 45%), it may be risky to feed protein supplements with urea. However, research in this area is rather limited (Dr. Bob Cochran, Kansas State

University, personal communication). In some cases, urea toxicity may be more related to reduced forage availability than to forage quality. A rule which is widely quoted is that urea should constitute no more than 1/3 of the crude protein of a cow's diet. If this amount of urea in the diet is exceeded, there may be increased risk of urea toxicity and death. Symptoms of urea toxicity have been observed in cattle unaccustomed to urea in doses approximating .4 lbs of urea (equivalent to approximately 1.15 lbs. of crude protein supplied by urea) for a 1000 lb. cow (Radostits et al., 1994). If the protein supplement being fed contains 32% crude protein with 26.5% crude protein being derived from urea, the cow eating this supplement may be at risk if she consumes 4.34 lbs. of the urea based supplement (4.34 lbs. supplement • .265 crude protein for urea = 1.15 lbs. equivalent protein from urea or .40 lbs. urea). The crude protein:urea ratio can be determined by the feed tag, forage analysis, estimated forage intake from Table 2, disappearance of urea supplement, and the formula in the box right.

For example, forage analysis reveals that the forage is estimated to contain 5% crude protein and 45% TDN. Forage intake from Table 2 is estimated to be 1.7% of body weight or 17 lbs. for a 1000 lb. cow. Crude protein intake from forage is 17 • .05 or .85 lbs. The feed tag on the supplement contains 32% crude protein and 83% of this, or 26.5% crude protein, is from urea. The cattle are eating 4 lbs. of supplement a day, or .22 lbs. natural protein from supplement (4 • .055) and 1.06 lbs. protein from urea (4 • .265). The crude protein:urea ratio in this instance would be greater than the desired 3:1 ratio.

$$\frac{(.85 + .22 + 1.06)}{1.06} = \frac{2.00}{1.00}$$

If it is desired to continue feeding a urea based supplement in this case, then the amount of urea in the supplement needs to be reduced. If cattle were fed a urea based supplement with 20% crude protein of which 70% of the ration, or 14% crude protein, was from urea, then cattle could probably consume 4 lbs. of this supplement. If forage quality drops to 4% crude protein and 40% TDN, then cattle can only consume safely 2 lbs. of the 20% protein supplement.

$$\frac{[(12 \text{ lbs. forage} \cdot .04) + (2 \text{ lbs.} \cdot .06 \text{ natural protein}) + (2 \text{ lbs.} \cdot .14 \text{ urea})]}{(2 \text{ lbs.} \cdot .14 \text{ urea})} = \frac{3.14}{1.00}$$

The cutoff value for a urea based supplement with forage of 5% protein and 45% TDN (15% increase in forage consumption factored in for protein supplementation) is 2 lbs. of a 32% protein supplement with crude protein from urea = 26.5% and 4.5 lbs. for a 20% protein supplement with crude protein from urea = 14%.

One may be tempted to control the intake of liquid urea based supplements

$$\frac{(\text{lbs. protein from forage} + \text{lbs. natural protein in supplement} + \text{lbs. protein from urea})}{\text{lbs. protein from urea}}$$

Table 2. Forage Intake of Lactating Cattle at Different Forage Digestibilities

Forage Digestibility or TDN, %	Amount Required to Eat to Meet Maintenance Requirements, % of Body Weight	Amount Can Eat at the Forage Digestibility Listed, % of Body Weight[1]
43	3.2	1.2 to 1.3
45	3.1	1.7 to 2.0
50	2.8	1.9 to 2.1
55	2.6	1.7 to 2.1
58	2.4	1.9 to 2.5
60	2.3	2.0 to 2.5
62	2.3	2.3 to 2.8
64	2.2	2.6 to 3.2
Greater than 64		2.6 to 3.2

[1]Research from various sources including Kronberg et al., 1986; Kragner et al., 1986; Havstad and Doornbos, 1987; Sprinkle, 1992.

by locking the wheels on the feeder. However, research suggests that after 3 days of urea deletion from the diet, adaptation to urea based supplements is lost (Davis and Roberts, 1959). It is a much better practice to either eliminate completely the feeding of urea during drought or else significantly reduce the amount of urea in the supplement.

Signs of urea toxicity include rapid, labored breathing, muscle tremors, severe abdominal pain, frothing at the mouth and nose, irritability to sound and movement to the point of being aggressive, slight incoordination followed by severe incoordination and the inability to stand, weakness, bloat, and violent struggling and bellowing (Essig et. al, 1988; Radostits et al., 1994). Treatment, which is often too late, is oral administration of 4 liters of a 5% vinegar solution for a 1000 lb. cow (Davis and Roberts, 1959).

TOXIC PLANTS AND ADDITIONAL CAUTIONS

An additional caution for supplementation during drought is to avoid feeding supplements containing ionophores (trade names of Rumensin® or Bovatec®). Doing so can increase the probability of nitrate poisoning (Radostits et al., 1994). Nitrates can accumulate in forage during drought, and especially in the "green-up" following drought. Plants which are particularly susceptible to nitrate accumulation include kochia, lambsquarters, oat hay, Russian thistle (tumbleweed), sorghum, and filaree. Symptoms of nitrate poisoning are similar to other kinds of poisoning and include rapid pulse rate, labored breathing, and possibly muscle tremors and convulsions. Symptoms which are somewhat unique to nitrate poisoning include darkened membranes in the mouth, nose, and eyes and dark red to brown blood instead of bright red blood (Essig et. al, 1988). Treatment is accomplished with intravenous injection of 100 ml of a 4% solution of methylene blue / 1000 lbs. body weight (Essig et. al, 1988). According to Radostits et al. (1994), supplemental feeding of sodium tungstate (wolfram) under veterinary advisement can reduce the effects of nitrate poisoning in cattle grazing pastures with high levels of nitrate (greater than 1% nitrate nitrogen; Essig et al. 1988,).

During drought, one also needs to be alert to possibilities of toxic plant poisoning. Oftentimes, the greenest plants may be toxic (e.g., bracken fern, whorled milkweed). Forage production should be monitored closely and cattle should not be subjected to excessive stocking rates on the depressed forage base. Be aware of poisonous plants which exist in your pastures and carefully monitor the use of these plants by livestock.

CONCLUSION

It is important to plan ahead when supplementing cattle during drought. The most effective time to supplement cattle is before calving. It is almost impossible to put weight back on a cow during the first 45 to 60 days after calving. Nutrient requirements at this time are about 50% greater than in the last trimester of pregnancy. Producers should analyze forage for deficits in protein and TDN and supplement accordingly to maintain cow weight before calving (Sprinkle, 1996). Reproduction will drop sharply if cattle are thinner than a body condition score of 4 at breeding.

It is acknowledged that drastic effects can occur in a relatively short period of time during drought. In some cases, cattle may be in adequate body condition shortly before calving and lose weight rapidly as forage supplies and forage quality decline. Cattle should not be allowed to get below a body condition score of 3 in order to avoid increased susceptibility to diseases. Also, conception rates in cattle will possibly drop to 40 to 50% at body condition score 3 and to practically zero at body condition score 2. **If at all possible, a cow should not be allowed to become protein deficient during drought.** For every 1 lb. of protein deficiency, the loss of 6.7 lbs. of body weight would be required to supply this level of protein. Conversely, if the diet was deficient in energy (TDN), this would only require 1 lb. of body weight loss for each 1 lb. of TDN. If a cow was deficient in TDN by 1.5 lbs. per day and initial body condition score was 4, the cow could lose 1.5 lbs. a day for 53 days and drop to a final body condition score of 3.

In the worse case scenario, some cattle should be sold to stretch forage supplies while also feeding supplement to remaining cows to maintain desirable body condition during breeding. Heavier milking and larger cattle would be good candidates for culling, because their maintenance requirements will be much larger. Since 2-year-old cows will require more supplementation and be more difficult to rebreed, you may want to consider selling these cows as well. Above all else, use pregnancy testing as a tool to reduce herd size and preserve a reasonable calf crop the following year. Income from sale of cattle during drought may be eligible for income deferment for 1 year if in an area that has been declared a drought disaster area. If extreme destocking is expected, early weaning of calves should be considered. Nonlactating cattle will eat only 70% as much as lactating cattle, so this will spare the forage base somewhat during drought.

In conclusion, drought usually requires some type of supplementation to avoid extreme weight loss in cattle. If cattle are allowed to become too thin, conception rates may decrease markedly. By obtaining forage or fecal samples and analyzing for protein and TDN, supplements can be matched to drought conditions.

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FROM:

Arizona Ranchers' Management Guide
Russell Tronstad, George Ruyle, and Jim Sprinkle, Editors.
Arizona Cooperative Extension

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MANAGING NUTRITIONAL CHALLENGES TO REPRODUCTION

Jim Sprinkle[1]

INTRODUCTION

Nutritional challenges placed upon the lactating cow can be extreme in Arizona. Among these are the extra nutritional requirements caused by lactation. Figure 1 illustrates the weight loss which usually occurs in a lactating cow during the first 45 to 60 days of lactation. At the period of time at which the cow has lost the most weight, producers are trying to rebreed her in order to maintain a yearly calving interval. It is usually not possible to entirely prevent weight loss during early lactation with range cattle. A better strategy is to plan ahead to allow for weight loss by building or maintaining body fat stores before calving.

Another challenge with Arizona ranching operations is the reduction in forage quality with mature forage. Rainfall often occurs in a biannual pattern and forage quality before the monsoon rains and in late winter can be low. As forage matures, protein, total digestible nutrients (TDN), and phosphorus often decline below levels considered adequate. In addition, certain trace minerals may be deficient year round. It is a good practice to analyze dormant forage to determine protein, TDN, and phosphorus content. You can then match cow supplementation to the forage resource (See *Matching Forage Resources with Cow Herd Supplementation*). It is also a good practice to analyze forage for trace mineral status over two or three years to establish baseline data for your ranch. Trace minerals in Arizona which may be of concern are selenium, copper, zinc, sulfur, and molybdenum.

There are several options one can take to help meet the nutritional challenges placed upon cows by lactation and the environment. Some of the most prominent are listed below and shall be explained more fully:

1. Create a “fat storage cushion” for lactating cows by maintaining body condition score (1 to 9, 9 = fattest; Richards et al., 1986) at 5 or greater before calving. As part of this strategy, utilize protein supplements for low quality forage to increase forage intake and digestibility.

2. If in spite of your best efforts, cattle are thin at breeding time, attempt to “flush” cattle with your best quality pasture and/or by supplementation. If combined with short-term calf removal, flushing will be more effective.

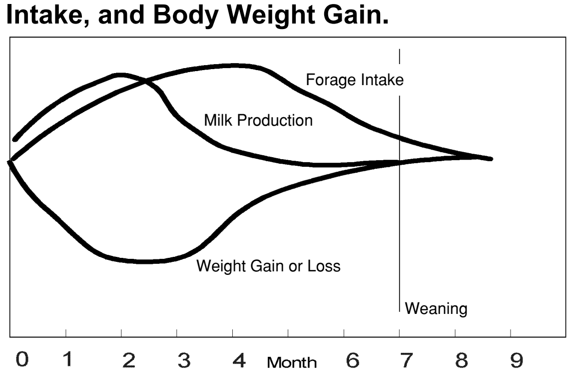
3. Match calving season to the forage curve.

4. Genetically match the cow to the environment.

OPTION 1: MAINTAINING BODY CONDITION AT 5 BEFORE CALVING

As shown in Figure 1, it is an advantage to allow cattle to have fat reserves they can mobilize during early lactation. Research has shown that reproduction will suffer if cows are allowed to become too thin at calving, especially with

Figure 1. Milk Production, Forage Intake, and Body Weight Gain.



After Coppock, 1985 (adjusted for beef animal)

Table 1. Pregnancy % by Body Condition Score

Body Condition at Calving	Day 40 of Breeding Season	Day 60 of Breeding Season
4	43 ± 5	56 ± 5
5	65 ± 4	80 ± 4
6	90 ± 9	96 ± 8

Spitzer et al. May 1995. Journal of Animal Science

younger cows. Table 1 illustrates the effects of different fat reserves with two-year-old cattle.

One problem faced in attempting to maintain body condition at 5 before calving is that during the last trimester of pregnancy forage quality can be quite low. As forage quality decreases, lignin and other more slowly digestible components of forage increase. The result of these changes in forage quality is that forage remains longer in the rumen before exit, reducing forage intake. Thus, the cow may be unable to eat enough forage to maintain body weight (Figure 2).

When forage contains less than 6.25% protein, protein supplementation can be effective. When additional protein is made available in the rumen, this increases the synthesis of new microorganisms in the rumen which are ultimately responsible for fiber digestion. This is illustrated in Figures 3 and 4 where forage intake and forage digestibility were increased by protein supplementation for cattle eating poor quality (2% crude protein) prairie hay. For Arizona, data collected by Cooperative Extension workers has shown that the crude protein of blue grama native range during the winter months of December to February varied between 1.58 and 7.55%.

In the above scenario, nonlactating cattle fed 2.7 lbs. of protein supplement should maintain body weight as the energy requirement for nonlactating cattle is around 52% TDN. Cattle fed less protein would probably lose weight; the greatest weight loss occurring with no protein supplement. Greater conception rates would be expected for the cattle fed 2.7 lbs. of protein supplement. If management will allow it, it is cost effective to separate thin cows from fat cows before calving and supplement protein to thin cows according to forage deficits. Research in West Texas (Huston et al., 1999) has indicated that protein supplements can be fed as infrequently as once a week without detrimental effect. If energy supplements are fed (e.g., corn, milo), they need to be fed daily.

Conception rate will be improved by keeping cattle in good body condition prior to calving. Forage intake and digestability can usually be improved with late season dormant forage through the use of protein supplements. Cost effective supplementation can be integrated into prepartum nutritional management programs by analyzing forage for nutritional deficiencies and then supplementing accordingly.

OPTION 2: FLUSHING AFTER CALVING AND SHORT TERM CALF REMOVAL

Table 2 shows the effect of flushing thin cattle with a high energy ration after calving. Cattle in this study (Richards et al., 1986) were fed different levels of energy after calving. Two of the groups were limit-fed a similar corn silage diet after calving to lose 1.00 to 1.50 lbs. of body weight per day. Two weeks before the breeding season started, one of these two groups was then flushed with 9 to 13 lbs. of corn and corn silage fed to appetite. The flushing ration was continued throughout the first 30 days of the breeding season. Both groups had calves removed from cow for 48 hours two days prior to the initiation of the breeding season. Flushing and calf removal had little effect upon cattle that were already in good condition at calving but increased conception markedly for thin cattle. Although it may be difficult to provide supplementation to cattle in extensive range operations, this principle can be applied by using excellent quality pastures after calving. For instance, if filaree was in abundance in a particular pasture, it could be used to help flush cattle before breeding.

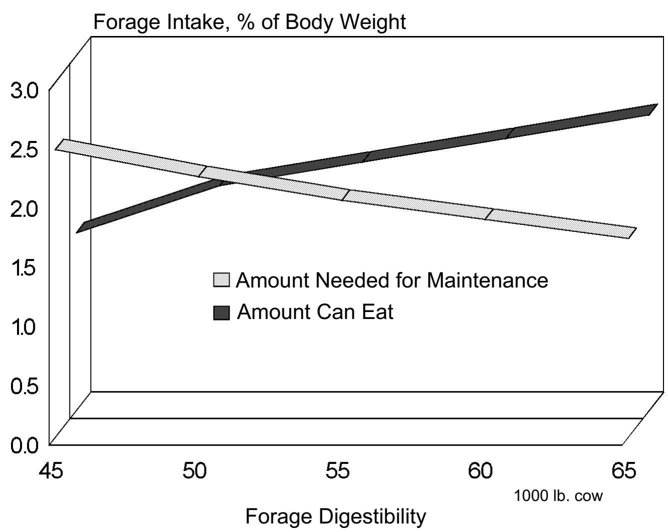
Another tool that can be used in combination with flushng is short term calf removal (Smith et al., 1979; Richards et al., 1986). If cattle are being worked for spring branding, calves could be separated from cows for 36 to 48 hours and not allowed to nurse. Research has shown this to be effective in increasing estrus with thin cows (body condition score 3 to 4; Nix et al., 1981). Researchers in Texas have shown that short term calf removal can be particularly effective with Brahman cross cattle which sometimes have long periods of time before the first estrus postpartum (Nix et al., 1981). *A note of caution:* short term calf removal with cows having a body condition score less than 4 may not be effective in increasing conception rate unless cattle are provided with some type of nutritional supplement as well (L. R. Sprott, Texas A & M University, personal communication). Additional research in Australia has suggested that lactating Brahman and Brahman cross cattle will preferentially shunt nutrients from supplements into milk for the calf (Hunter, 1991). Therefore, it may be necessary to combine short term calf removal with flushing in order to elicit a positive response for Brahman crosses in any supplementation done after calving. Researchers in Texas (Randel and Welker, 1980) compared Brahman x Hereford first-calf heifers fed at 125% of daily energy requirements in a drylot and either exposed to normal calf suckling or once-daily suckling. At 90 days postcalving, 100% of once-daily suckled heifers had returned to estrus compared to only 35.3% of normal-suckled heifers.

Table 2. Body Condition and Feeding Level (Pregnant 1 breeding)

Feeding Level[1]	Body Condition: 4 or less	Body Condition: 5 or greater
Low + Flushing	75%	70%
Low	54%	70%

[1] The low energy diet consisted of a corn silage diet fed at approximately 62% of daily requirements (if cattle weighed 1000 lbs. and were milking 12 lbs. per day) from calving throughout the first 30 days of breeding season. Cow that were flushed received the same diet until two weeks prior to the breeding season. At this time, cows of the flushing diet received a diet that provided approximately 1.5 times the daily energy requirement. The flushing diet was continued throughout the first 30 days of breeding. Both groups had calves removed from suckling for 48 hours at the initiation of breeding season.

Figure 2. Forage Intake of a Nonlactating Range Cow

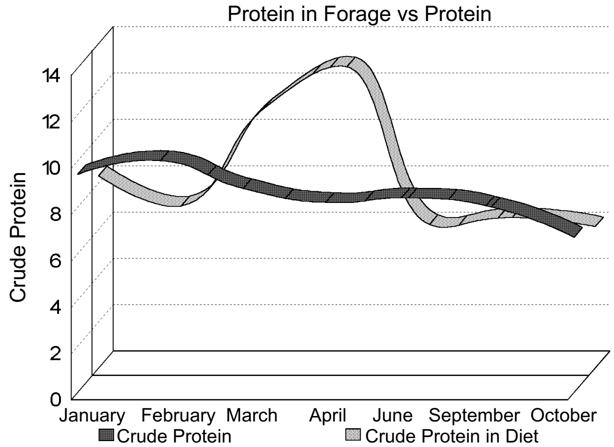


OPTION 3: MATCH CALVING SEASON TO FORAGE CURVE

From Figure 1, it would make sense both physiologically and economically to match the calving season to times in which forage quality is at its peak. In fact, Deseret Ranches of Woodruff, Utah attributes moving calving forward to match the forage curve as one of the key ingredients in reducing cow costs and improving fertility (Simonds, 1991).

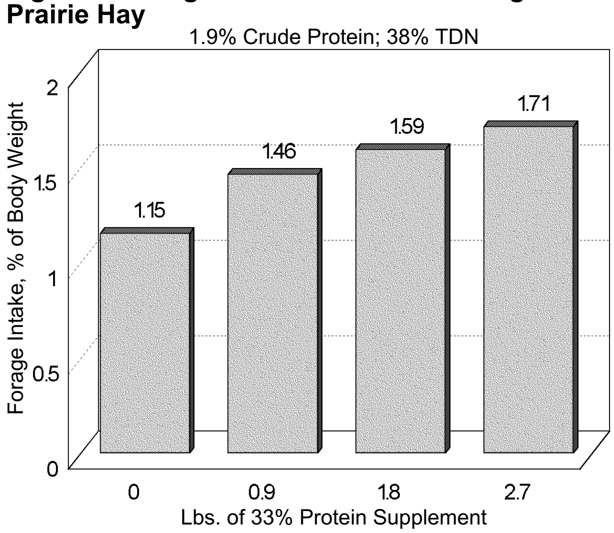
Figure 3 illustrates crude protein content of forage produced and consumed by

Figure 3. Mohave County Ranch



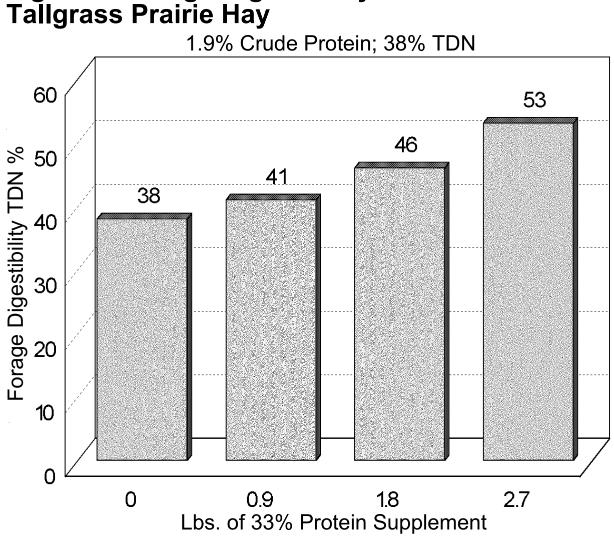
Chaparral to Grassland (4800 to 5500 ft.)

Figure 4. Forage Intake on Dormant Tallgrass Prairie Hay



Stafford et al., March 1996 *Journal of Animal Science*

Figure 5. Forage Digestibility on Dormant Tallgrass Prairie Hay



Stafford et al., March 1996 *Journal of Animal Science*

cattle on a Mohave County Ranch. The dark line indicates the crude protein requirements at different times of the year with estimated forage intakes at these times. Composition of the diet was determined on this chaparral-grassland ranch (4800 to 5500 ft.) by micro histological analyses of fecal samples. Crude protein of the diet chosen (light-colored line) was then determined by lab analyses of forage samples. The diet chosen during January and February was 50 and 60% *turbinella* oak, respectively. In April, the diet consisted of 30% filaree and 30% ceanothus. Forage intake and fiber and protein digestibility during January and February would have been reduced due to the negative effects of tannins present in turbinella oak. Crude protein content of filaree was very high in April (22.1%) and had a major effect on crude protein of the diet consumed. Looking at Figure 5, it would appear that the ideal time for calving would be in early March. This would allow for nutrition to be at its peak during the 60 days preceding breeding. There are also two times of the year in which management decisions would need to be made. In January to February, it would appear that protein supplementation would be appropriate to prevent accelerated weight loss before calving. During June breeding season, supplementation decisions would be based upon body condition. If cows had gained sufficient weight during March and April, they would be able to coast through June without any supplementation. However, if cows were slipping in body condition in May or early June, supplementation would be advisable. Each ranch will be a little different in its forage curve and it is a good idea to analyze forage at different times of the year to gain an understanding of the forage curve for that ranch. Matching the calving season to the forage curve should improve cow nutrition and increase the number and size of calves weaned.

OPTION 4: MATCH THE COW TO THE ENVIRONMENT

Cattle of intermediate size (1000 to 1200 lbs.) and milk production (18 lbs. or less peak milk production per day) appear to work best in more arid environments. Low desert chapparal rangelands with limited herbaceous forage may require the use of small framed cattle (850 to 900 lbs.) with low milk production (8 to 12 lbs. peak milk production). Modest increases in cow size are accommodated more readily than are increases in milk production.

If forage availability is not a problem, cattle with greater milk production can increase forage intake to meet increased energy demands due to milk production. In areas with greater rainfall (e.g., Midwest) this can be easily accomplished. In more arid areas of the West, cattle with greater milk production are often at a disadvantage. Each additional lb. of milk production (butter-fat content = 4.03%) would require an additional .52 lbs. of forage intake if forage TDN was equal to 56%. By increasing peak milk production by 2 lbs. per day, calf weaning weights could be increased by 26 lbs. at 205 days while also increasing forage demand of the cow by 1.04 lbs. per day. If the cow was unable to satisfy this demand due to constraints placed upon her by lesser forage quality and quantity, weight loss would occur.

Table 3 compares a hypothetical cow with peak milk production of 19 lbs. to one with peak milk production of 21 lbs. Forage TDN ranged from 50 to 62% in this example and forage intake was adjusted downward in December, January, and February. In this fictitious example, cattle were supplemented with adequate protein in January and February to maintain weight as shown in the last column. Cattle in this example had a frame score of 4 with a weight of 1103 lbs. at a body condition score of 5 (Fox et al., 1988). The average weight difference between

Table 3. Comparison of Increasing Milk Production

Average Cow with 19 lb. Peak Milk Production					
Month	Forage TDN%	Est' d Forage Intake, lbs.	Milk Prod., lbs.	Cow Wt. w/o suppl.	Cow Wt. with suppl. Jan. & Feb.
Jan.	50	19.9	0	1045	1103
Feb.	52	18.8	0	988	1103
Mar.	59	26.5	18	943	1059
Apr.	60	28.7	19	940	1056
May	62	30.9	17	961	1076
June	58	26.5	15	937	1052
July	60	28.7	11	955	1071
Aug.	62	27.6	8	981	1097
Sept.	60	24.3	6	990	1105
Oct.	58	23.2	0	1017	1132
Nov.	55	21.0	0	1027	1143
Dec.	52	19.9	0	982	1097
Cow with 21 lb. Peak Milk Production					
Jan.	50	19.9	0	1045	1103
Feb.	52	18.8	0	988	1103
Mar.	59	26.5	20	924	1040
Apr.	60	28.7	21	903	1019
May	62	30.9	18	922	1037
June	58	26.5	16	888	1004
July	60	28.7	13	902	1018
Aug.	62	27.6	8	928	1043
Sept.	60	24.3	7	934	1050
Oct.	58	23.2	0	961	1077
Nov.	55	21.0	0	972	1087
Dec.	52	19.9	0	926	1042

body condition scores (1 to 9) was 86 lbs. The cow with the lower milk production achieved a body condition score of 5 at the end of the year with supplementation in January and February. The cow with increased milk production had less body condition at the end of the year, being approximately 4.25 at 1042 lbs. At breeding time in June, the cow with greater milk production would have a body condition score of 3.7 as compared to 4.4 for the other cow. If we assume a modest decrease in conception from 85 to 77% for greater milk production, there would be a net loss of $1269.80 for 100 cows with the following parameters: 477 lb. weaning weight for lesser milk production, 503 lb. weaning weight for greater milk production, 70¢ per lb. calves.

(477 lbs. • .85 • .70 • 100) - (503 lbs. • .77 • .70 • 100) = $ 1269.80

In Table 3, cattle with greater milk production were not adjusted upwards for greater forage intake to show the effects of greater milk production in a more limiting environment. In periods of time with better forage quality and adequate forage availability, cattle with greater milk production can have greater forage intake. Therefore, weight loss could be somewhat less than that projected in Table 3. However, the extra milk production would result in greater weight loss for these cattle and most likely would result in lower body condition at the end of the year. Ultimately, it is expected that the greater milk production cattle would wean fewer lbs. of calf per cow exposed.

Cattle can be selected to match Arizona's environment. Data is available from the Meat Animal Research Center of Clay Center, Nebraska to compare breeds for different traits (http://www.ansi.okstate.edu/breeds/research/marccomp.htm). Selection within breeds can also be practiced by using EPDs (Expected Progeny Differences) as a selection criteria (Sprinkle, 1996b) for targeting production goals. Important traits to set selection criteria for to achieve optimum reproduction in Arizona could include fleshing ability, mature size, milk production, and longevity. If cattle are not properly matched to our Arizona environment, an additional handicap is placed on the cowherd during years with unfavorable precipitation. On average, this occurs in Arizona four years out of ten (Holochek et al., 1998).

CONCLUSION

Maintaining body condition at a score of 5 at calving should help enhance conception rates for Arizona range cattle. A key component of management is to have a knowledge of forage quality at different times of the year. Supplementation and calving season can then be matched to the forage resource. Finally, matching the cow to the environment can help overcome nutritional challenges to reproduction.

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HEIFER DEVELOPMENT ON RANGELAND

Jim Sprinkle[1]

INTRODUCTION

Heifer development is one of the three largest expenses for beef cattle operations when the opportunity cost for retaining heifers is factored in. You can purchase replacement heifers of breeding size or develop your own heifers in the feedlot, farm dry lot, irrigated pasture, or on range. In some areas of the country, companies which develop ranchers' heifers for a fee are available as well. The option you choose depends upon the timetable desired for heifer replacements and the economics of each option for a particular operation. Unless hampered by a lack of good quality, inexpensive feed, there is usually a cost advantage in developing heifers from the herd instead of purchasing them. An additional advantage is that you have knowledge of the performance of selected females' dams and the ability to more closely match replacement females to the particular environment. Inexpensive computer programs or worksheets are available ($1 for publication, $20 for computer program, Willett and Nelson, 1992) which allow you to calculate the costs of buying vs. retaining replacement heifers.

It has been well documented that in order to achieve puberty, heifers need to weigh around 60 to 65% of mature weight at breeding time. For British breeds this is around 650 to 700 lbs. at around 14 to 15 months, and for Continental breeds, 750 to 800 lbs. at the same age. (There are exceptions to this rule; a small percentage of heifers will be pubertal while still nursing). Achieving this level of weight gain following weaning is rather easy in the feedlot, dry lot, and possibly irrigated pasture, but can be rather difficult on rangelands with poor quality winter forage. The disadvantage with feedlot development is cost. One Arizona breeder calculated that when he utilized feedlot development of replacement heifers, the cost per pregnancy (90% conception rate) was over $160 compared to a little over $60 per pregnancy for heifer development on pasture with supplement (85% conception rate).

RANGE LIMITATIONS

The difficulty in developing replacement heifers on low quality feed is illustrated by Figure 1. The lower portion of each bar represents the amount of forage a 500 lb. heifer would have to eat of a given forage quality in order to maintain body weight. The shaded portion of each bar represents the amount of additional forage the heifer would have to eat in order to gain .5 lbs./day, a reasonable expectation for weight gain on winter range. The solid line represents the amount of forage a heifer can actually eat for that particular forage quality. With lower quality forages, forage intake could possibly be increased 10 to 15% by protein supplementation. However, from this diagram it can be seen that the heifer may not be able to gain any weight until forage quality approaches 56% digestibility. What often happens with heifers

Figure 1. Heifer Development on Rangeland

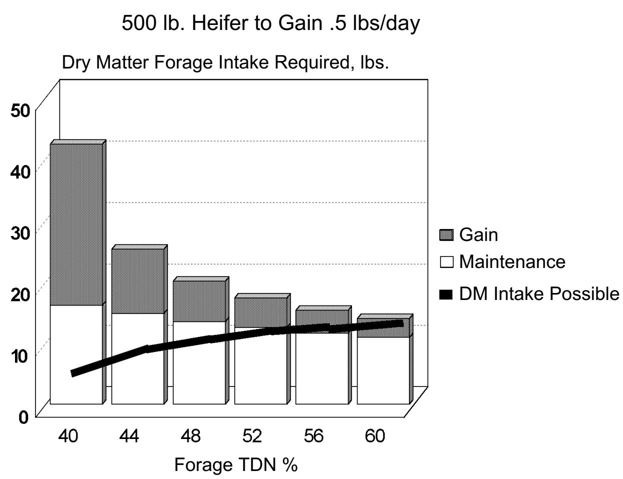

Table 1. Forage Quality and Heifer Weight Gains[a]

TDN, %[b]	ME,Mcal/lb. forage[b]	Neg,Mcal/lb. forage[b]	Est. forage intake lbs./day[c]	Est. weight loss or gain lbs./day
40	.66	.03	6.0	-4.2
42	.69	.07	6.0	-4.1
44	.72	.10	7.0	-3.5
46	.75	.13	8.5	-2.7
48	.79	.16	9.5	-2.0
50	.82	.19	9.5	-1.8
52	.85	.22	10.0	-1.3
54	.89	.25	10.0	-1.2
56	.92	.28	11.0	-0.3
58	.95	.31	11.0	-0.1
60	.98	.33	11.5	+.10[d]

[a] 500 lb. medium frame heifer with no supplementation, approximate Mcal ME required for maintenance=10.64/day.

[b] TDN=total digestible nutrients, ME=metabolizable energy, Mcal=megacalories (1,000,000 calories), Ne_g=net energy for gain. Each 1 lb. of gain requires 2.1 Mcal of Ne_g. Ne_g is energy available for gain *after* satisfying maintenance demands.

[c] Estimates of forage intake at different forage digestibilities are best guesses based upon the following research: Kronberg et al., 1986; Wagner et al., 1986; Havstad and Doornbos, 1987; and Sprinkle, 1992.

[d] Gain will probably be greater due to greater forage intake at this forage quality. If a heifer eats 13 lbs. of forage/day, average daily gain will be approximately .4 lbs./day. High growth potential cattle may exceed this gain projection.

Table 2. Heifer Development on the R100

San Carlos Apache Tribe			
	Supplement, lbs./day		
	0	4.2	5.6
Weaning Weight (10-6), lbs.	396	396	400
ADG, lbs.	-0.21	0.43	0.66
Ending Weight (3-23), lbs.	361	468	513
% Calving	0	31	54
% Calves Weaned of Total		20	36
% Calves Weaned of Those Calving		65	66

Study by University of Arizona, Ray et al.,1993, AZ Ranchers' Management Guide

developed on native range is that replacement heifers will often coast through the winter with no weight gain or a slight weight loss and then start gaining weight following "green up." This makes it difficult to achieve weight gains needed to get heifers cycling for early breeding. Table 1 presents some rough projections of anticipated weight gains with different forage qualities. From this, it should be quite clear that heifer development on rangeland usually requires some type of supplementation in addition to forage consumption.

Tables 2 and 3 contain data for two different studies relating to heifer development. Table 2 compares heifers at San Carlos (Ray et al., 1993) fed either 0, 4.2, or 5.6 lbs./day of a protein-energy supplement with 65% milo and 25% cottonseed meal (24% total crude protein). Heifers weighed around 400 lbs. at weaning and heifers gained -.21, .43, and .66 lbs./day for 0, 4.2, and 5.6 lbs. of supplement. Beginning in May, heifers were exposed to bulls for 60 days. Although the authors did not report weights at breeding, it is assumed that the weights were less than ideal target weights. None of the control heifers conceived, compared to 31% and 54% for the low and high feeding levels. However, due to small size of heifers at calving, approximately one-third of the heifers lost calves at or shortly after calving.

Table 3 reports the findings of Lemenager et al. (1980). Cattle in this study were fed poor quality fescue hay (9%, 8.5%, and 8.8% crude protein for trials 1, 2, and 3, respectively; TDN not determined). Heifers in this study appeared to be deficient in both protein and energy. When the control heifers had 1.8 lbs. of protein supplement added to their diet, they went from a small weight loss to an average daily gain of around .5 lbs. Addition of protein also nearly doubled weight gains for animals fed corn. If control heifers in this study had been able to eat 2% of their body weight daily, they

Table 3. Heifer Development with Different Levels of Corn

		Supplemental Corn Fed		
	Base Ration	0 Lbs.	2.7 Lbs.	5.4 Lbs.
		Starting Wt., lbs.		
Trial 1 (113 d)	fescue hay (poor quality)	516	516	510
Trial 2 (153 d)	fescue hay (poor quality)	494	493	475
Trial 3 (150 d)	fescue hay + 1.8 lbs. protein supplement (32%)	481	500	499
		Winter ADG, lbs.		
Trial 1 (113 d)	fescue hay (poor quality)	-0.18	0.35	0.62
Trial 2 (153 d)	fescue hay (poor quality)	-0.09	0.29	0.53
Trial 3 (150 d)	fescue hay + 1.8 lbs. protein supplement (32%)	0.49	0.79	1.15

Lemenager et al., 1980. *Journal of Animal Science*

would have had nearly adequate crude protein intake during trial 1, (although not all the protein may have been available) and would have been slightly deficient in crude protein in the other trials if no additional protein were supplied. In reality, forage intake during trials 1 and 2 may have been less than 2% of body weight. The addition of supplemental protein during trial 3 could possibly have increased both digestibility and forage intake. Heifers in this study were placed on good quality pasture following the study and pasture bred for 60 days. The heifers receiving lesser amounts of supplement during the winter exhibited compensatory gain while on pasture. Weight gains on pasture averaged over all years were 1.7, 1.5, and 1.3 lbs. for heifers fed 0, 2.7, and 5.4 lbs. of corn during the winter, respectively. Pooled data over all three years had 69%, 74%, and 84% conception for the heifers fed 0, 2.7, and 5.4 lbs. of corn per day.

UNIVERSITY OF NEVADA STRATEGY

Heifers in the Lemenager et al. (1980) study performed better than the San Carlos study (Ray et al., 1993) due to being larger at the beginning of the feeding period. Heifers need to reach an age and weight threshold to initiate puberty (Table 4). Chronic feed restriction will prevent or delay puberty in heifers. The University of Nevada, Reno (Torell et al., 1993) has developed a 4 point plan for heifer development with smaller framed range cattle.

1) Meet target weight of 600 lbs. at breeding time.
2) Have heifers at a body condition score of 5 or greater at breeding.
3) Have heifers at a reproductive tract score (LeFever and Odde, 1986) of 3 or greater at breeding. (No immature uterine tracts with less than 3/4" diameter uterine horns and no tone).
4) To ensure less calving difficulty, make sure pelvic areas exceed 150 sq. cm at 12 months of age.

Following these guidelines will improve reproductive success with replacement heifers. It is also important to avoid nutritionally stressing replacement heifers after breeding and prior to calving. This will reduce growth in the pelvic opening and nullify attempts to manage for less calving difficulty.

FEEDING STRATEGY

Achieving acceptable weight gains on winter range in order to reach target

Table 4. Puberty Traits

Breed	13.5 Mos., % pubertal	Adjusted age,[a] days	Adjusted Wt.,[a] lbs.
Red Poll	88.6	359	650
Hereford	39.9	411	695
Angus	57.4	393	697
Limousin	44.0	408	743
Braunvieh	94.2	350	732
Pinzgauer	92.1	360	739
Gelbvieh	92.9	353	745
Simmental	86.8	363	758
Charolais	60.6	391	814
Composite, 75% Continental	85.8	366	765
Composite, 50% Continental	89.3	361	738
Composite, 75% British	84.0	368	723

[a]Adjusted to 100% puberty basis.
Gregory et al., 1995. USDA-MARC, Clay Center, Nebraska

weights for puberty can be a challenge. If weaned heifers weigh from 450 to 500 lbs. in late October and the target weight for breeding in June is 650 lbs., then heifers need to gain from .7 to 1.0 lbs. per day. Achieving this level of gain will enhance fertility by allowing heifers to have at least one heat cycle before the breeding season starts.

Based upon computer modeling and limited research data available for Arizona rangelands, weight gains that can be expected on moderate quality winter range (50% TDN, 5% crude protein) in conjunction with 4.5 to 5.0 lbs. of supplement (protein or protein/energy) per day would be around .5 lbs. of weight gain per day. If the supplement costs $180 per ton, daily cost of the supplement alone would be from $0.41 to $0.45 per head per day.

Replacement heifers can be placed in a dry lot during the time period when winter forage quality is poor and achieve weight gains of 1 lb. per day on a high roughage diet (less than 20% grain) at a cost of $0.72 to $0.82 per head per day (based upon feed costs of $100 per ton or good quality alfalfa hay and $10 per cwt. for grain). Depending upon the genetics of your herd and the quality of your hay, you may be able to achieve this rate of gain with little or no grain. If you desire to increase average daily gain to 1.5 lbs. per day, this would require an additional 1.7 lbs. of corn, 2.3 lbs. of cottonseed meal, or 5.3 lbs. of good quality alfalfa hay. This is in addition to the 14.4 lbs. of feed previously allocated for a 600 lb. heifer fed in the dry lot.

An ideal strategy for meeting target breeding weights when developing heifers on rangeland could be as follows. After calves have the “bawl” out, turn them into excellent quality riparian pastures (rested all year for winter grazing) or on hay stubble for about a month (November) or until forage utilization goals are reached. When forage quality declines significantly on rangeland (approximately November 1 to February 15 for low elevation or November 1 to March 15 for high elevation range sites), feed heifers in a dry lot with excellent quality hay. If winter precipitation is favorable and annual grasses are growing well, turn the heifers out after the dry lot feeding period to utilize the cheap range forage. Heifers will exhibit compensatory gain when placed on excellent quality forage. If average daily gain on spring pasture is 1.2 lbs. per day for 75 days, then weight gains in early winter for 450 to 500 lb. British cross replacements will only need to be from .5 to .9 lbs. per day. By monitoring weight gains regularly and by looking at forage quality and quantity closely, you will be able to decide when grazing winter range is appropriate and when additional feed is required.

Since you will probably have to supplement your replacement heifers to achieve desired weight gains before breeding, you may want to consider adding an ionophore (Rumensin® or

Bovatec®) to the grain, protein, or liquid molasses supplement. In a recent review in the Oct. 21, 1996 issue of *Feedstuffs,* Huntington reported that grazing ruminant animals supplemented with ionophores had increased nitrogen digestibility and 6% greater weight gains than controls. These findings were determined on more than 2,000 cattle in over 30 studies.

An additional advantage which has been observed by feeding Rumensin® to replacement heifers may be inducement of puberty at an earlier age (Lalman, et al., 1993).

CONCLUSION

When considering a breeding program, you may wish to use breed combinations to improve puberty traits. Table 4 shows that there is a great deal of variation in puberty traits for the percentage of females showing estrus at 13.5 months. Dual purpose breeds of cattle generally express puberty earlier than most other breeds except Red Poll. You may desire to include a percentage of one of the earlier puberty breeds in your breeding herd if you need to improve conception for yearling heifers.

When replacement heifers are selected at weaning, weigh the heifers and then determine how much weight heifers will need to gain by breeding time (see Table 4). Next, count the number of days until the start of breeding time and calculate average daily gain needed. Target weights for heifers should be achieved at least one heat cycle (21 days) prior to the start of breeding season. It is to your advantage to select heavier heifers (at least 450 to 500 lbs.) so that the desired weight gain can be achieved without excessive cost. Tailor the heifer development program so that the feeding program will accommodate the desired weight gains without allowing heifers to get too fat. If heifers gain weight too rapidly, it will increase feed costs and decrease lifetime productivity due to excessive fat deposition in the udder. Feeding tables are available from the National Research Council or your local Cooperative Extension office which will predict the nutrient requirements needed for your heifer development feeding program.

I would recommend that if you develop breeding heifers on rangeland that you analyze forage for protein and TDN and supplement accordingly. Supplement to achieve desired weight gain according to "Matching Forage Resources with Cow Herd Supplementation," in this Guide. Do not let heifers become deficient in protein, or weight loss will accelerate. Keep mineral supplements out to heifers according to mineral deficiencies in your area by season of the year. Certain areas of Arizona are deficient in selenium, copper, or zinc, and most areas will be deficient in phosphorus when forage is dormant. If you need help in balancing rations for your forage base, contact your local extension office.

Though the Nevada system of heifer development works for the most part, scoring reproductive tracts has limited value for Arizona. However, having heifers in good body condition and selecting for adequate pelvic area are good management practices to follow. The bottom line is to achieve target breeding weights and ages in replacement heifers at breeding time (Table 4). Combined with genetic selection for puberty and matching forage deficits to nutritional supplements, heifer development on rangelands can be made more cost effective.

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FROM:

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RANGE COW CULLING: HERD PERFORMANCE

Russell Tronstad,[1] Russell Gum,[2] Don Ray,[3] and Richard Rice [4]

This article is the first in a series of three articles on range cow culling. The focus of this article is biological performance related to fertility, calf weight, and cull cow weight. The second article will focus on price relationships, while the last article will incorporate both biological and market considerations to present a framework for increasing profits through better culling decisions.

Biological factors determine a cow's ability to produce marketable products, specifically calves and salvage value as slaughter cows. Performance measures for one ranch's herd in Arizona are presented below. Estimates of fertility, calf weights and slaughter cow weights were made from the herd's individual cow records for the years, 1982 to 1989. The results presented below represent an average expected performance for this herd and should be compared to the performance of your herd.

FERTILITY

Fertility encompasses three basic stages before a marketable product is obtained from cow-calf operations. These stages are: 1) conception, 2) calving, and 3) survival of calves until weaning. Fertility percentages for each of these three stages can be calculated for different classes and ages of cows if records are kept on individual cows. These three percentages multiplied by each other give the "marketable fertility." For example, if 85% of the cows in a particular class conceived, 96% of those that conceived had live calves, and 98% of these cows had a live calf at weaning, your marketable fertility for this class of cows would be 80% (i.e., .85 x .96 x .98 = .80). Simply stated, 80% of all the cows in this class produced a marketable calf.

What determines fertility? Some of the major factors are: each cow's individual genetic make-up, body condition, and age. The genetic make-up of your herd can be changed by the selection of replacement cows but is fixed for the year once you have selected the replacements. Cow body condition on the range is influenced by weather fluctuations and forage availability. Because the weather cannot be controlled, supplementing range forage with minerals and/or nutrients may be a wise investment during periods of poor forage availability resulting in improved cow condition and subsequent improved fertility.

As a cow gets older, condition and associated fertility are likely to deteriorate from age factors rather than forage factors. The chance that a cow will die within the next year or become physically unable to produce another calf is related to the cow's age. These probabilities are very influential in the decision of whether to keep or cull a range cow since a cow that dies on the range will bring nothing for "salvage" whereas an older cow that makes it to slaughter will generally bring $400 or better. Also, older cows that become physically unsound tend to have relatively light weights and no sale calf at their side when culled.

The conception rate for the Arizona herd analyzed was calculated for cows that were open with a calf at side and open without a suckling calf at their side. Since the reproductive history and nutrition requirements are different for these two groups of open cows, their conception rates are likely to differ too. To determine fertility rates, calving and weaning records were used, after the fact, to determine which cows had become pregnant. Cow and calf records were linked and sorted by cow tattoo and year. Cows recorded as having a newborn calf (live or dead) in the spring or sale calf in the fall, obviously had to have been pregnant in the previous fall. Cows that were kept in the herd and had no calf show up the following year were obviously open in the fall. Cows that were sold because they were simply open or lost their calf were treated as open cows fit to breed again. Cows that were sold because of bad udder, structural unsoundness, and/or cancer eye were classed in the category of physically unfit to breed. The “dead category” included cows that were recorded as dying or cows that disappeared from the herd.

Figure 1 is a flow chart illustration of how the estimated calving rates (Table 1) and fertility estimates for open cows (Tables 2 and 3) fit into the fall-spring cycle. The Arizona ranch operation analyzed only considered spring calving so that cows which were open

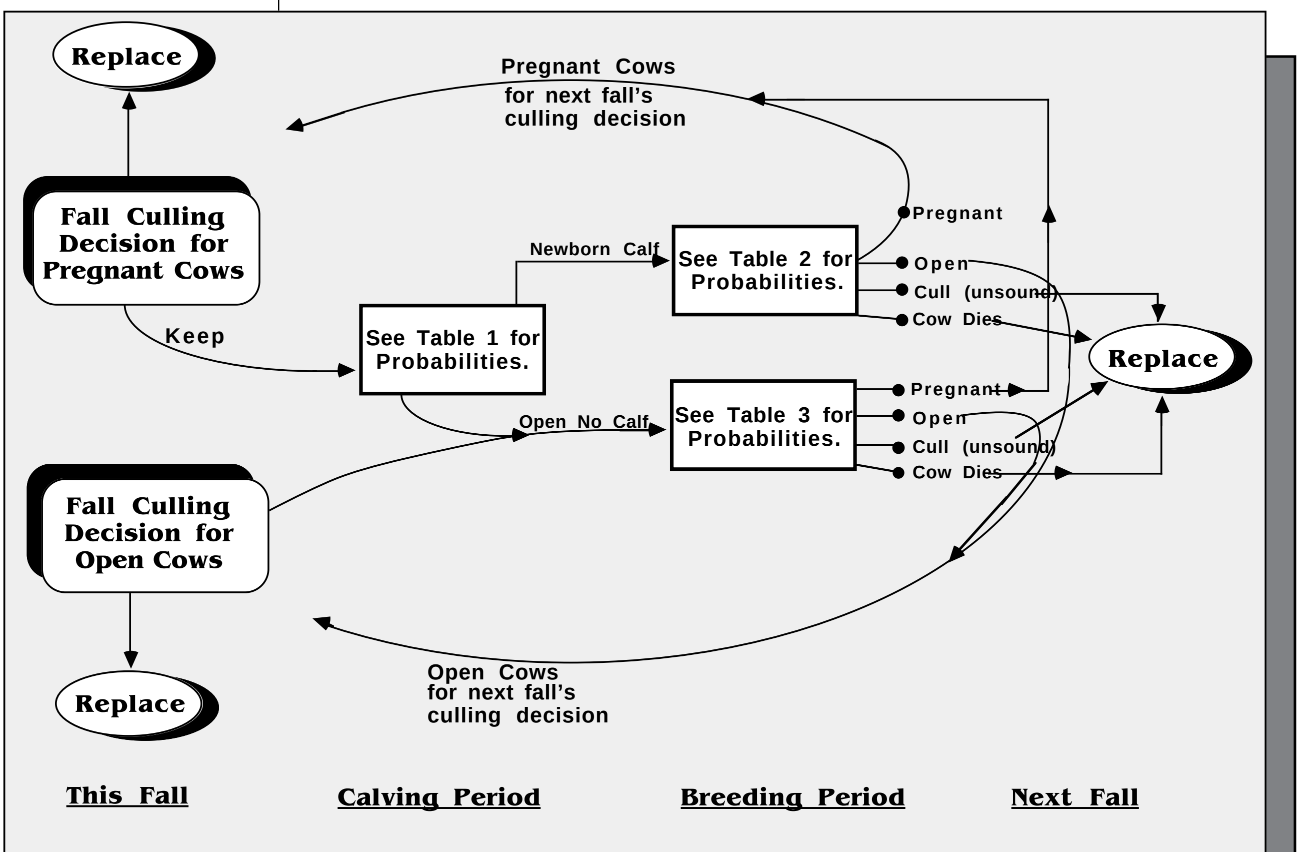

Figure 1. Flow Chart of Herd Fertility.

Table 1. Calving Rates for Pregnant Cows by Age.

Cow Age (year)	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
	%											
Pregnant to No Calf	2.17	2.78	3.23	3.53	3.68	3.68	3.52	3.22	2.76	2.15	1.39	0.48
Pregnant to live Newborn Calf	97.83	97.22	96.77	96.47	96.32	96.32	96.48	96.78	97.24	97.85	98.61	99.52

Table 2. Estimate Fertility of Open Cows with Calf by Age.

Cow Age (year)	3	4	5	6	7	8	9	10	11	12	13
	%										
Newborn calf at side to Pregnant	81.95	80.80	79.33	77.52	75.39	72.94	70.15	67.04	63.59	59.83	55.73
Newborn calf at side to Open	14.59	14.59	14.59	14.59	14.59	14.59	14.59	14.59	14.59	14.59	14.59
Newborn calf at side to Cull (unsound)	1.40	1.86	2.65	3.77	5.21	6.98	9.08	11.51	14.26	17.35	20.76
Newborn calf at side to Cow Died	2.06	2.75	3.43	4.12	4.81	5.49	6.18	6.87	7.55	8.24	8.93

Table 3. Estimated Fertility of Open Cows with No Calf by Age.

Cow Age (year)	3	4	5	6	7	8	9	10	11	12	13
	%										
Open to Pregnant	70.99	69.26	67.03	64.41	61.52	58.49	55.44	52.49	49.75	47.36	45.43
Open to Open	25.09	24.09	23.08	22.08	21.08	20.08	19.07	18.07	17.07	16.07	15.07
Open to Cull (unsound)	3.32	5.58	8.21	11.09	14.10	17.13	20.04	22.72	25.05	26.90	28.15
Open to Cow Dies	0.60	1.07	1.68	2.42	3.29	4.30	5.44	6.71	8.12	9.67	11.35

in the fall would still be open the following spring. Cows that were pregnant in the fall could have either a live or dead newborn calf in the spring. For example, if a cow is 5.5 years old and pregnant, results indicate that this cow has a 3.53% chance of losing her calf and a 96.47% chance of having a live calf (see Table 1). Because future calving records were used to determine which cows were pregnant, no cows were classed in a pregnant to "dead cow category." All the cow deaths are accounted for in an open to dead cow category.

Table 2 gives the fertility estimates for open cows with a calf at their side. These cows could: 1) remain open, 2) become pregnant (determined by future calving records), 3) become physically unfit to breed, or 4) die. Results show that death and cull rates increase quite sharply for cows greater than eight years of age while the rate of pregnancy drops. The rate for open cows with a calf at side to stay open (structurally sound) was found to remain constant with age and estimated at 14.59%.

Fertility estimates for open cows with no calf at their side are given in Table 3. As shown in Figure 1, these cows could have either lost their calf in the spring or have been open in the previous fall. Similar to the open cows with a calf at their side, these cows could go into the four categories of 1) open, 2) pregnant, 3) physically unfit to breed, or 4) or dead cow. Fertility estimates in Tables 2 and 3 indicate that cows with no calf at their side have a higher chance of failing to conceive than cows that have a suckling calf at their side. Our results are based on data from years with good forage production on the ranch used for the analysis. Other studies have shown that in periods of nutritional stress cows without calves have higher fertility levels than cows with suckling calves.

WEIGHT PERFORMANCE

Since cattle are sold by weight, it is fertility, calf weight and cow weight when culled that determine total production. Weight performance from the cow comes from its annual calf weaning weight and its own weight when sold for slaughter. Although the cow herd is not sold on an annual basis like the calf crop, cow weight is an important consideration for the culling decision since a cow losing weight is equivalent to losing production and a cow gaining weight is equivalent to increasing production.

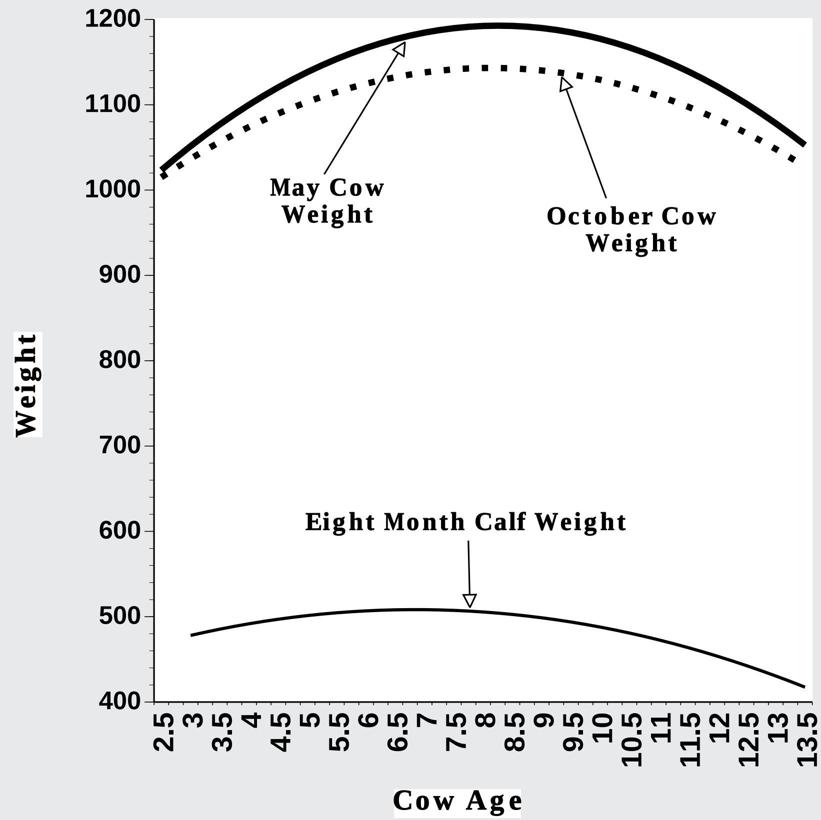

Figure 2. Estimated May and October Cow Weights and Eight Month Calf Weights, all as a Function of Cow Age.

Figure 2 gives the estimated May and October cow weights as well as the eight month calf weight, all estimated as a function of cow age. As expected, calves from the youngest and oldest cows are lighter than calves from cows in their prime age. Estimated calf weights start out at 470 lbs. for heifers that calve when they are three, reach a maximum of 508 lbs. for seven year old cows, and drop off to 431 lbs. for 13 year old cows. Although the expected differential between the “largest” and “smallest” calf may seem small at only 77 lbs., this is about a 15% reduction in gross sale receipts that translates to a much higher percentage reduction in profit. Calf weight is obviously influenced by other factors that are hereditary and related to cow-calf nutrition and range conditions. However, the linkage of calf weight to cow age is especially important to the culling decision since a cow retained in the herd becomes one year older while her genetic make-up remains the same.

Figure 2 shows that May cow weights are greater than October cow weights with the greatest weight differential occurring for cows that are between 6 and 10 years of age. These weights reflect that for the ranch used as the basis for this analysis, good winter forage was available. After cows attain their maximum weight at around 8 years of age (1192 and 1143 pounds for May and October, respectively), weights drop off about 10 lbs. a year until they are 10 and then drop off nearly 30 lbs. a year after that. One needs to consider both the lower slaughter weight for culls and a lower weaning weight when keeping an older cow one more year. Conversely, a young cow will generally increase its own weight and calf weaning weight if kept for another year. However, more nutrients are generally required for cows carrying their first calf to obtain this growth. All these considerations influence the economic decision of whether one should keep or cull a range cow.

Because range, breeding stock, and environment are different for most Arizona ranches, herd fertility and weight performance will vary from ranch to ranch. This variation indicates that your ranch needs to keep good fertility and weight records so that you can make accurate culling decisions on every cow in your herd. If you don't know the performance characteristics of cows in your herd by age class perhaps its time to consider improvements in your record keeping system. The next article in this series will focus more on the economics of the culling decision by looking at market prices. Specifically, current market prices for replacement stock, cull cows, and calves plus the likelihood of increases or decreases in these price relationships are explored in the next article.

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MARKET IMPACTS ON CULLING DECISIONS

Russell Tronstad [1]
and Russell Gum [2]

Biological considerations determine the quantity of product that will reach the market, but economic considerations, particularly market prices and supplemental feed costs need to be combined with biological performance to determine the bottom line of profitability for a culling strategy. (See previous article for a discussion of biological performance.) This article will concentrate on market considerations and profitability of culling strategies. The next article will conclude with our recommendations of optimal culling strategies.

MARKET PRICES AND THE CULLING DECISION

The culling decision has long-term consequences. Each replacement heifer you buy or raise this year will, hopefully, remain productive for at least five years. This lengthy time span complicates calculating the productivity of an existing cow in the herd versus a replacement. In addition to the uncertainty involved with future production, uncertainty exists about future prices.

Each individual rancher is a "price taker." That is, an individual rancher cannot have any noticeable impact on total livestock supply available or price, even if they are one of the largest ranches in the state. A rancher will receive whatever price the going market rate is at the time livestock are sold or bought. Subsequently, timing in relation to market prices is very crucial to the culling decision. The three market prices of 1) feeder calves, 2) replacement heifers, and 3) slaughter cows are all inter-related and vitally important to the economics of the culling decision.

If culling decisions are made in the fall for a spring calving operation, feeder calf prices may be overlooked as an unimportant market factor. Another year will pass before either the current cow or replacement will have a calf for sale, but there is a substantial association of the feeder calf price level from one year to the next. This is why one should not ignore current calf prices as being important for the culling decision.

Ranches that raise their own replacement stock sometimes overlook replacement prices as being an important market consideration for their culling decisions. But even if one raises their own replacement stock for feed costs that add up to only half the value of the current market price for replacement heifers, current replacement prices (minus any transportation and selling costs) should be utilized as the cost for bringing a heifer into the herd. If one can sell a bred replacement heifer for \$650, even though you may only have \$450 of total costs into raising the heifer, the cost of bringing the heifer into the herd is \$650. (\$450 in costs and \$200 in forgone profits if the animal is not sold)

Slaughter prices directly enter the decision of whether to cull since a cow culled will be sold for the going market slaughter price. If slaughter prices are high while replacement prices are relatively low, replacing marginal older cows will be more economical (buy low and sell high). Conversely, if replacement prices are high and slaughter prices are relatively low, keeping marginal older cows will be more economical (don't buy high and sell low). It is not just market prices that need to be considered. Since the value of a cull cow is weight times price, market prices need to be considered jointly with weight performance. (See the previous article for a discussion of biological performance.)

If ranchers were able to accurately predict future prices it would be a relatively simple exercise to evaluate alternative culling strategies. However, ranchers aren't the only individuals that have trouble predicting prices. Ag economists have problems predicting prices as well. One reasonable approach to get around the problem of not being able to predict distant future prices exactly, is to calculate the probabilities associated with ranges of future price movements from one period to the next. These price movement probabilities can then be utilized in conjunction with current price levels to evaluate alternative culling strategies. The results are based most heavily on nearest price movements plus the more distant or average consequences expected over a number of years.

These probabilities of future price movements can be calculated from the behavior of past prices. Long-term price levels for calves, calculated as an average of steer and heifer calf prices, and bred replacement heifer prices are shown in Tables 1 and 2. Table 1 shows the percent of the time various price level combinations have occurred for November while Table 2 presents comparable information for May. For example, the historical probability of November calf prices being above 100$/cwt. and replacement prices being above 805 $/head is just over 2% (the bottom right entry in the Table 1). The same value for May prices is over 3% reflecting the normally higher spring calf prices. Over time these probabilities have been observed to follow predictable patterns that are highly dependent upon the level of current prices. It is the prediction of the probabilities of price movements from a current price level which is useful for evaluating culling strategies. For example, consider the following situation:

Table 1. Long-Term Probability Price Levels for November.

		Calf Prices				
		< 70	70-80	80-90	90-100	> 100
Replacement Prices	< 475	0.1018	0.0545	0.0189	0.0013	0.0001
	475-585	0.0789	0.1037	0.0635	0.0096	0.0010
	585-645	0.0393	0.1017	0.1201	0.0356	0.0068
	695-805	0.0085	0.0379	0.0742	0.0445	0.0143
	> 805	0.0009	0.0077	0.0243	0.0295	0.0215

Table 2. Long-Term Probability Price Levels for May.

Replacement Prices	Calf Prices < 70	70-80	80-90	90-100	> 100
< 475	0.0659	0.0645	0.0377	0.0080	0.0007
475-585	0.0343	0.0808	0.1022	0.0339	0.0054
585-645	0.0133	0.0529	0.1400	0.0760	0.0212
695-805	0.0017	0.0113	0.0630	0.0667	0.0352
> 805	0.0001	0.0016	0.0161	0.0301	0.0360

It is May, and we are interested in predicting next fall's calf and replacement prices. The current calf price is 95 $/cwt. and the current replacement price for a bred heifer is 750 $/head. Our calculations, based on the behavior of prices over previous years, lead to the probabilities of price movements as shown in Table 6, panel 4. The probability of the calf price staying in the 90 to 100 $/cwt. range and the replacement price staying in the 695 to 805 $/head range is .1162 (a bit better than 11 chances in 100). The probabilities of the calf price increasing to the more than 100 $/cwt. range and the replacement price decreasing to the 585 to 645 $/head range is only .0003 (3 chances in 10,000) . The probability of both decreasing is much higher, .3797, reflecting the fact that calf and replacement prices almost always move together and that calf prices are generally lower in the fall than spring.

In order to predict future price movements for all ranges of calf and replacement prices, 25 probability tables were calculated for the at May to November price movements and another 25 for the at November to May price movements (Tables 8-12). Besides being necessary to evaluate culling strategies these probability tables provide useful insights into price movements for calves and replacements.

Cull cow prices are also important to the culling decision. But cull cow prices are highly related to calf and replacement prices since an existing cow in the herd has value for either slaughter or replacement stock. Thus, this relationship was exploited for deriving optimal culling decisions — and is why we have focused on just calf and replacement prices in this article.

FEEDING COSTS

Costs directly determine the bottom line of profitability for an operation. Feed costs are generally the largest expense item for a ranching operation, assuming that land costs are considered in the feeding cost calculations. Veterinary, livestock hauling, and marketing costs also affect profits, but are generally much smaller in magnitude. Because the nutrition requirements of young cows, especially those with their first calf, is greater than more mature cows, feed costs directly influence the economics of the culling decision.

Although you may be able to buy a replacement heifer for almost the same amount that you can get in salvage value for an older cow, a differential in feeding costs for the replacement versus the older cow in the subsequent year(s) may be enough to make it more profitable to keep the older cow for another year. This is especially true if you are in a range situation with coarse forage that requires a well developed rumen and doesn't have adequate nutrients, vitamins, and/or minerals for a young cow to grow, raise a calf, and breed back. Supplementation of nutrients, vitamins, and/or minerals is often given as the alternative for improving the young cows performance. However, the added feed costs associated with the younger cow's diet need to be weighed against the performance of an older cow with less feed costs.

The differential in your feed costs for a new replacement versus an older cow is more crucial to the culling decisions than the level of your feeding costs. If the level of your feed costs for all cows is $150/yr. instead of $250/yr., your level of profits will be $100 more for each cow. However, the decision of whether to keep or cull a cow will not change much, if any, since the cost of feeding a replacement will be relatively high (low) if the cost of feeding an older cow is high (low). The differential in feed costs for a replacement versus an older cow is the most crucial cost figure in the culling decision. For example, if the annual feed costs for a replacement are $50/head more than for an older cow, versus say $10/head more, the rancher with a $50/head feed differential is much more likely to keep older cows than one with a $10/head differential.

CONCLUSION

The price probability predictions presented in Tables 1 through 12 describe a small part of the market analysis necessary to evaluate culling strategies. These tables also are useful for predicting price movements for other purposes as well. The variation in cost for different ages of cows is also critical to evaluating culling strategies. The next article in the culling series puts all the pieces together, herd performance, market prices, and costs and present our recommendations of an optimal culling strategy for a reasonably typical Arizona ranch.

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Table 3. May Calf Price <70.

May Replacement Price <475

November	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0.584	0.009	0.000	0	0
475-585	0.240	0.055	0.003	0	0
585-695	0.033	0.046	0.015	0	0
695-805	0	0	0	0	0
>805	0	0	0	0	0

May Replacement Price 475-585

November	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0.267	0.000	0.000	0	0
475-585	0.384	0.013	0.000	0	0
585-695	0.215	0.096	0.017	0	0
695-805	0	0	0	0	0
>805	0	0	0	0	0

May Replacement Price 585-695

November	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0	0	0	0	0
475-585	0.326	0.001	0.000	0	0
585-695	0.377	0.020	0.000	0	0
695-805	0.164	0.089	0.017	0	0
>805	0	0	0	0	0

May Replacement Price 695-805

November	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0.389	0.001	0.000	0	0
695-805	0.358	0.028	0.001	0	0
>805	0.120	0.080	0.017	0	0

May Replacement Price >805

November	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0.121	0.000	0.000	0	0
695-805	0.333	0.003	0.000	0	0
>805	0.413	0.107	0.018	0	0

Table 4. May Calf Price 70-80.

May Replacement Price <475

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0.495	0.095	0.006	0	0
475-585	0.097	0.155	0.046	0	0
585-695	0.004	0.034	0.055	0	0
695-805	0	0	0	0	0
>805	0	0	0	0	0

May Replacement Price 475-585

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0.262	0.011	0.000	0	0
475-585	0.276	0.112	0.010	0	0
585-695	0.070	0.161	0.097	0	0
695-805	0	0	0	0	0
>805	0	0	0	0	0

May Replacement Price 585-695

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0.314	0.018	0.000	0	0
585-695	0.249	0.134	0.015	0	0
695-805	0.046	0.131	0.092	0	0
>805	0	0	0	0	0

May Replacement Price 695-805

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0.366	0.030	0.001	0	0
695-805	0.214	0.151	0.021	0	0
>805	0.029	0.103	0.085	0	0

May Replacement Price >805

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0.126	0.001	0.000	0	0
695-805	0.290	0.044	0.002	0	0
>805	0.193	0.238	0.105	0	0

Table 5. May Calf Price 80-90.

May Replacement Price <475

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0.515	0.078	0.004	0
	475-585	0	0.114	0.148	0.036	0
	585-695	0	0.006	0.038	0.049	0
	695-805	0	0	0	0	0
	>805	0	0	0	0	0

May Replacement Price 475-585

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0.265	0.008	0.000	0
	475-585	0	0.296	0.095	0.007	0
	585-695	0	0.085	0.160	0.083	0
	695-805	0	0	0	0	0
	>805	0	0	0	0	0

May Replacement Price 585-695

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0.319	0.014	0.000	0
	585-695	0	0.271	0.116	0.010	0
	695-805	0	0.057	0.134	0.079	0
	>805	0	0	0	0	0

May Replacement Price 695-805

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0	0	0	0
	585-695	0	0.374	0.023	0.001	0
	695-805	0	0.237	0.134	0.015	0
	>805	0	0.036	0.107	0.074	0

May Replacement Price >805

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0	0	0	0
	585-695	0	0.127	0.001	0.000	0
	695-805	0	0.300	0.034	0.001	0
	>805	0	0.221	0.228	0.088	0

Table 6. May Calf Price 90-100.

May Replacement Price <475

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0	0	0.532	0.062	0.003
475-585	0	0	0.132	0.138	0.028
585-695	0	0	0.008	0.041	0.044
695-805	0	0	0	0	0
>805	0	0	0	0	0

May Replacement Price 475-585

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0	0	0.268	0.005	0.000
475-585	0	0	0.315	0.078	0.004
585-695	0	0	0.101	0.158	0.070
695-805	0	0	0	0	0
>805	0	0	0	0	0

May Replacement Price 585-695

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0.323	0.010	0.000
585-695	0	0	0.292	0.098	0.007
695-805	0	0	0.069	0.134	0.067
>805	0	0	0	0	0

May Replacement Price 695-805

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0	0	0.380	0.017	0.000
695-805	0	0	0.260	0.116	0.011
>805	0	0	0.045	0.109	0.063

May Replacement Price >805

November Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0	0	0.127	0.001	0.000
695-805	0	0	0.309	0.026	0.001
>805	0	0	0.249	0.215	0.074

Table 7. May Calf Price >100.

May Replacement Price <475

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0.316	0.230	0.050
	475-585	0	0	0.021	0.129	0.148
	585-695	0	0	0.000	0.010	0.083
	695-805	0	0	0	0	0
	>805	0	0	0	0	0

May Replacement Price 475-585

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0.214	0.056	0.004
	475-585	0	0	0.123	0.208	0.066
	585-695	0	0	0.013	0.105	0.211
	695-805	0	0	0	0	0
	>805	0	0	0	0	0

May Replacement Price 585-695

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0	0.245	0.081	0.007
	585-695	0	0	0.098	0.213	0.086
	695-805	0	0	0.007	0.075	0.187
	>805	0	0	0	0	0

May Replacement Price 695-805

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0	0	0	0
	585-695	0	0	0.272	0.112	0.012
	695-805	0	0	0.075	0.206	0.106
	>805	0	0	0.004	0.051	0.162

May Replacement Price >805

November		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0	0	0	0
	585-695	0	0	0.116	0.012	0.000
	695-805	0	0	0.179	0.136	0.020
	>805	0	0	0.055	0.221	0.260

Table 8. November Calf Price <70.

November Replacement Price <475

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0.325	0.225	0.047	0	0
475-585	0.023	0.132	0.143	0	0
585-695	0.000	0.011	0.082	0	0
695-805	0	0	0	0	0
>805	0	0	0	0	0

November Replacement Price 475-585

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0.217	0.053	0.003	0	0
475-585	0.129	0.206	0.062	0	0
585-695	0.014	0.108	0.206	0	0
695-805	0	0	0	0	0
>805	0	0	0	0	0

November Replacement Price 585-695

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0.249	0.078	0.006	0	0
585-695	0.104	0.212	0.081	0	0
695-805	0.008	0.078	0.184	0	0
>805	0	0	0	0	0

November Replacement Price 695-805

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0.277	0.108	0.011	0	0
695-805	0.079	0.206	0.101	0	0
>805	0.004	0.053	0.159	0	0

November Replacement Price >805

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0.116	0.011	0.000	0	0
695-805	0.185	0.132	0.018	0	0
>805	0.059	0.225	0.253	0	0

Table 9. November Calf Price 70-80.

November Replacement Price <475

May	Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
	<475	0.099	0.256	0.241	0	0
	475-585	0.001	0.030	0.267	0	0
	585-695	0.000	0.001	0.093	0	0
	695-805	0	0	0	0	0
	>805	0	0	0	0	0

November Replacement Price 475-585

May	Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
	<475	0.095	0.133	0.046	0	0
	475-585	0.015	0.136	0.246	0	0
	585-695	0.000	0.019	0.309	0	0
	695-805	0	0	0	0	0
	>805	0	0	0	0	0

November Replacement Price 585-695

May	Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
	<475	0	0	0	0	0
	475-585	0.101	0.163	0.069	0	0
	585-695	0.010	0.115	0.273	0	0
	695-805	0.000	0.011	0.258	0	0
	>805	0	0	0	0	0

November Replacement Price 695-805

May	Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
	<475	0	0	0	0	0
	475-585	0	0	0	0	0
	585-695	0.105	0.191	0.101	0	0
	695-805	0.006	0.091	0.290	0	0
	>805	0.000	0.006	0.211	0	0

November Replacement Price >805

May	Replacement Price	Calf Price <70	70-80	80-90	90-100	>100
	<475	0	0	0	0	0
	475-585	0	0	0	0	0
	585-695	0.068	0.051	0.008	0	0
	695-805	0.040	0.165	0.130	0	0
	>805	0.004	0.071	0.462	0	0

Table 10. November Calf Price 80-90.

November Replacement Price <475

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0	0.119	0.267	0.210	0
475-585	0	0.001	0.038	0.258	0
585-695	0	0.000	0.001	0.092	0
695-805	0	0	0	0	0
>805	0	0	0	0	0

November Replacement Price 475-585

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0	0.109	0.128	0.036	0
475-585	0	0.021	0.154	0.222	0
585-695	0	0.001	0.025	0.302	0
695-805	0	0	0	0	0
>805	0	0	0	0	0

November Replacement Price 585-695

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0.117	0.160	0.056	0
585-695	0	0.014	0.133	0.250	0
695-805	0	0.000	0.015	0.254	0
>805	0	0	0	0	0

November Replacement Price 695-805

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0	0.122	0.191	0.083	0
695-805	0	0.009	0.108	0.270	0
>805	0	0.000	0.008	0.208	0

November Replacement Price >805

May	Calf Price				
Replacement Price	<70	70-80	80-90	90-100	>100
<475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0	0.075	0.046	0.006	0
695-805	0	0.051	0.173	0.111	0
>805	0	0.005	0.088	0.444	0

Table 11. November Calf Price 90-100.

November Replacement Price <475

May		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0.140	0.274	0.182
	475-585	0	0	0.002	0.049	0.247
	585-695	0	0	0.000	0.001	0.092
	695-805	0	0	0	0	0
	>805	0	0	0	0	0

November Replacement Price 475-585

May		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0.124	0.121	0.028
	475-585	0	0	0.029	0.171	0.198
	585-695	0	0	0.001	0.032	0.295
	695-805	0	0	0	0	0
	>805	0	0	0	0	0

November Replacement Price 585-695

May		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0	0.134	0.154	0.045
	585-695	0	0	0.020	0.151	0.227
	695-805	0	0	0.001	0.020	0.249
	>805	0	0	0	0	0

November Replacement Price 695-805

May		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0	0	0	0
	585-695	0	0	0.141	0.187	0.068
	695-805	0	0	0.013	0.126	0.248
	>805	0	0	0.000	0.012	0.205

November Replacement Price >805

May		Calf Price				
		<70	70-80	80-90	90-100	>100
Replacement Price	<475	0	0	0	0	0
	475-585	0	0	0	0	0
	585-695	0	0	0.082	0.041	0.004
	695-805	0	0	0.064	0.178	0.093
	>805	0	0	0.008	0.105	0.424

Table 12. November Calf Price >100.

November Replacement Price <475

May	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0	0	0.023	0.142	0.432
475-585	0	0	0.000	0.003	0.295
585-695	0	0	0.000	0.000	0.093
695-805	0	0	0	0	0
>805	0	0	0	0	0

November Replacement Price 475-585

May	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0	0	0.028	0.111	0.134
475-585	0	0	0.001	0.037	0.360
585-695	0	0	0.000	0.002	0.326
695-805	0	0	0	0	0
>805	0	0	0	0	0

November Replacement Price 585-695

May	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0	0	0	0	0
475-585	0	0	0.03	0.12	0.18
585-695	0	0	0.00	0.03	0.37
695-805	0	0	0.00	0.00	0.27
>805	0	0	0	0	0

November Replacement Price 695-805

May	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0	0	0.030	0.132	0.235
695-805	0	0	0.000	0.018	0.369
>805	0	0	0.000	0.000	0.216

November Replacement Price >805

May	Calf Price <70	70-80	80-90	90-100	>100
Replacement Price <475	0	0	0	0	0
475-585	0	0	0	0	0
585-695	0	0	0.025	0.064	0.038
695-805	0	0	0.005	0.074	0.256
>805	0	0	0.000	0.011	0.525

FROM:

Arizona Ranchers' Management Guide
Russell Gum, George Ruyle, and Richard Rice, Editors.
Arizona Cooperative Extension

OPTIMAL ECONOMIC RANGE COW CULLING DECISIONS: BIOLOGICAL AND MARKET FACTORS COMBINED

Russell Tronstad [1] and Russell Gum [2]

This is the third in a series of three articles addressing culling decisions. The first article addressed biological considerations while the second article focused on market considerations. This article focuses on combining the biological and market considerations to increase profits. These decisions must take into account the dynamic aspects associated with the culling decision. That is, cows kept in the herd will become one year older and on average have a different; chance of calving, calf weaning weight, cow weight, and chance of remaining fit for the herd. Also, future returns and expenses are discounted so that all economic comparisons are made with current dollars.

Optimal economic culling decisions are made for two basic scenarios. The first scenario assumes that the rancher has the ability to only calve cows once a year (i.e., spring calving). The second scenario assumes that a rancher has the ability to breed and calve cows at two different times during the year (i.e., spring and fall calving). The latter scenario has about a six month time lead for bringing an open cow back into production. For example, if a cow is tested open in the fall, this cow couldn't be bred until the following summer with only spring calving. Whereas, if calving is possible in both fall and spring, this cow has the opportunity to be bred in late fall and brought into production six months earlier than with only spring calving possible. When looking at culling decisions, six months has a noticeable difference on economic profitability.

On average, market price conditions are higher for eight month old weaned calves sold in the spring than in the fall as pointed out in the second article on market conditions. However, calves born in the fall and weaned in the spring are expected to be five percent lighter than calves sold in the fall from spring calving. These differences, among others pointed out in the previous two articles, are accounted in the optimal economic culling decisions.

Costs associated with selling a cull cow and bringing a replacement into the herd are also important. For the costs associated with selling a cull cow, this analysis used a 4% shrink, $.01/lb. trucking cost, and a sale commission equal to 1.5% the gross selling price. The cost of bringing a bred replacement heifer on the ranch was $10/head for veterinary costs and $10/head for trucking costs.

The optimal culling decisions and associated economic results are presented in Figure 1 through Figure 3b as decision trees. A decision tree is simply a branched structure where a choice must be made at each branch. Imagine a cat climbing a tree. At each branch the cat must make a decision on which way to go. Decision trees are simply upside down trees where at each branch you must decide which way to go. For the culling decision model presented, the decision of which way to go at each branch is determined by: cow age, cull cow prices, calf prices, or replacement cow prices. When you run out of branches the decision on whether to cull or keep a cow is revealed. For example, consider the case of open cows in the fall with both spring and fall calving possible. This situation is depicted in the decision tree in Figure 2. If current replacement prices are $850/head, current calf prices average $95 and cull cow values are $650/head, should a 5 year old open cow be kept or culled? A "replace" is put in the top box of Figure 2 indicating that the optimal economic decision would be to replace an open cow if no further criteria was utilized. But the first decision on which direction to go is made on the basis of age. The cow was identified as 5 years old so the left branch is chosen (i.e., 5 < 7.5 years of age). Replacement prices determine the direction to take at the next branch. Since the current replacement price of $850/head is greater than $695, the right branch is chosen. Calf prices determine the direction for the next branch. Calf prices are $95/cwt., thus the right branch should be taken. Another decision is made on replacement prices. Replacement prices are greater than $805/head so the right branch is chosen. Cull cow values determine the direction at the final decision branch. If your cow's cull value is less than $768/head, which it is at $650/head, our economic model says that you should keep this cow. The terminal box or node for this scenario is box #13.

Table 1. Economic Values that are Associated with the Terminal Boxes from Figure1.

Terminal Box Number	Optimal Cull Value	Cost of Mistake	Chance of Box Occurring
1	$1,552	$49	0.1057
2	$1,464	$24	0.0044
3	$1,557	$3	0.0024
4	$1,779	$7	0.0046
5	$1,771	$13	0.0061
6	$1,592	$99	0.4649
7	$1,384	$500	0.0144
8	$1,917	$23	0.0007
9	$1,830	$74	0.0139
10	$1,873	$14	0.0001
11	$1,984	$12	0.0003
12	$1,762	$179	0.0062
13	$1,784	$95	0.0645
14	$1,873	$108	0.0196
15	$1,841	$19	0.0030
16	$1,794	$26	0.0064
17	$1,598	$246	0.0032

Tables 1 through 3 give the optimal expected returns for each terminal box or node displayed in Figure 1 through Figure 3b. For example, Table 2 and box #13 gives an optimal value of $1,574. This optimal decision value represents our estimated value for this slot in the herd for the next 15 years when a correct (keep for box #13) decision is made, given our initial price conditions. The expected cost of making a mistake is also given. This cost is a "one year" culling mistake since it is assumed that optimal culling decisions are made after the "one year" mistake. If the same culling decision mistake is made year after year the costs will add up. The cost of making a "one year" mistake at box #13 is $43/head.

Tables 1 through 3 also give the chance that on average a cow would end up in a box. These chances are based on the herd fertility and market conditions presented in the first two articles. Thus, the chance of being in any box is dependent on the chance of a cow falling into a given age bracket, the odds of a cow being open or pregnant, and the chance of market conditions represented by every terminal node existing. The sum of all chances occurring from both pregnant and open cows doesn't sum to 1

Table 2. Economic Values that are Associated with the Terminal Boxes from Figure 2.

Terminal Box Number	Optimal Cull Value	Cost of Mistake	Chance of Box Occurring
1	$1,412	$12	0.0098
2	$1,367	$46	0.0114
3	$1,548	$34	0.0245
4	$1,426	$32	0.0119
5	$1,474	$2	0.0020
6	$1,640	$32	0.0116
7	$1,438	$67	0.0118
8	$1,416	$43	0.0011
9	$1,580	$8	0.0015
10	$1,549	$33	0.0005
11	$1,545	$19	0.0015
12	$1,693	$31	0.0042
13	$1,574	$43	0.0030
14	$1,703	$13	0.0020
15	$1,505	$106	0.0622

because these chances only include cows that were fit to breed (i.e., these chances don't include cows that died or became unfit to remain in the herd). Terminal boxes that have a relatively high chance of occurring and a large "cost of mistake" should be given close attention. However, the culling decision is often more obvious for these cases. For example, terminal box #6 from Table 1 has a "cost of mistake" at $99 and a relatively high chance of occurring at about 47% probability. This decision rule reinforces the economic reality that under typical price conditions it makes economic sense to keep a pregnant cow. Box # 7 from Table 1 indicates that the cost of keeping a cow beyond the age of 13.2 years of age is quite large at $500 since it was assumed that the cow would die if kept beyond 14 years of age.

Even if some market price and cow age situations rarely occur, large "cost of mistake" values are important on an individual cow basis when found in those specific situations. For example, terminal box #23 from Table 3 and Figure 3b indicates that the cost of keeping a pregnant cow with spring only calving is quite high at $221. For box #23, market prices are such that replacement prices are less than $805/head, calf prices are less than $80/cwt., cull cow values are above $493/head, and the cow exceeds 11.75 years in age. When replacement values are not real high and the odds of getting a high priced calf out of an older cow are not great (i.e., calf price less than $80/cwt.), economic results suggest that you should replace this cow, even though she is pregnant.

Figures 1 and 2 plus Tables 1 and 2 represent culling decisions where both spring and fall calving are possible. Our economic results indicated that the value expected for an average slot in the herd for the next 15 years was $1,561 when both spring and fall calving were possible. However, this value slipped by $100 to $1,461 when only spring calving was possible. This translates to an estimated 6.8% increase in herd profitability by having both spring and fall calving instead of just spring calving. Much of the difference between these two calving systems is attributed to the economic profitability of the open cow. When only spring calving is considered, our results indicate that it is never optimal to keep an open cow. Irrespective of how high replacement prices may be and even if the cow is at a prime age, our economic model indicates that it is always more

Table 3. Economic Values that are Associated with the Terminal Boxes from Figures 3a and 3b.

Terminal Box Number	Optimal Cull Value	Cost of Mistake	Chance of Box Occurring
1	$1,444	$48	0.0748
2	$1,396	$9	0.0053
3	$1,643	$13	0.0049
4	$1,517	$19	0.0109
5	$1,720	$30	0.0068
6	$1,494	$74	0.1373
7	$1,794	$19	0.0023
8	$1,625	$7	0.0072
9	$1,796	$20	0.0019
10	$1,559	$129	0.2778
11	$1,467	$42	0.0216
12	$1,720	$10	0.0019
13	$1,650	$34	0.0038
14	$1,786	$13	0.0001
15	$1,899	$31	0.0004
16	$1,781	$104	0.0196
17	$1,769	$11	0.0024
18	$1,717	$41	0.0025
19	$1,355	$118	0.0310
20	$1,309	$14	0.0032
21	$1,415	$29	0.0108
22	$1,245	$26	0.0040
23	$1,256	$221	0.0068
24	$1,335	$6	0.0037
25	$1,317	$25	0.0078
26	$1,146	$20	0.0004
27	$1,283	$91	0.0050
28	$1,532	$120	0.0437
29	$1,461	$21	0.0031
30	$1,636	$56	0.0072
31	$1,460	$42	0.0049
32	$1,315	$15	0.0015
33	$1,504	$15	0.0013
34	$1,640	$4	0.0009
35	$1,621	$32	0.0017
36	$1,331	$680	0.0015

profitable to replace an open cow in the fall with a bred replacement heifer. The six month time jump associated with bringing an open cow into production under a dual calving season translates into almost a 7% increase in herd profitability, for the herd estimated.

A simple culling rule is to cull all cows that are open and keep all cows that are less than 12.5 years of age and pregnant in the fall. However, a representative slot in the herd has a value of only $1,414 for this type of culling strategy, with only spring calving possible. This translates into 3% less profit than if culling decisions were made optimal with spring only calving (Figures 3a and 3b for pregnant cows plus culling all open cows) and over 10% less profit than if optimal culling decisions were made given that both spring and fall calving were possible (i.e., Figures 1 and 2).

It should also be pointed out that the culling decisions and economic values presented are for cows with production potentials as reported in the first article of this series. A particular cow could have either a better or worse production potential. The best use for this information is as a guide to help you judge whether individual cows in your herd should be kept or replaced. If our model recommends culling a specific cow but the cost of making a mistake (according to the model) is low then you should feel free to use your own knowledge and judgment to determine whether this cow should be culled or kept. On the other hand, if our model projects a large cost of making a mistake and your judgment does not agree with the model then you should try to find out why the model is wrong. Review the first article in this series to check if our biological productivity estimates and costs by age group are representative of your particular situation? Review the second article to check if our market price predictions are out of line with your expectations. Calculate the expected economic profits of replacing or keeping a particular cow. Going through such a process should help you fine tune your culling strategy for your specific conditions. It might even convince you that there is value on having information quickly available to you at culling time on past cow performance and cow age.

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Figure 1. Decision Tree for Pregnant Cows in the Fall when Spring and Fall Calving are Possible.

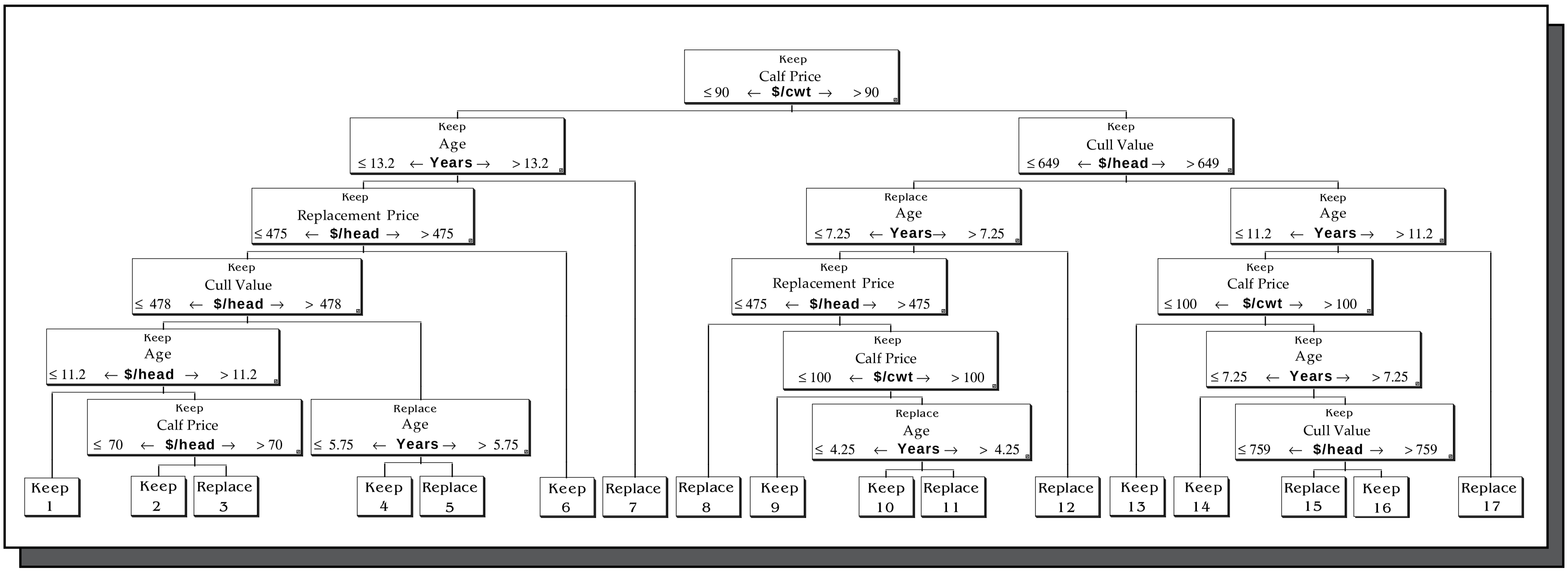


Figure 2. Decision Tree for Open Cows in the Fall when Spring and Fall Calving are Possible.

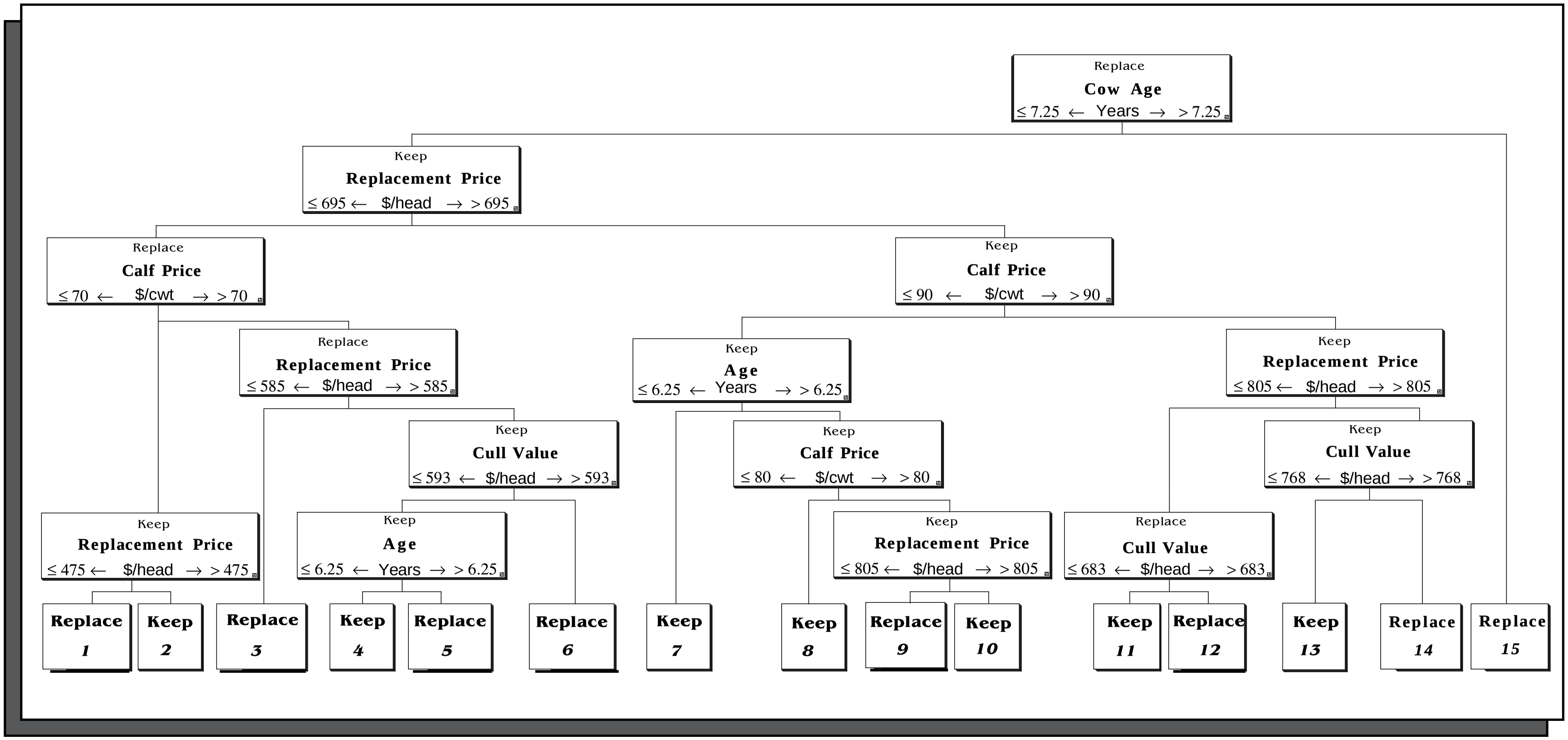


Figure 3a. Decision Tree for Pregnant Cows in the Fall that are Younger than 8.75 Years of Age when only Spring Calving is Possible.

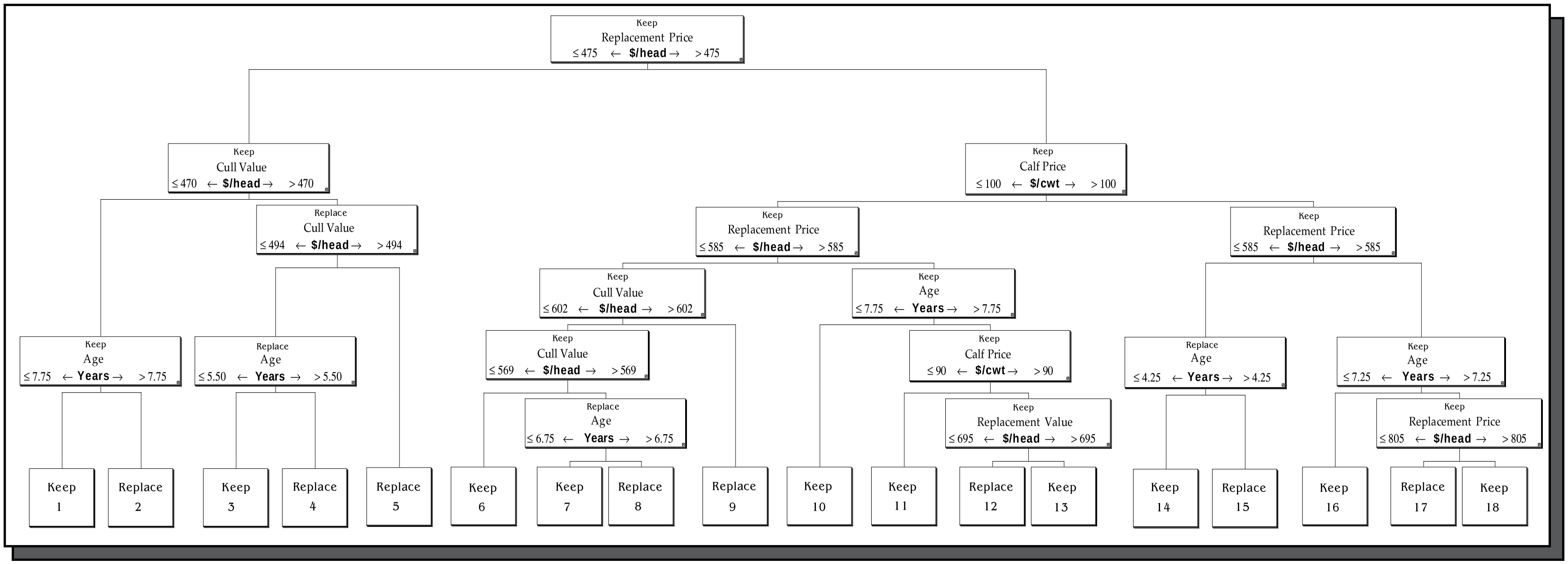
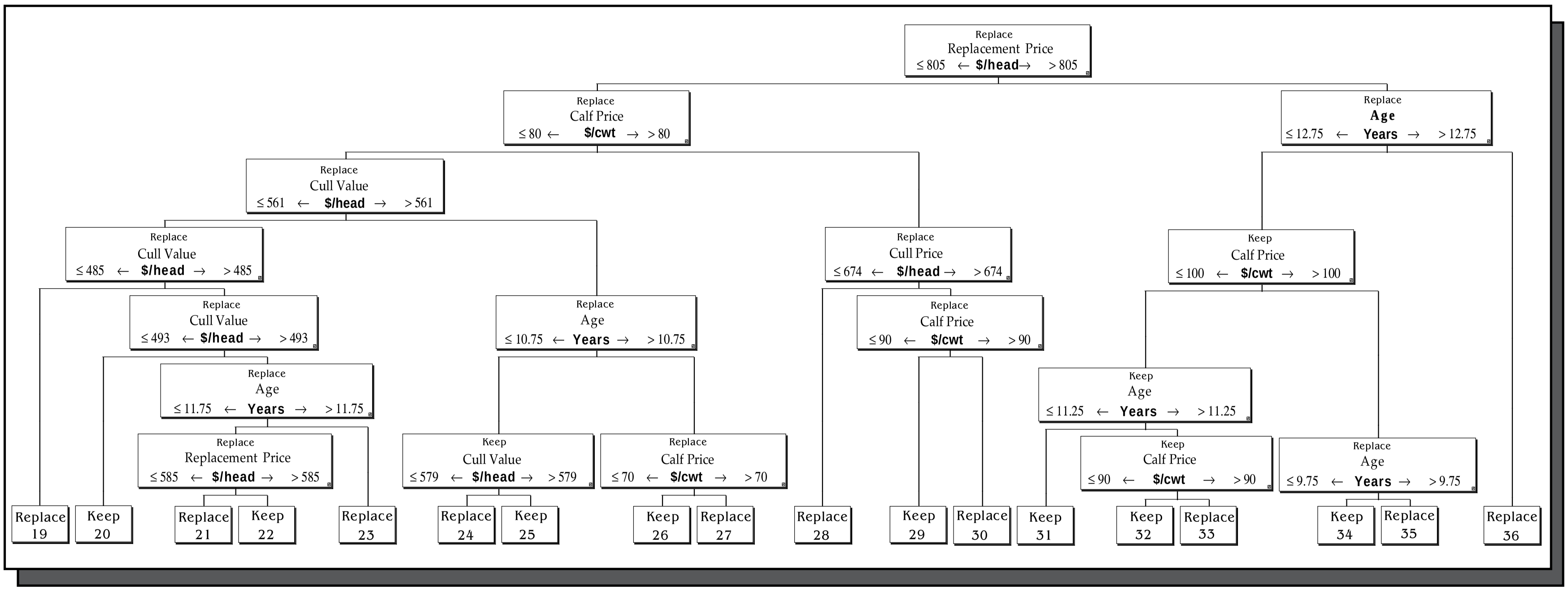


Figure 3b. Decision Tree for Pregnant Cows in the Fall that are Older than 8.75 Years of Age when only Spring Calving is Possible.



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THE INFLUENCE OF LOT SIZE ON FEEDER CATTLE PRICES AT ARIZONA AUCTIONS

Russell Gum[1] and
Lew Daugherty [2]

One of the decisions that ranchers must make when marketing their cattle at auctions is what size lots to sort their cattle into. Experience and previous research has shown that lots of a size equal to the capacity of a cattle truck (about 60 head for feeder cattle) will receive a premium over lots of fewer head. At the same time, experience and limited research suggest that uniform lots will sell at a premium over non-uniform lots. The rancher is faced with a choice. Large lot sizes and less uniformity or smaller lots with more uniformity. Another alternative which has become more popular in recent years is to combine your cattle with other ranchers cattle to be able to sell large uniform sized lots.

How much difference can lot size make? Data on each lot of cattle sold from 1984 to 1991 at the Gila and Mohave spring yearling cattle sales were statistically analyzed to gain insights into the influence of lot size on feeder cattle prices. The results are displayed in Figure 1. The form of the results is in terms of the price received for lots of varying sizes compared to the price received for lots of average size (15 head) at the same sale. Adjustments were made to remove the influence of weight and sex from the results. As shown in the figure very small lots (1 to 5) head tend to have a price about 3% below the sale average for animals of the same sex and weight. Lots at or near truckload capacity tend to have a price of about 4 to 5% higher than the sale average for animals of the same sex and weight. The difference between the smallest lots and truckload sized lots is over 8%. This difference should not be overlooked in planning your marketing strategy, but don't forget that uniformity in lots is also valued.

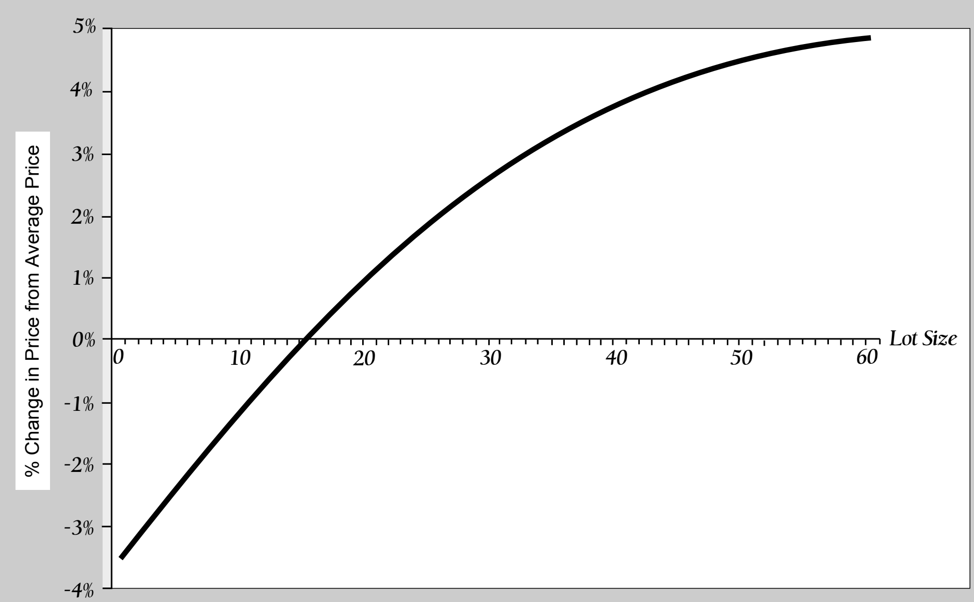

Figure 1. Comparison of Lot Size Impacts.

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THE ECONOMICS OF SHRINKAGE

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Shrinkage is of economic importance to ranchers in two ways. First, as you move and handle your animals in the process of selling them they will lose weight due to the combination of stress and of not having feed and water readily available. Because they will lose this weight before they are weighed at sale time, the gross returns to the rancher will be reduced by the shrinkage if price does not depend upon shrinkage. However, shrinkage does affect price, and further is often an important element in the negotiations of a cattle sale. This linkage of shrinkage into the negotiations is the second way in which shrink becomes economically important.

DESCRIPTION

Shrinkage occurs due to the elimination of digestive track contents and urine, and as a result of dehydration and other loss of tissue. Part of this loss can be rapidly regained by the animals, and thus, has little long run effect upon the animals. However, the loss due to tissue shrinkage is the result of prolonged stress and is difficult to replace. Estimates of the proportion of easily regained loss vary from 35% to 50% (St. Clair, 1976) (Self and Gay, 1972) (W. Gordon Kerl, 1987).

Shrinkage depends on handling methods, weather, time off feed and other factors. General estimates of expected shrinkage expressed as a function of the distance that cattle are shipped are displayed in Figure 1. Gross shrinkage is the total shrinkage and net shrinkage is that part of the shrinkage which cannot easily and quickly be regained by the animals.

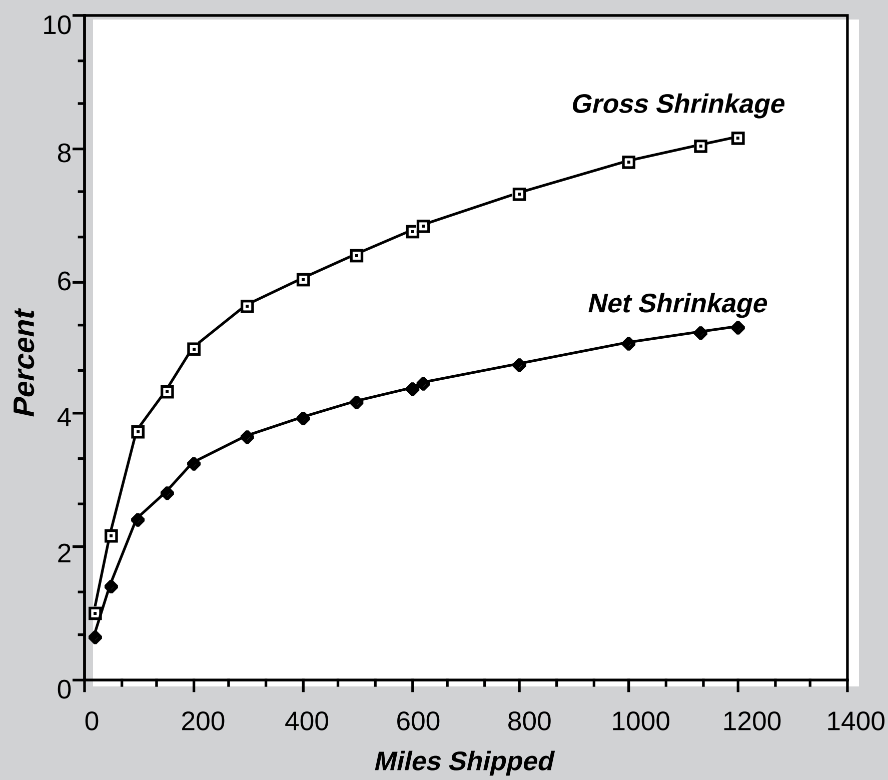

Figure 1

COMPARING OFFERS

Comparing prices with varying allowances for shrink is sometimes necessary to determine the best bid for your cattle. The simplest way to do this is with a calculator. For example if a buyer offers you $80/cwt for your 500 lb. steers and wants a 4% pencil shrink, this will result in a price per head of 500 times 96% (100% - 4%) times $80 ($384 per head) If another buyer offers you $79 with a 2% shrink this will result in a price per head of 500 times 98% (100% - 2%) times $79 ($387.10 per head). Even though the price is lower the second offer is obviously better as it results in more money per head.

Another way to make the same comparsion is to use the **less shrink table**. The first offer was $80 with 4% shrink, while the second had 2% less shrink and was $79. From the table an $80 price is equivalent to a $78.40 price with 2% less shrink. Since this is less than the $79 offer it should be rejected.

By use of a calculator or the Less Shrink Table alternative offers for your cattle can easily be compared. If the conditions of handling the cattle differ then considerations of the actual difference in shrinkage as well as any pencil shrink must be made. For example if you have an offer where the cattle will be weighed at the ranch on the day the cattle are gathered and another alternative where the cattle will be weighed after being shipped 100 miles, you will need to estimate the actual difference in shrink to correctly compare these alternatives. From the shrink figure a 100 mile shipment results in approximately a 4% shrinkage. You must consider this shrinkage in comparing the two offers. In fact you can consider it in exactly the same manner as a pencil shrink. The less shrink table can be used to show that an offer of $84 at the ranch is equivalent to an offer of $87.50 with weighing 100 miles away.

CONCLUSIONS

Be sure to consider both actual and pencil shrink when you are considering alternative offers or ways to market your cattle. A sharp pencil or calculator will help you to make the most from your cattle.

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BREAKEVEN PRICES
EQUIVALENT PRICE WITH LESS SHRINK

PRICE WITH SHRINK	-1%	-2%	-3%	-4%	-5%	-6%
50	49.50	49.00	48.50	48.00	47.50	47.00
51	50.49	49.98	49.47	48.96	48.45	47.94
52	51.48	50.96	50.44	49.92	49.40	48.88
53	52.47	51.94	51.41	50.88	50.35	49.82
54	53.46	52.92	52.38	51.84	51.30	50.76
55	54.45	53.90	53.35	52.80	52.25	51.70
56	55.44	54.88	54.32	53.76	53.20	52.64
57	56.43	55.86	55.29	54.72	54.15	53.58
58	57.42	56.84	56.26	55.68	55.10	54.52
59	58.41	57.82	57.23	56.64	56.05	55.46
60	59.40	58.80	58.20	57.60	57.00	56.40
61	60.39	59.78	59.17	58.56	57.95	57.34
62	61.38	60.76	60.14	59.52	58.90	58.28
63	62.37	61.74	61.11	60.48	59.85	59.22
64	63.36	62.72	62.08	61.44	60.80	60.16
65	64.35	63.70	63.05	62.40	61.75	61.10
66	65.34	64.68	64.02	63.36	62.70	62.04
67	66.33	65.66	64.99	64.32	63.65	62.98
68	67.32	66.64	65.96	65.28	64.60	63.92
69	68.31	67.62	66.93	66.24	65.55	64.86
70	69.30	68.60	67.90	67.20	66.50	65.80
71	70.29	69.58	68.87	68.16	67.45	66.74
72	71.28	70.56	69.84	69.12	68.40	67.68
73	72.27	71.54	70.81	70.08	69.35	68.62
74	73.26	72.52	71.78	71.04	70.30	69.56
75	74.25	73.50	72.75	72.00	71.25	70.50
76	75.24	74.48	73.72	72.96	72.20	71.44
77	76.23	75.46	74.69	73.92	73.15	72.38
78	77.22	76.44	75.66	74.88	74.10	73.32
79	78.21	77.42	76.63	75.84	75.05	74.26
80	79.20	78.40	77.60	76.80	76.00	75.20
81	80.19	79.38	78.57	77.76	76.95	76.14
82	81.18	80.36	79.54	78.72	77.90	77.08
83	82.17	81.34	80.51	79.68	78.85	78.02
84	83.16	82.32	81.48	80.64	79.80	78.96
85	84.15	83.30	82.45	81.60	80.75	79.90
86	85.14	84.28	83.42	82.56	81.70	80.84
87	86.13	85.26	84.39	83.52	82.65	81.78
88	87.12	86.24	85.36	84.48	83.60	82.72
89	88.11	87.22	86.33	85.44	84.55	83.66
90	89.10	88.20	87.30	86.40	85.50	84.60
91	90.09	89.18	88.27	87.36	86.45	85.54
92	91.08	90.16	89.24	88.32	87.40	86.48
93	92.07	91.14	90.21	89.28	88.35	87.42
94	93.06	92.12	91.18	90.24	89.30	88.36
95	94.05	93.10	92.15	91.20	90.25	89.30
96	95.04	94.08	93.12	92.16	91.20	90.24
97	96.03	95.06	94.09	93.12	92.15	91.18
98	97.02	96.04	95.06	94.08	93.10	92.12
99	98.01	97.02	96.03	95.04	94.05	93.06
100	99.00	98.00	97.00	96.00	95.00	94.00

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POTENTIAL PROFITS FROM WILDLIFE

Russell Gum[1]

As ranchers look for ways to increase profitability the possibility of marketing wildlife resources is often thought of as an additional product that might generate income. In Texas the income of many ranchers depends heavily upon the marketing of wildlife resources. In Wyoming many ranchers serve as big game guides as a means of supplementing their income from ranching. Is there a possibility that wildlife resources could become a source of income for Arizona ranchers?

WAYS OF MARKETING WILDLIFE RESOURCES

There are many ways to market wildlife resources. Possibilities include:

1. Selling access to hunters.
2. Selling guided hunts.
3. Raising wildlife for the restaurant market.
4. Raising exotic game for hunters.
5. Selling hunting permits.

ACCESS

Selling access to hunters is probably the most common means of marketing wildlife resources. The basic requirements to be able to sell access is to have both private land and a means to control access to this land. If you can meet these requirements then you have to find a way to market the product.

GUIDED HUNTS

Since ranchers typically have the equipment and knowledge of their area required to perform guiding service, many ranchers have turned to guiding as a means of generating income. However, guiding requires both excellent hunting abilities and the ability to take care of camp and get along with the hunters paying for the guiding services.

RAISE WILDLIFE FOR THE RESTAURANT MARKET

A small but growing number of fancy restaurants are now serving wild game. Producing game meat for this select market is a possibility. Not only do you need to be able to produce and market this product, you will need processing facilities and the ability to operate under a large number of regulations with respect to selling wild game.

RAISING EXOTICS FOR HUNTERS

Another possibility is to raise exotics for hunters. Obviously in addition to being able to raise the animals, you will need fencing to be able to keep the animals on your ranch. You will also face exotic disease problems and regulations on game farms. The marketing of exotics is also a potential problem. You can't just take them to the local auction.

SELL PERMITS

At the present time, hunting permits in Arizona are the property of the state and are allocated by a lottery. Under this arrangement there is little incentive for ranchers to manage their resources in a manner that will increase wildlife. A logical change in the system would be to reward ranchers for management practices which increase wildlife resources. For example, the state could allocate permits to ranchers and allow the ranchers to sell these big game permits as compensation for the ranchers efforts to increase wildlife resources. If as a result of a ranchers actions an additional 10 elk permits could be justified in an area, why not allow the rancher to sell these permits as a reward. Such a system has been tried in California. The major problem of course is to document the increase in wildlife due to the ranchers management actions.

Such a system could, in theory, also be applied to public lands. Suppose a rancher has a lease which allows him to graze 400 cows. Why couldn't he only graze 300 cows and manage for an additional 200 elk? If his management did in fact result in an additional 200 elk, which justified say an additional 50 permits, why not charge him grazing fees for the additional elk and allow him to sell the additional 50 permits?

CONCLUSIONS

Marketing wildlife has potential to increase rancher income. However, just as with any new enterprise, there are many obstacles to be overcome. First, there are a multitude of rules and regulations which apply to marketing wildlife. Second, all of the methods of marketing wildlife require more marketing effort than just taking cows to the auction. Third, many of the methods of marketing wildlife require skills and abilities in working with people not normally required in managing a cattle ranch. Guiding hunters, for example, requires skills similar to a golf pro at a resort. While marketing wildlife is certainly not a quick fix for low profits in ranching, it does offer potential for increasing ranch income in well thought out and well managed situations.

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LEAST COST FEED RATIONS ON YOUR PERSONAL COMPUTER

Russell Gum and Gary Thompson[1]

Mathematical programming models are routinely used to calculate everything from minimum-cost feed rations to scheduling plane flights and blending petroleum products in refineries. A revolution in the software necessary to solve these powerful models has occurred in the past couple of years. Now anyone owning the latest version of most commercial spreadsheets such as Microsoft Excel or Quattro Pro has computational power which only Fortune 500 companies possessed a decade ago. Putting this enhanced computational power to work, however, requires the ability to put together a useful mathematical programming model.

All mathematical programming models have two critical elements: something to be *maximized* or *minimized*, and *constraints* or limitations which reflect production requirements and the availability of resources. In the minimum-cost feed ration, the costs of mixing a nutritional feed are minimized. The constraints in the feed mix problem are the nutritional requirements necessary to maintain good health and assure weight maintenance or gain.

Once the objective to be maximized or minimized is identified, the constraints or limitations directly affecting the objective must be recognized. Most constraints identify scarce resources and biological, physical, or financial requirements. Scarce resources are often easily recognized. In a grazing operation, the extent of available range land limits the number of head that can be grazed. The number of acres a farmer owns and leases limit the area planted in crops. Biological, physical, and financial requirements are sometimes more difficult to quantify. Finding the nutritional requirements for targeted weight gain may not be easy. Determining the proper fertilizer dosage for the targeted yield may require some searching.

A SIMPLE EXAMPLE

Most real life problems involve many complex interrelationships. The simple example presented here should give you an idea of the kinds of problems which could be solved. The details of the example are necessarily simplified.

The problem is the classic feed mix problem. The objective is to find a feed formulation that meets given nutritional requirements at minimum cost. Our possible ingredients are hay, corn, barley and meal. Their nutritional analysis is as shown in the spreadsheet table below. The hay used for this simple example is assumed to have 15 percent protein and 50 percent TDN by weight. The nutritional analysis for corn, barley and meal are 8, 7, and 40 percent protein and 85, 78, and 75 percent TDN, respectively.

A simple spreadsheet can be set up to calculate the protein energy and cost of any possible ration by simply defining the appropriate formulas for

	A	B	C	D	E	F
1		hay	corn	barley	meal	ration
2	% protein	0.15	0.08	0.07	0.40	.1595
3	% energy	0.50	0.85	0.78	0.75	.6355
4	cost $/LB	0.05	0.10	0.08	0.15	.0755
5	lbs	50	0	35	15	100.0000

the ration column. If % protein is in A2 then a formula of: (B2*B$5+C2*C$5+ D2*D$5+E2*E$5)/F$5 will define the % of protein in the ration and if copied down will mutate to define the % energy and cost per pound as well. The pounds in ration (F5) is simply the sum of the pounds of each individual ingredient, i.e., (B5+C5+D5+E5).

Once you have this simple spreadsheet set up you could then simply try different combinations of ingredients until you found a combination of ingredients that met the nutritional requirements at a reasonable cost. Such a solution is shown in the above table. However, this brute force approach might take a fair amount of time.

A much better way is to use the "solver" option of your spreadsheet. The mechanics of using this option in Microsoft Excel are as follows: (other brands of spreadsheets with solver options have very similar mechanics)

F2 > = .12 (Protein level must be greater than or equal to 12 percent)

F3 > = .60 (Energy level must be greater than or equal to 60 percent)

F5 = 100 (You want to mix 100 pounds of ration)

B5:E5 > = 0 (Negative weights are hard to measure out in formulating a ration. This insures only positive or zero values)

At this point, you have told the computer what cell describes your objective function (F4). You have given it instructions to minimize this value subject to a set of constraints by varying the amount of the various ingredients in your ration. Click on solve and the computer should return the following results.

	A	B	C	D	E	F
1		hay	corn	barley	meal	ration
2	% protein	0.15	0.08	0.07	0.40	.1214
3	% energy	0.50	0.85	0.78	0.75	.6000
4	cost $/LB	0.05	0.10	0.08	0.15	.0607
5	lbs	64.285714	0	35.7142865	0	100.0000

1. Set up your spreadsheet to calculate the necessary values, as described above.

2. Choose the **Solver Option** from the menu.

3. Enter the cell you want to minimize in the **Set Cell Box** (F4, ration cost per pound).

4. Click on the **Minimize Button**.

5. Enter the cells you want to solve for in the **By Changing Cells Box** (B5:E5, the pounds of possible ingredients).

6. Add the following constraints by clicking on the **Add Button**:

As you can see, the computer found a cheaper ration meeting all requirements than was found by simply fiddling with the original spreadsheet. Further, additional information is available in the form of a sensitivity report.

What is a Reduced Gradient or a Lagrange Multiplier? These terms are just techno babble for expressing what happens if you make a small adjustment to the optimum solution the computer found. For example, if you were to add one pound of meal to the solution and let the computer recalculate the ration so that the original constraints were still met the cost per pound of this modified ration would be

Changing Cells

Cell	Name	Final Value	Reduced Gradient
B4	lbs hay	64.28571398	0
C4	lbs corn	0	.0000357036
D4	lbs barley	35.71428654	0
E4	lbs meal	0	.000732134

Constraints

Cell	Name	Final Value	Lagrange Multiplier
F2	protein constraints	.1214	.0000
F3	energy constraints	.6000	.1071
F5	lbs constraints	100.0000	.0000

.000732134 $/lb higher than the original ration. Adding a pound of corn would increase the cost even less. If instead of adjusting the ingredients you made small changes in the constraints the Lagrange multipliers indicate how the optimum cost would change. For example a small increase in the protein requirement (say to 12.1 percent) would not change the cost at all. This is because the optimal solution already has more than 12.1 percent protein. A larger change to any value above 12.4 percent would increase the cost and the model would need to be re-optimized to calculate the new optimum and its associated new sensitivity values. Increasing the energy requirement to .61 percent would raise the ration cost .001071 $/lb. (We raised the constraint by .01 units so we must multiply the Lagrange multiplier by .01.)

Could this mathematical modeling stuff be of any real use on a ranch? Is it as easy as the simple model above? The answer to the first question is yes. The simple ration mix problem might even be useful on your ranch. The answer to the second question is Nope. Even the simple ration problem becomes more complex in reality. For example, are the analyses based on dry matter weights or at the feed scale weights? How many different ingredients are reasonable to consider? Most importantly, how should I decide on what the protein, energy, minerals, etc. content of the ration should be. The bottom line is that the current high end spreadsheets have capabilities to help you think about and solve some of the management problems common in ranching today.

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COMPARISON OF LIVESTOCK MARKETING ALTERNATIVES

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An evaluation of marketing alternatives is complicated by the fact that less traditional marketing avenues like electronic auctions are difficult to directly compare with more traditional selling methods like local auction markets. This article discusses economic criteria for evaluating livestock marketing methods. Criteria are discussed for 1) electronic marketing, 2) private treaty, 3) local auction, 4) special auctions, 5) cooperative arrangements, 6) Chicago Merchantile Exchange (CME) Futures, and 7) CME Options.

ECONOMIC CRITERIA

Economic criteria are divided into tangible and non-tangible items. Physical terms of a marketing method such as shrinkage (refer to The Economics of Shrinkage article), trucking costs, overnight water and feed restrictions, commissions, interest costs, are tangible items that need to be calculated when determining a net selling price. The combined selling costs to the buyer and seller can range from between 8% and 10% of the gross animal value (Bailey). More intangible factors like the number of legitimate buyers in a market, riskiness of receiving full payment, the degree of convenience offered, and certainty in obtaining a targeted price level are economic criteria that also need to be considered when choosing a marketing method. Both tangible and intangible factors need to be evaluated jointly when deciding which marketing method or "road map" will best meet goals and target price levels set. Target price levels must be realistic with current market factors and price trends. Costs of production and breakeven prices should be identified and utilized as a reference mark for marketing. These tangible and non-tangible economic criteria are discussed below in conjunction with six different marketing methods.

ELECTRONIC MARKETING

Electronic marketing is a mechanism for marketing beef cattle by a description of standardized terms and/or videotape with virtually instantaneous communication between buyers and sellers, regardless of physical location between both people and cattle. Electronic marketing methods hope to increase the number of legitimate buyers by decreasing the transaction costs of inspecting, shipping, and buying cattle. This reduction in transaction costs is hoped to translate into a higher net price for the rancher and lower cost for the buyer. The degree that transaction costs will be decreased depends greatly on information, volume, location, and trucking costs.

Standardized information regarding terms, grades, and descriptions are necessary for electronic pricing efficiency. If one lot of cattle is sold under different terms than another comparable lot of cattle, it is difficult to make a direct comparison as to which buyer is offering the "best deal." Common or standardized terms allow for an equal comparison of bids and is a necessary condition for a market to be price efficient. Electronic marketing terms are the same for all buyers, allowing for improved price efficiency over individual private treaty bids that may have different terms. Standardized terms require that a trained grader make an accurate representation of your livestock compared to other livestock.

The grading reputation of an electronic auction needs to be evaluated closely since a misrepresented grade that has been lowered will cost a rancher more than if no grade had been given at all.

Adequate volume is necessary to attract many buyers so that top dollar is paid for all lots sold. If buyers discover that low numbers of livestock are offered for sale at an electronic auction, they may be unwilling to invest the resources for getting into a particular electronic auction. Prices could also fall significantly lower than the prevailing market, if available volume exceeds the number of orders that buyers have to fill. Lack of sufficient participation in electronic markets is one of the chief concerns among both sellers and buyers. When considering an electronic market, buyer participation expected for each specific sale needs to be examined carefully. An advantage of electronic markets is that a minimum selling price can be specified prior to the sale, but a fee comparable to regular commission rates will still be charged if the minimum selling price is not met.

Locational considerations that relate to shrink, trucking costs, and disease endangerment are potentially beneficial features of electronic auctions over local auctions. First, trucking costs can be lowered significantly by a more direct route, and the elimination of one unloading and loading of the livestock. Remote ranch areas can significantly reduce their shrink by having livestock weighed on or closer to the ranch. Reducing the livestock's exposure to diseases gives the buyer an advantage, especially if the cattle are going to a feedlot with cattle from only one or two ranches.

Primary disadvantages of electronic auctions to local auctions are the frequency of sales and discounts incurred for small lots. Any lot that doesn't make a full truckload (generally 50,000 lbs.) can expect to be discounted. Commission charges are often higher too to cover costs associated with grading and the electronic auction. Specific electronic markets of a) tele-auction, b) video auction, and c) computer auction are further discussed below.

Tele-Auction

Many times ranchers will join a marketing cooperative with a tele-auction so that more sellers are committed to market through the cooperative. This organization and seller commitment is given to attract more prospective buyers. Livestock are graded on each individual's ranch by a trained grader. Load lots are then assembled on paper according to location, number, weight, quality grade, and other noteworthy descriptions. After buyers receive this written description of cattle offered for sale, a prearranged conference phone call connecting potential buyers and an auctioneer must be set up. The auctioneer offers each lot for sale with buyers calling out their identification number over the phone if they wish to bid at the current asking price. A lot is sold when no higher bid is received, unless the seller's minimum price set before the auction is not obtained.

Video Auction

A video auction is very similar to the tele-auction except that more information is given to potential buyers. Two components comprise the video auction — a visual component provided by a video and a written component given by a sale catalogue. A videotape of animals sold is generally made by a regional representative of the video auction company prior to soliciting buyers. About a $2.00/head videotaping fee is required and this fee is generally included in the sales commission. Sales catalogue descriptions are prepared by the seller and regional video representative when the cattle are videotaped.

The sale is conducted with buyers assembled in one or more rooms looking at a large screen TV monitor — possibly connected by satellite to other buyers at very distant locations. Buyers must register with the auction and go through a credit check and clearance before the sale like in telephone and computer auctions. Videotapes of about two minutes in duration are shown while an auctioneer solicits bids. During the sale, buyers bid on livestock over the telephone like in a tele-auction but they also "see" the animals when bidding. The video auction representative oversees delivery and is responsible for ensuring contract compliance with both seller and buyer.

Cows and heifers that are guaranteed bred and/or with a negative bangs test are to be tested prior to delivery. This requires certification from a licensed veterinarian and these costs are usually paid for by the seller, unless stated otherwise. Although many efforts are made to ensure that the "catalog" description and terms are up-to-date, all announcements from the auction block take precedence over previously printed matter.

Computer Auction

Computer auctions are similar to video and tele-auctions except that information and bidding is conducted with electronic computers. Cattle are described before the sale with information transmitted via computer connections. When the sale is conducted, buyers indicate a bid by activating the bid key on a computer terminal. Initially, the offering price for a lot of cattle may drop by $1.00/cwt. every 5 seconds until a buyer activates their bid key. This buyer has the bid until another buyer raises the bid. Bids are generally raised in smaller increments than they are lowered. The Electronic Auction Market (TEAM) from Calgary Stockyards increases bids by $.25/cwt. and drops the price by $1.00/cwt. to secure a bid (Rust and Bailey). If a higher bid is not received within the buying interval for bid increases (e.g. 20 seconds), the lot is declared sold. Unlike video and tele-auction, buyers have no way of telling who they are bidding against in the absence of any collusion. With the conference call associated with video and tele-auction, the voice signals of prominent bidders can be recognized fairly quickly. The computer identifies who has made every bid to the auctioneer but buyer bids are not identifiable to other buyers.

Slide Considerations

Virtually all feeder cattle are sold on a sliding scale when sold electronically or direct. A slide establishes the discount or premium from a base price depending on differences in actual base weight (after shrink) from those expected. Since heavier weight feeders generally sell for less than light feeders, a slide is part of the terms of trade. Many contracts allow for a small weight allowance of like 10 lbs./head before any weight adjustment is made. A slide is defined in $/cwt. and can have a range from $0.00/cwt. to $10.00/cwt.

The slide is effective for both over and under weight cattle so that light (heavy) weight cattle will receive a premium (discount) from the bid price. The net price received can be calculated as follows:

1) Determine if the weight after shrink is within the weight allowance. If within weight allowance then,

   net price = bid price x (1.0 - shrink %).

2) If heavier than the maximum weight allowed after shrink before the slide is effective then,

   net price = {bid price - [weight after shrink - max. weight allowed] x slide/100} x (1.0 - shrink %).

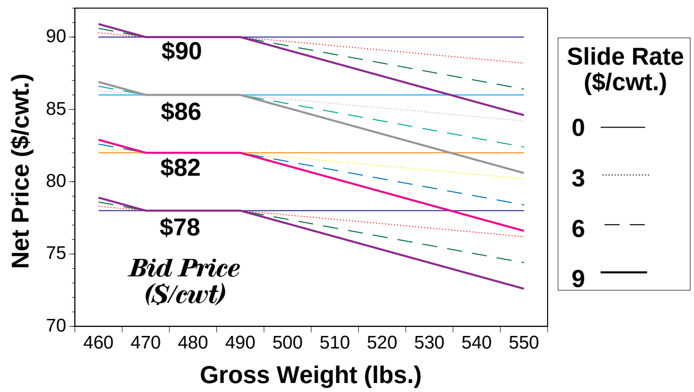
3) If lighter than the minimum weight specified after shrink before the slide is operative then,

   net price = {bid price + [min. weight specified - weight after shrink] x slide/100} x (1.0 - shrink %).

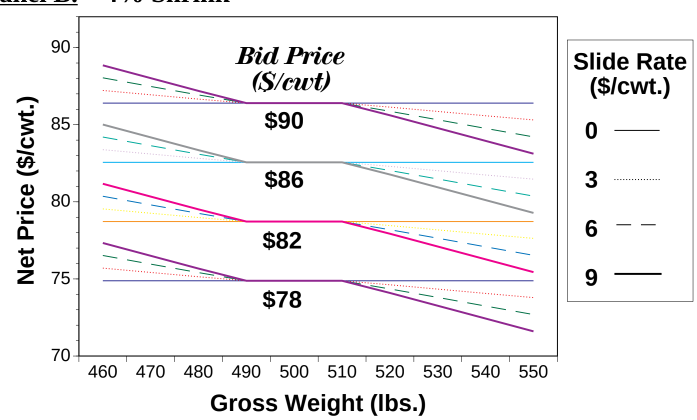
For example, what is the net price received if the bid price is $80/cwt., the base weight after shrink is 480 lbs. with a 10 lb. weight allowance and 4% shrink, and a slide of $4.00/cwt. is utilized? A calf weighing 510 lbs. would have a net weight after shrink of 489.6 lbs. (510 x .96), within 10 lbs. of the specified base weight of 480 lbs. Thus, the net price would be $76.8/cwt. ($80/cwt. x .96) or $391.68/ head. If the calf had a gross weight of 550 lbs., the net price received would be $75.34/cwt. ({80 - [(528-490) x 4.0/100]} x (1.0 - .04)). If the calf weighed only 480 lbs. on the scale, the net selling price would be $77.15/cwt. ({80 + [(470 - 460.8) x 4/100]} x (1.0 -.04)). The figures to the left net price of cattle with different shrinkage rates, bids, and slides illustrates how net prices vary based on gross weight.

Net Price Received on Gross Weight with a 480 lb. Base Weight (after shrink), and 10 lb. Weight Allowance.

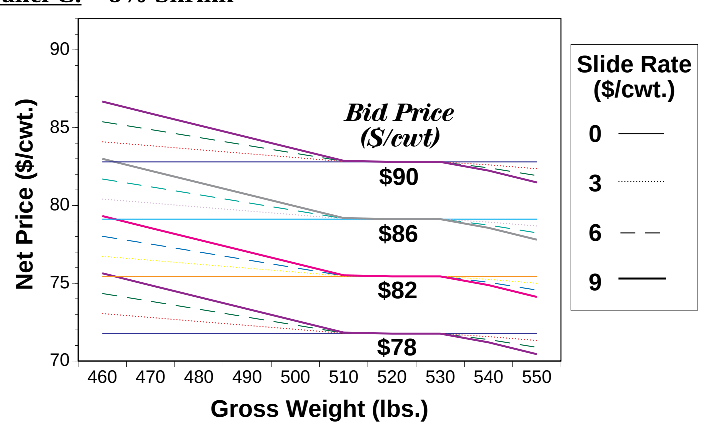
Panel A. **0% Shrink**



Panel B. **4% Shrink**



Panel C. **8% Shrink**



All livestock are weighed on certified scales and sell FOB (not including transportation charges) at the ranch, unless otherwise stated. Any cuts made from a pen are made after the cattle are weighed.

PRIVATE TREATY

Private treaty refers to individual buyers and sellers negotiating one-on-one the terms and price of sale. This method generally works best when the buyer knows the quality of livestock available and the rancher knows that the reputation of the buyer is reliable. Under these conditions, negotiations can occur over the telephone without the need for travel and inspection of animals.

Price efficiency is generally lacking under a private treaty method due to insufficient information. All potential buyers don't have adequate and equal information on a particular rancher's livestock and all rancher's don't have full information on the trustworthiness and legitimacy of all buyers. In general, buyers must be bonded and licensed in order to buy livestock. Verify that these qualifications are met. Insist upon a wire transfer of funds, certified check, letter of credit, or cashiers check to lower the risk of not receiving full payment. A personal check is the least expensive for the buyer, but also a high risk for the rancher selling livestock. It is always a safe practice to retain title of livestock until the final payment has cleared the buyer's financial institution. If a personal check doesn't perform in full the seller has to pursue legal procedures in order to obtain funds. Legal fees can add up in a hurry and when livestock are removed from the state of origin it is very difficult to even repossess them. An example of what a "Livestock Bill of Sale and Contract" (Bahn, Brownson, and Rust) might include is noted on the following page.

LOCAL AUCTION

Local auctions are a centralized market where buyers, sellers, and animals merge to a particular location and specific time. Livestock are generally sorted so that each lot is somewhat uniform. The disadvantage of sorting animals into more uniform lots is that smaller lot sizes receive a discounted price (Gum and Daugherty). Sellers may be able to combine small lots with one another in order to avoid some of this price discount, but this requires more organization, weighing, and agreement that all cattle are of equal quality and value.

Livestock are generally displayed in a round ring or pen at the local auction while buyers look on and call out bids. Animals are weighed immediately before or right after they enter the sale ring. Modern sale rings often display the total and average weight of a pen simultaneously while bids are requested by the auctioneer. Buyers generally don't see the cattle until they enter the ring but they develop a very trained eye for weight, yield, grade, and other characteristics.

Marketing costs of a local auction are relatively high due to increased transportation costs, higher shrink/weight losses, and the costs of maintaining facilities and staff to run a local auction. However, a local auction provides good liquidity to ranchers with sales occurring on a much more frequent basis than other marketing methods. Also, the auction insures the legitimacy of buyers rather than the seller as in a private treaty sale. The magnitude of strengths and weaknesses for a local auction are often site, animal, and season specific.

____________________19 ____

LIVESTOCK BILL OF SALE AND CONTRACT

This certifies that __________________________ of ____
full address and phone

has this date bargained and agreed to sell to __________________ of ______________________________
full address and phone

_____________________ head of _________ to be delivered F.O.B.__________________________________
location and method

on or before the ____ day of ________ 19___ at $_____ per head or at $_____ per cwt., to be weight on _____ hours

shrink or ____% shrink at _____ with _____% cut back. Received as part payment $ ______, with balance of $______

to be paid on delivery, I hereby guarantee title thereto, viz:

No. Head	Description	Brands	Location of Brands	Price Per Head

1. On the delivery date specified above, the seller hereby reserves the right to demand full payment for the described livestock by a) cash, b) wire transfer of funds to the seller's requested destination, c) cashier's check drawn on purchaser's financial institution, d) certified check drawn on purchaser's financial institution.
2. The seller further stipulates that title does not change on the above described livestock until the payment is made in full. Therefore, the seller retains title to the above described livestock until payment is made in full.
3. Should the purchaser fail to meet any of the above noted terms, the down payment will be forfeited to the seller.
4. All of the above stock is free from encumbrances, except as noted in paragraph 5 below, including taxes for year of delivery, and will pass federal and state inspection for interstate shipment. Health and brand certificates will be furnished to the purchaser, free of charge, on delivery.
5. The stock is subject to encumbrance(s) held by the following named person(s) with address and nature of encumbrances set forth as follows:

____

____

6. Time is of the essence in this agreement, and this agreement shall apply to and bind the heirs, executors, administration, successors and assigns of the respective parties and constitutes the entire agreement between the parties herein.
7. The law of the State shall govern the constriction and interpretation of this agreement.

(Seal)______________________________Seller

Witness ________________________________ ____
date *signature*

_________________________________Purchaser

Billsale.chr/file/5/20/90/pcr

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Source: Great Plains Beef Cattle Handbook, GPE-4115.4.

For example, many buyers may be bidding for heifer calves in the spring but few in the fall.

SPECIAL AUCTION

Special auctions are generally feeder cattle sales that are held seasonally or on an infrequent basis. A special auction usually has more publicity and promotional efforts to increase the number of sellers and buyers at the auction. A livestock association will often sponsor a special sale. The association can give greater credibility to the quality and quantity of livestock available for sale. Assuring buyers of quantity and quality is centered at increasing buyer attendance. An additional small commission fee is usually charged with a special auction to cover greater advertisement and promotional efforts.

Similar to local auctions, the magnitude of strengths and weaknesses are usually sale specific. If a special feeder auction occurs every year about when your calves are weaned, the liquidity of special auctions may be adequate. One disadvantage of following a rigid special auction marketing strategy is that you may sell all of your "crop" at the low price for the year. Spreading out the timing of sales can diversify some of the price risk associated with marketing, but may make shipping livestock more difficult and costly. Utilization of CME futures and options is one way ranchers can "enter the market" at different times and still ship all of your livestock on the same day.

COOPERATIVE ARRANGEMENTS

Cooperative arrangements for marketing can range anywhere from a formal cooperative agreement to a marketing "pool" with a rather loose commitment. Cooperative legislation was initiated in the early 1900s with the general goal of enabling producers to "empower themselves" to provide goods and services required by member patrons. The Capper-Volstead Act places no size on the market share that can be attained by a cooperative and be legal. Thus, all the cattle in Arizona could be marketed through one cooperative and not be subject to any anti-trust legislation. Ownership and control of a cooperative must be in the hands of those that utilize its services and business operations shall be conducted so as to approach a "cost basis." Cooperatives operate for a profit motive like a private company but the return on capital accumulations are limited. Profits are distributed back to member patrons through a dividend that is generally in proportion to the dollar patronage by members. Chief control of a cooperative lies with a Board of Directors elected by patron-owners. Voting is generally 1 vote for each member although some cooperatives vote in relation to dollar patronage. Liability of the cooperative is generally limited to the assets of the cooperative.

Cooperatives have not been a big tool for ranchers marketing livestock in the US. In 1986, it was estimated that 8% of all livestock and livestock products were sold through cooperatives. This compares relatively low to dairy products (83%), cotton (41%), fruits and vegetables (35%), and grains and soybeans (34%) (Kohls and Uhl). Nonetheless, they may still be the best avenue available for some ranchers at attaining top dollar for their products.

Obtaining the initial equity for something like a livestock cooperative can be difficult. The sale of common or preferred stock often provides capital for cooperatives but the market for such stock must come primarily from cooperative members. Preferred stock customarily has a fixed dividend and no voting rights. Although limited, it is often the best tool for attracting "outside capital." Various methods and rules apply from one association to another for owners withdrawing capital. Usually a member can sell his stock and/or earnings to another member, subject to approval of the board. Some cooperatives have a fixed time for redeeming stock certificates as well. This is often referred to as the "use of a revolving fund" since these funds generally do not accrue interest. Disbanding an entire cooperative can be a long and complicated process with many legal fees. Ranchers in an area need to know for sure that a marketing cooperative is what they want before making the commitment to start a marketing cooperative. USDA, Agricultural Cooperative Service has put together a 31 minute videotape on "How to Start a Cooperative." This videotape is a good starting place and something all ranchers should watch together as a group and discuss before taking the first steps to forming a cooperative. A copy of the videotape can be obtained by sending a $25 check or money order payable to Agricultural Cooperative Service, and mail to ACS, P.O. Box 96576, Washington, DC 20090-6576.

A more informal organizational structure for marketing livestock could be an association sale or "pool." An association or pool generally commits ranchers to bringing a specific product like yearling bulls, steer calves, bred heifers, lambs, or wool for a particular sale. The association spends money on advertising and soliciting buyers for everyone so that these costs can be reduced on a per unit basis. These costs are generally covered by charging a small percentage of the gross selling price. The success of association or pooling sales largely depends on the ability and reputation of assuring buyers that a sufficient volume of an identified class of livestock or livestock products will be sold. A legally binding commitment may be necessary for the initial sale years to attract a "competitively viable" number of buyers. Increasing buyer attendance is key to attaining higher sale prices and better ranch profits.

CHICAGO MERCHANTILE EXCHANGE (CME) FUTURES

CME futures is a method for hedging price risk that is similar in form to forward contracting. Because they are similar one may ask why utilize the CME? A chief reason for utilizing the CME is liquidity. A decision to sell can be made immediately knowing that the prevailing market price on the exchange will be received. The CME consists of many traders that are receiving buy and sell orders from individuals all over the world. Because all contracts are standardized, no differentiation is made between offers and bids. All bids and offers are made with vocal outcries so that all traders in the pit have equal price trading information. Standardization of contracts and equal information are necessary conditions for a market to operate in a price efficient manner.

The CME market is considered a "base point" or reference market for local markets throughout the world. Trading occurs for the months of January, April, May, August, September, October, and November for feeder cattle. Contracts trade in 50,000 lb. increments, up from 44,000 lbs. prior to January 1993. Because local markets follow the CME, a rancher can hedge by taking a position in the futures market that is opposite of his cash position. After January 1993, feeder cattle futures contracts can be "cash settled" to the new CME Composite Weighted Price for 700-799 pound a) Medium Frame #1 and b) Medium and Large Frame #1. Feeder futures contracts were previously settled to the U.S. Feeder Steer Price (USFSP) for 600-800 pound feeder steers as calculated by Cattle-Fax. The new cash settlement index is expected to have a lower basis variability than the previous USFSP index.

Some reasons why basis variability should be lower with the new index are:

1) The weight range has been narrowed from 600-800 lbs. to 700-799 lbs., eliminating more price variation due to weight.

2) The region from which sale transactions are used to calculated the index has been narrowed. Feeder cattle transactions have been reduced from 27 states to the 12 states of Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, North Dakota, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. A smaller and more homogeneous geographic region is expected to make the cash settlement index better for the feeding industry, but the impact of a reduced geographic region for Arizona's ranchers and feedlots is more ambiguous.

3) The new index is a true volume-weighted average price rather than a regional weighting formula. That is, there is no distinction between boundaries or cattle sold at a local auction, direct sale, or electronic market. Every pound of livestock sold has equal impact in determining the CME Composite Weighted Average Price. All direct and electronic sales included are quoted on an FOB basis, 3% equivalent standing shrink.

4) The description of cattle used in calculating the index has been changed. The new index will include livestock of Medium Frame #1 and Medium and Large Frame #1, as determined by Federal-State Market News reporters. The old criteria was a "60-80% choice grade criteria" that was inconsistent terminology for current USDA grading definitions.

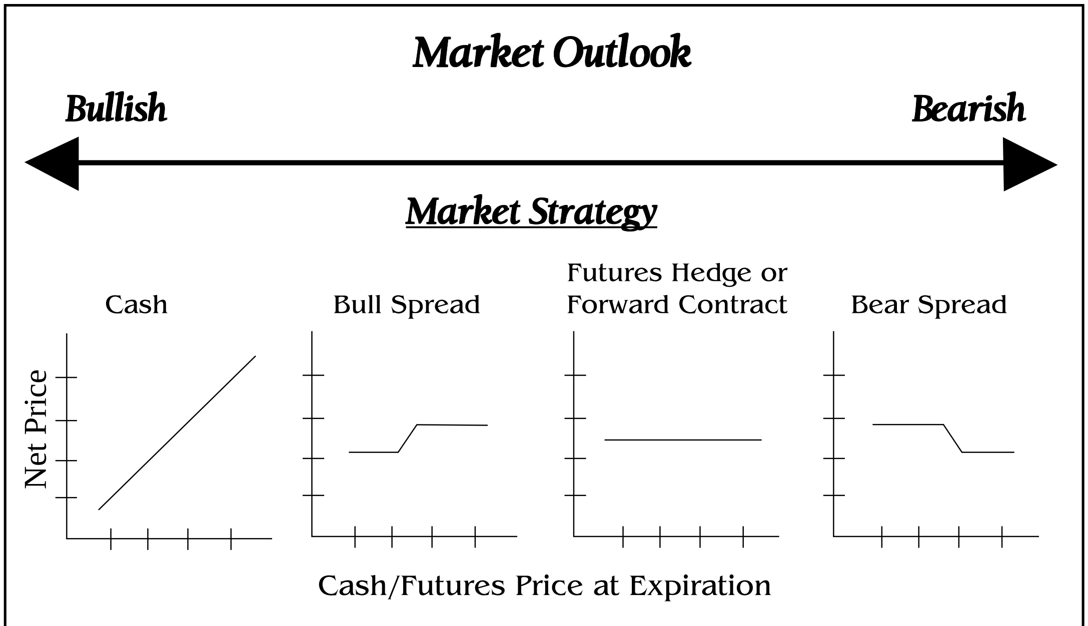
For hedging an October weaned calf crop in the summer, one could sell an October feeder contract in the summer through a local broker. Then at weaning in October, concurrently buy an October feeder contract while selling in the local cash market. If the differential between the cash market and futures (basis) is the same when October futures were sold as when they were bought back, a "perfect hedge" is said to have occurred. Thus, a $5 cwt. price decline in the cash market would be offset by a $5 cwt. gain in the futures market (i.e., buy back at $5 cwt. lower in the futures than sold for) with a constant basis or "perfect hedge." An increasing basis (cash minus futures) would be desirable for the rancher hedging with futures but a decreasing basis would decrease a rancher's net price received. Understanding what the basis will be when a hedge is completed is key to predicting a final net price.

As previously mentioned, one advantage of hedging with futures is that futures can allow one to enter the market at several different times throughout the year but still have one delivery date. Because futures are sold in 50,000 lb. increments, approximately 100 head of feeder cattle are "sold" with every contract. If one has a herd of 200, a strategy for reducing price risk could be to sell one futures contract in the spring and one later in the summer, rather than selling both at the same time in the spring or summer.

Because hedging with futures "locks in a price" the net price received will only be affected by changes in the basis rather than the general price level. This is desirable when the price level is declining but prices can increase too. Not selling 100% of your anticipated feeder sales on the futures market is one way of reducing the "risk" of not benefiting from price increases in the market. But another approach is to hedge utilizing CME options.

CHICAGO MERCHANTILE EXCHANGE (CME) OPTIONS

An option is the right but not the obligation, to sell or buy a commodity traded on the futures market for a limited time period at a specified price. In order to obtain the right to sell feeder cattle or live cattle futures (put option) on the CME at a prespecified price level or strike price, a premium must be paid. A put option works very much like auto or accident insurance. The premium you pay for auto insurance will depend on the driving record of other drivers in your class (e.g., neighborhood, age, distance of daily commute) and level of insurance. Similarly, the premium you would pay for a put option depends on how volatile market conditions have historically been and the level of insurance or strike price (how much above or below current futures prices). More distant time horizons will require a higher premium than nearby contracts, due to more uncertainty. If feeder cattle futures remain or fall below the previously specified strike price, a put option will be exercised like an insurance claim would be filed if one had an auto accident. That is, futures can be sold at a higher price (strike price) than the current futures price so the option is exercised. If futures rise about the strike price purchased, the option is left to expire and the cost of the premium is absorbed in the same way that an auto insurance holder absorbs the cost of a premium when a policyholder is not involved in any accidents. If prices drop, a put option will give price protection much like an auto insurance policy provides coverage for an auto accident. The amount of coverage in a put option depends on the strike price (i.e., higher the strike price the higher the premium and level of coverage) and time period covered.



MARKET OUTLOOK

An individual's financial position, risk aversion, market outlook, and personal preferences need to be accounted for in developing a marketing plan. The figure above illustrates how market strategy and tools utilized will differ depending on a rancher's market outlook. Market strategies of cash sale, bull spread, forward pricing, and bear spread are compared.

Cash Marketing: A bullish market outlook is consistent with the cash marketer since the rancher receives the full benefit of any price advances. Cash marketing is appealing in that minimal transaction costs are required, and the method is straightforward and familiar. On the down side, the rancher also absorbs the full risk of any price declines in the market. Another disadvantage is that a rancher can only sell when delivery is possible. This limits the ranchers ability to reduce price risk. If a rancher can market livestock throughout the year, cash marketing is somewhat diversified and risk averse in that an average price somewhere between the high and low seasonally adjusted price for the year is realized. But marketing a few animals at a time throughout the year has increased round-up, transportation, calving, and other management considerations that generally make this strategy prohibitive. Other price risk management tools that don't require delivery to "enter the market" are briefly described below.

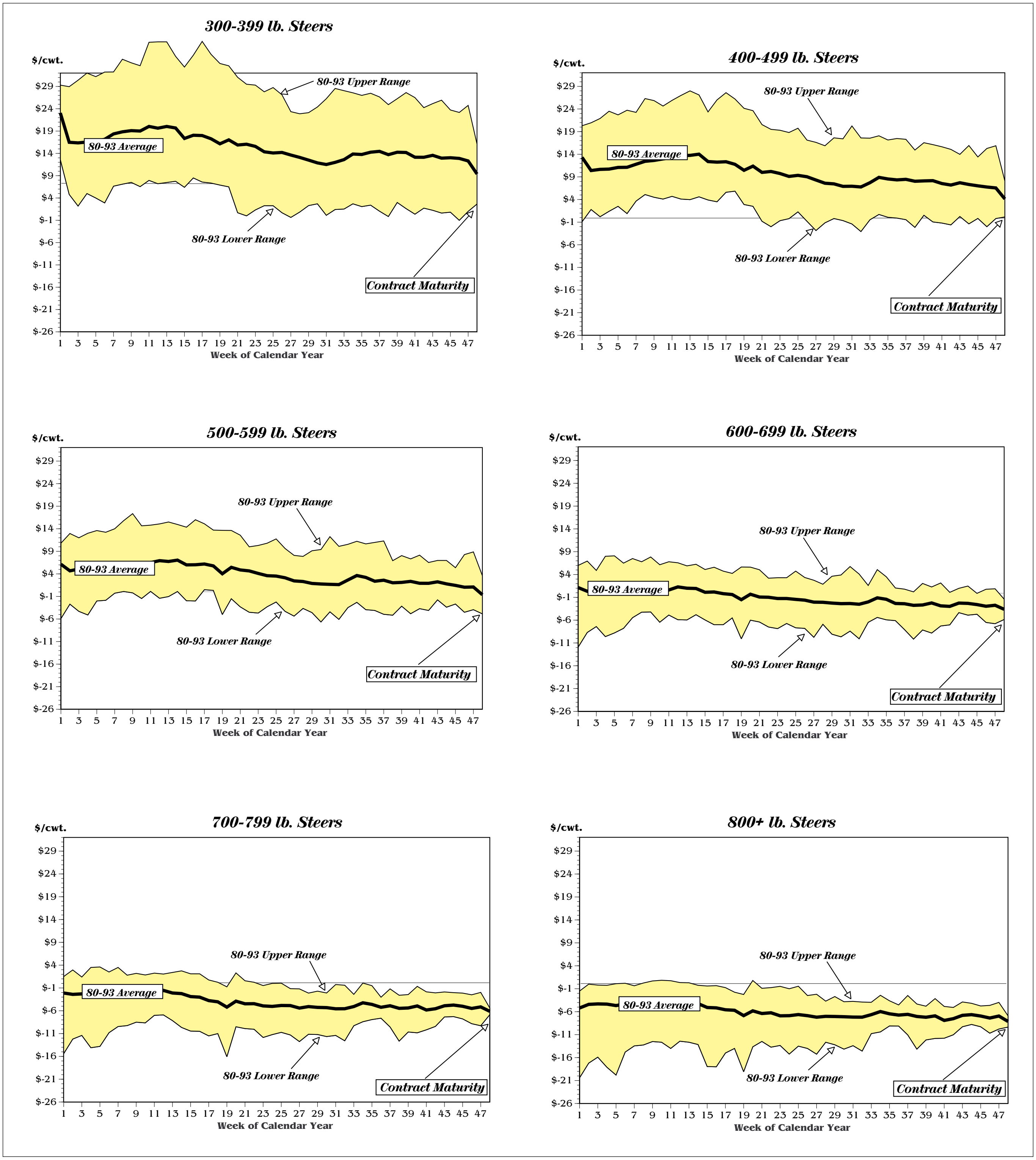
Bull Spread: Bull and bear spreads are very common market positions taken by future traders and equivalent positions are available to ranchers. A bull spread is appealing in that a rancher is protected from a price decline but can still benefit from higher prices, albeit less than the cash marketer if prices increase a lot. A rancher can take a bull spread position by: 1) writing a call option (right to buy at a specified strike price) for say November with a strike price that is above current November Futures, and 2) buying a November put option (right to sell at a specified strike price) that is below the November Futures price. The spread will be determined by how much the strike prices of the call and put options differ. In writing a call option, one receives a premium — amount associated with taking the risk that November Futures will increase above the specified strike price before November. ***The premium received from writing the call option can offset all or most of the premium required for purchasing the put option.*** But when writing a call option, margin calls have to be made if November Futures advance above the strike price. Losses incurred when the market advances above the call option's strike price are offset by advances made from feeders on the ranch that will be sold in the spot market. This is why the figure shows a net price ceiling for large market advances. Similarly, the net price received is a price floor for large market declines. The put option purchased increases in value as the market declines, offsetting losses incurred from selling feeders in the spot market at a lower price.

Forward Pricing: As described earlier, forward contracting or hedging with futures are two common ways to "lock in a price." Forward contracting has a simple and straightforward approach with appeal similar to cash marketing. Forward contract specifications can be written so that a rancher's net price is known for certain when the contract is signed, providing weight, and specified standards are met. Pricing terms should describe a schedule of discounts and premiums that is at least as detailed as that described in the "Livestock Bill of Sale Contract" discussed under private treaty sales. Forward contracting is no better than the reliability of the contractor and terms specified. Hedging with futures has an edge over forward contracting in liquidity. That is, numerous buyers and sellers trade in a competitive environment on the Chicago Merchantile Exchange, insuring that a fair market price is obtained whenever buy and sell decisions are made.

Bear Spread: A bear spread uses the same tools as a bull spread. A rancher can take a bear spread position by: 1) writing a call option for a strike price that is below the prevailing November Futures price and 2) purchasing a November put option that is above the current November Futures price. As above, the magnitude of the "spread" will be determined by how much the strike prices of the put and call options differ. The spread is bearish since the strike price of the put purchased is above the strike price specified on the call written. Both put and call options are "in-the-money" since they both have value if exercised now. The put and call options for a bull spread are both "out-of-the-money" since they have no immediate value if exercised. Most options are traded out-of-the-money so that trading is often very thin for a bear spread. A licensed broker can provide up-to-date information on the volume or liquidity for a specified option. As above, market declines are offset by an increase in value from the put option purchased and market advances are reduced by decreases in value from the call option written.

When hedging with futures or following a bear or bull spread market strategy using options, a rancher's net price can be reduced or increased from basis (cash minus futures) fluctuations. If the basis declines (increases), the net price received by the rancher will decrease (increase). The basis for Arizona steers and heifers of varying weight classes are described for feeder contracts of November and May in Figures 1 and 2, respectively, on the following pages. These graphs illustrate that the basis can vary greatly depending on sex, weight, and year. However, the range in basis values for 700-799 lb. steers, what

Figure 1. November Basis (Cash-Futures) Range and Average, 1980-93.



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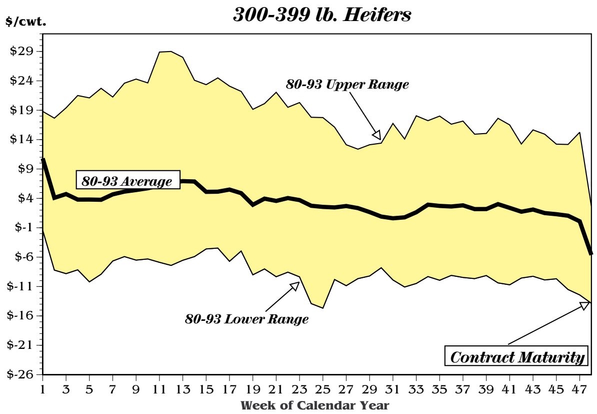
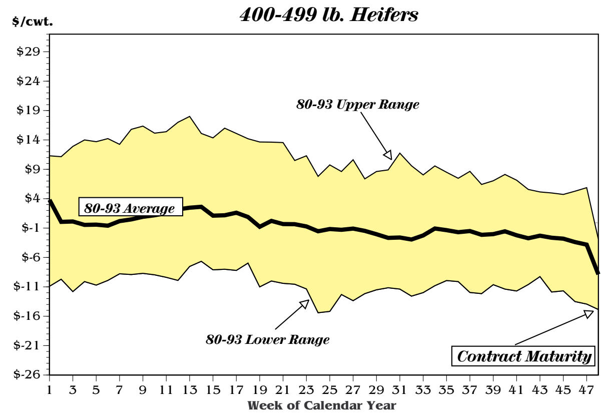
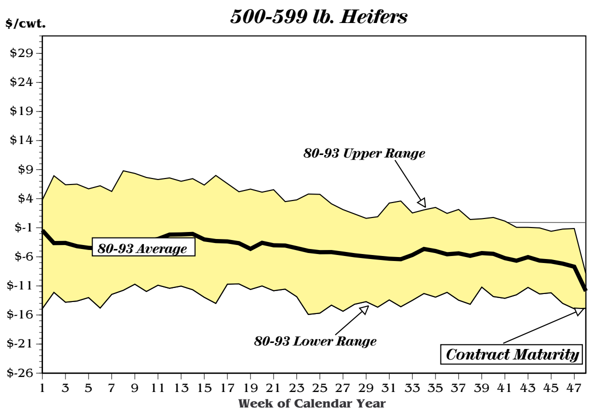
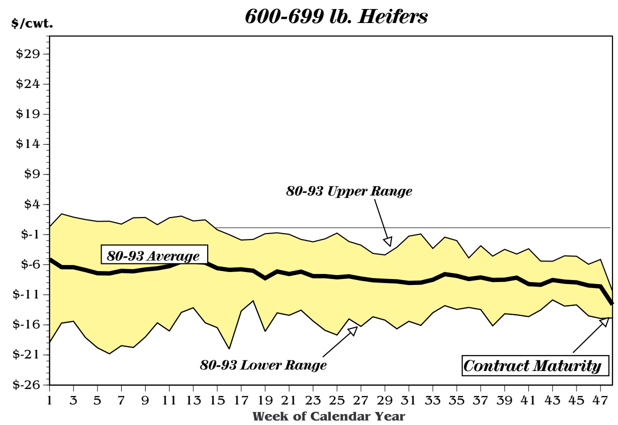
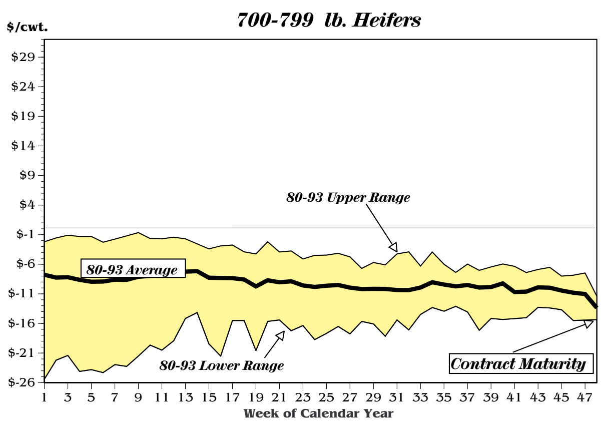










Data Sources: Chicago Merchantile Exchange and Cattle-Fax.

Figure 2. May Basis (Cash-Futures) Range and Average, 1980-93.

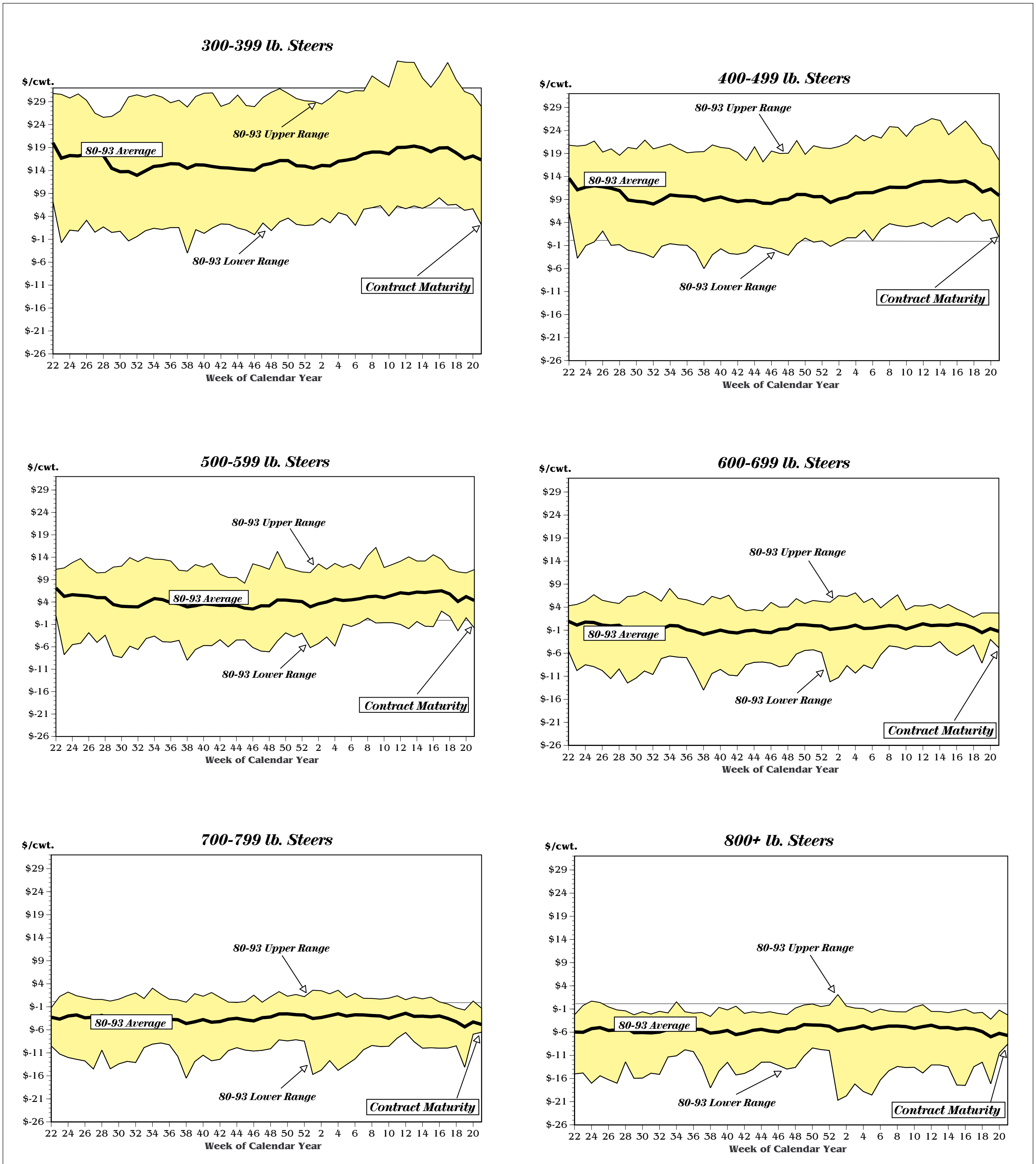
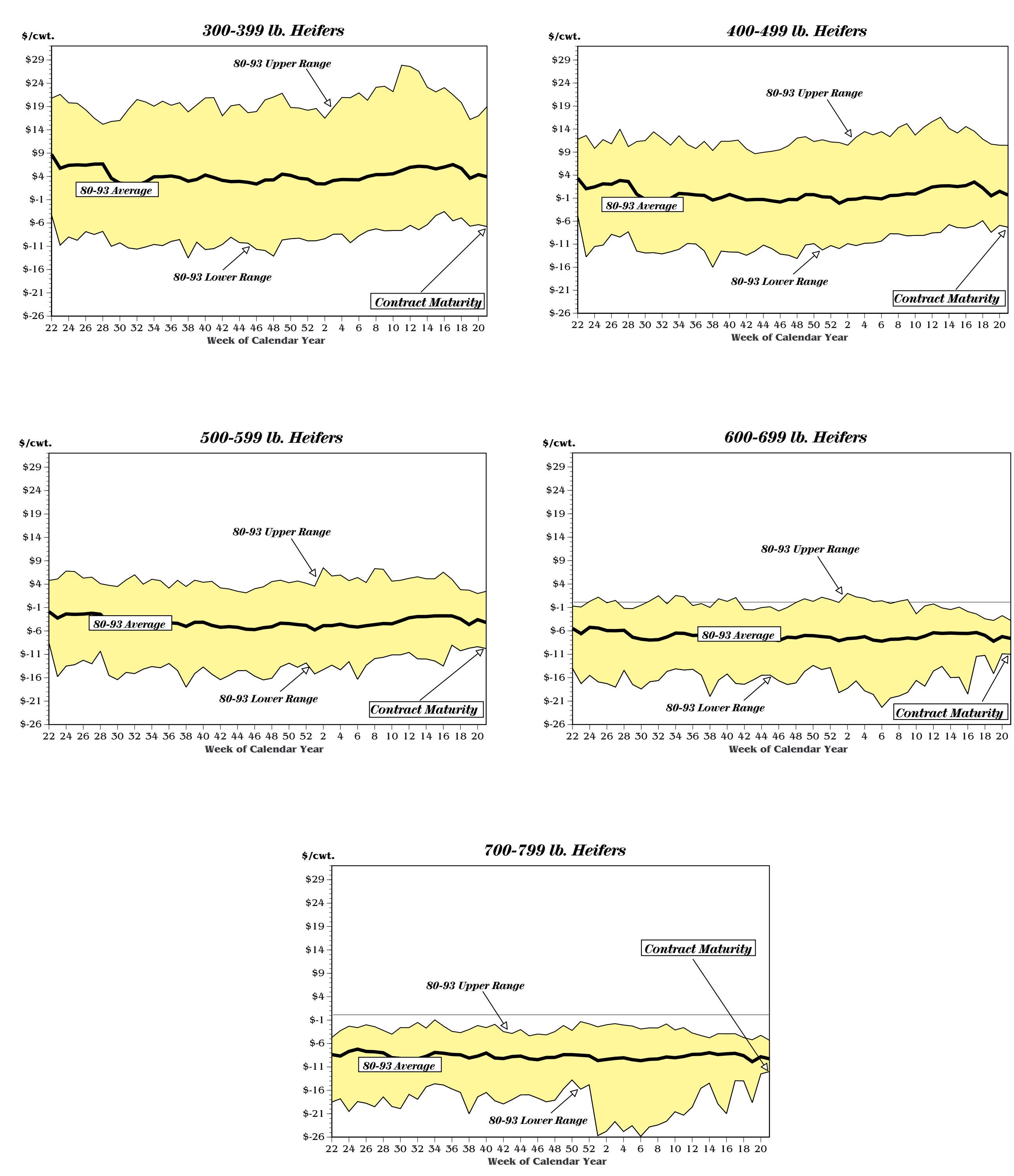


Figure 2 (continue)



Data Sources: Chicago Merchantile Exchange and Cattle-Fax.

the futures market primarily reflects, has been quite narrow. Average basis values shown between 1980 and 1993 for the calendar week of the year you plan to sell your steers or heifer give a reasonable estimate for calculating an expected net price.

For example, in mid-November (week 46) the average basis for 400-499 lb. steers is $6.75/cwt. If in March the November feeder cattle futures is trading at $80.00 cwt., a net price of $86.75/cwt. would be a reasonable price estimate for hedging with futures. November futures would be sold at $80.00 in March. Then, feeder steers weighing 400-499 lbs. would be sold in mid-November locally at the same time the November futures contract is bought back. If the cash price is $6.75 above the futures as anticipated, a net price of $86.75 (less a small commission fee and some interest accrued or expensed from margin calls) is realized by the rancher. If the cash price were only $2.00 above the future in November, then the net price received would decline by $4.75. The difference between the cash and futures market or basis is the key factor rather than the overall price level. Gains (losses) in the futures market are offset by declines (advances) in the cash market for all livestock hedged with a futures contract, if the basis remains constant.

Many other market tools and strategies are available than the few briefly described. Combinations of cash and hedging with futures can attain similar outcomes to the bear, and bull spreads described. The range and number of strategies available is only limited by the understanding and creativity of every marketer.

Margin calls may be required for hedging with futures or writing a call option. One reason the purchase of a put strategy has appeal is that no margin monies are ever required. But premium costs can add up with a put strategy. It is important that your banker or source of financing understands your hedging strategy if margin calls are a possibility. A hedging strategy can turn sour for the rancher if adequate cash is not available to meet margin expenses. Also, the hedging legitimacy of writing a call option and receiving a premium may be under question by the IRS. This may require the consultation of a tax advisor and futures broker since each individual situation can vary.

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Table 1. Pros and Cons of Marketing Methods

Method	Advantages	Disadvantages
Cash Marketing	* Full benefit of price advances.	* Only sell when delivery is possible. * Full risk of price declines in market. * Basis risk.
Electronic Marketing	* Lower costs of shipping, inspecting and buying cattle. * Standardized terms, more buyers—increased price efficiency.	* Infrequent sales. * Discounts likely for small lots.
Private Treaty	* Terms can be tailored to specific situation. * Can develop a long-standing reputation and business relationship.	* Few buyers may be interested in making a bid. * Integrity of buyer can be question-able regarding settlement price.
Local Auction	* Auction insures legitimacy of buyers. * Frequent sales.	* Transportation, shipping, and selling costs high.
Special Auction	* Target buyers for a particular sales.	* Special sale may be a “dud”-may be unsatisfied with sale price.
Cooperative Arrangements	* If cooperative is successful, returns will go back to member patrons. * Cooperation may increase number of buyers.	* May be difficult to get all ranchers to agree on business decisions. * Obtaining equity for forming a cooperative can be difficult.
Forward Contracting	* Can be tailored to specific situation and needs. * No basis risk.	* No upside price potential.
Hedging with Futures	* Widely traded competitive market. * Hedging costs minimal.	* No upside price potential unless basis change is favorable to target basis level. * Basis risk. * Margin monies required.
Put Option Hedge	* Allows for significant upside price potential. * No margin expenses.	* Premium costs can be significant for your minimum price targeted. * Trading sometimes thin. * Basis risk.
Bull Spread	* Premium costs minimal. * Allows for limited upside price gains. * “Wide spreads” generally plausible.	* Trading sometimes thin. * Basis risk. * Margin monies required.
Bear Spread	* Premium costs reduced. * Allows for limited gains in a bearish market.	* Trading generally very thin. * Magnitude of “spreads” limited. * Basis risk. * Margin monies required.

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HEDGING POTENTIAL IN CALIFORNIA CATTLE MARKETS

Steven Blank [1] and Dawn Thilmany [2]

Introduction

The potential of any futures market to serve as an effective hedge against price risk depends on the relationship between that market's futures price and the local cash price relevant to an individual hedger (Blank et al., p. 217). However, cash prices of commodities vary over time, space, and product form (Bressler and King), therefore each futures market's potential as an effective risk management tool will vary for hedgers pursuing different objectives and involved in different temporal, spatial and product markets.

The goal of this paper is to demonstrate the relationship between an individual hedger's objectives and the potential for successful hedging in various markets and to analyze these relationships for California cattle markets. The results derived from a simple model are used in an empirical analysis of the hedging potential in the case of California cattle markets. These results are intended to help readers understand the influence of price behavior over space, time and product form on the effectiveness of using a futures market as a hedging tool. The results also offer guidance to hedgers in the specific cattle markets evaluated.

The Objective of Hedging and Hedging Potential

For decades, it was assumed that the objective of hedging has to reduce price risk. However, if hedgers are viewed as investors, the motive for all market activities is to earn a return. Risk associated with an investment is considered by risk averse investors to be a by- product of market activity, not the object. The incentive for any action is the expected return, whereas risk is a disincentive. With this perspective it is unrealistic to assess business decisions using risk as the only criterion. This view of all investors being profit maximizers[1] does not preclude hedgers from acting like risk minimizers at some points in time. For example, if stable prices are expected, all hedgers behave as risk minimizers during that period even though they are still maximizing utility.

Since profit is defined as a function of cash and futures prices, factors which influence hedging objectives and hedging potential include a hedger's risk aversion, confidence in a forecast of expected prices, correlation between cash and futures prices, the nature of basis, and the ratio of basis variance to cash price variance. This analysis focuses on the correlation between cash and futures prices, the nature of basis and the Variance Ratio (see Blank and Thilmany). Together these three statistical measures illustrate how effective hedging is as a tool to accomplish either of a hedger's potential objectives.

Hedging Potential Across Time, Space, and Product Form

Differentiation of products can be based on elements of a product's form, geographical location, or the time it is available to the market (Bressler and

[1] Profit maximizers are substituted for utility maximizers here, with the understanding that risk considerations enter into their business decisions.

King). The California cattle industry is especially interesting because cattle are less storable and more expensive to transport than most commodities. Commodities which are storable and relatively inexpensive to transport, such as corn, have a basis[2] which can be reliably estimated using the cost of storage and transportation. However, delivery on cattle futures contracts is not economically feasible for California producers and, consequently, basis will not necessarily converge to any specific value at a futures contract's maturity date.

Commodity prices are related across time by storage costs, but cattle is not truly "storable." Some production flexibility allows producers to market their cattle in more than one time period, so prices are expected to be somewhat related across seasons. However, the change in basis across seasons (i.e., April vs. October contract maturities) may differ.

There is potentially a separate spatial equilibrium between California markets (where intra-market transportation may be feasible) and more distant markets. As a separate spatial market, the California industry will share some widespread shocks with other, U.S. markets, but there are factors that affect California only. Although prices in a local area may be related to prices in regional markets, the price in a local market depends on local supply and demand and the costs of transportation into or out of the local market (Bressler and King).

A market may also be viewed as extending through alternative and successive forms of a product with a consistent structure of prices interrelated through processing costs (Bressler and King). For this reason, feeder and slaughter animal contracts will have related, but not perfectly correlated cash and futures prices. Also, there are likely to be unique market conditions for alternate product forms such as steers versus heifers.

Empirical Analysis

The theoretical analysis discussed in the previous sections and derived in Blank and Thilmany will be illustrated by presenting empirical estimates for three measures of hedging potential for the California cattle industry. There are basically three regions with significant cattle production in California: the Southern San Joaquin Valley, the Northern San Joaquin Valley, and the Sacramento Valley.[3] This study will use market prices from Visalia, Stockton, and Cottonwood as the available cash price for producers in each of these regions, respectively, although some inter-regional transportation may occur.

The product specifications of each contract and delivery point used are listed and defined in Table 1. Futures prices from the Chicago Mercantile Exchange (CME) and monthly average spot prices (USDA) from each of the regional markets between January, 1987 and August, 1991 are included in the sample. To illustrate temporal price differences, Table 1 includes the mean futures price and the mean basis for both the April and October contracts for all cattle products and locations. In general, these statistics show two primary results: the October futures price is, on average, consistently below the April futures price and, the October mean basis is consistently less than the April mean basis for these California markets.

[2] "Basis" is defined as the difference between futures and cash prices of a product.

[3] These regions include the mountains on both sides of the valley. For example, the Sacramento Valley includes cattle sold in the Sierras to the east and the Coastal Range to the west.

TABLE 1-CONTRACT DEFINITIONS AND SUMMARY STATISTICS

Seasonal Contract	April Contract		October Contract	
Contract, Product and Delivery Location	**Mean Futures Price**	**Mean Basis***	**Mean Futures Price**	**Mean Basis***
Cottonwood Slaughter Bulls, Utility	$72.54	$13.16	$69.57	$10.19
Cottonwood Slaughter Cows, Utility	$72.54	$25.05	$69.57	$21.88
Cottonwood Feeder Steers #1, 600-700 lbs.	$79.65	-$3.92	$78.87	-$4.71
Cottonwood Feeder Heifers #1, 500-600 lbs.	$79.65	$1.92	$78.87	$1.14
Stockton Slaughter Steers, 1100-1300 lbs.	$72.54	$0.12	$69.57	-$2.85
Stockton Slaughter Heifers, 100-1200 lbs.	$72.54	$1.87	$69.57	-$1.10
Stockton Feeder Steers #1, 600-700 lbs.	$79.65	-$2.28	$78.87	-$3.06
Stockton Feeder Heifers #1, 500-600 lbs.	$79.65	-$1.47	$78.87	-$2.25
Visalia Slaughter Steers #2 & #3, 1100-1300 lbs.	$72.54	$0.03	$69.57	-$3.00
Visalia Slaughter Heifers #2 & #3, 1000-1200 lbs.	$72.54	$1.57	$69.57	-$1.40
Visalia Feeder Steers #1, 600-700 lbs.	$79.65	$0.27	$78.87	-$0.39
Visalia Feeder Heifers #1, 500-600 lbs.	$79.65	$0.62	$78.87	-$0.12

Sample: Monthly data from January 1987 to August 1991.
*Where basis is defined as the difference between the futures and cash price.

The nearby futures contract price series was used to estimate the long-run (five-year average) price correlations and Variance Ratios (VRs are defined as basis variance divided by cash price variance; see Blank and Thilmany). The price correlations were less than one in the majority of the cases. The estimated Variance Ratios were greater than one in 42 of the 96 cases, (and significantly greater in six cases).

The systematic nature of basis can be measured several ways, based on various theories of basis. The primary criteria of this study was to estimate whether basis has systematic or seasonal patterns that producers can predict. In this analysis, an equation to estimate basis was developed for each location that included lagged values of basis and a time trend, as well as other information available to producers (see Blank and Thilmany).

Statistical estimation of the cattle price data was performed and four tests were used to measure whether a contract exhibited systematic basis. Using the statistical results (see Blank and Thilmany), the hedging potential for various combinations of market attributes was broadly categorized. Exhibit 1 summarizes the likely hedging objective and potential for the twenty-four combinations of product form, hedging season and cash market location.

Applications of Results

The empirical results of this study have useful applications for the California cattle market. There are many similarities in potential hedging objectives across location, time and product form, as demonstrated by the large number of cases where the best potential objective for hedging is utility maximization (see Exhibit 1). Yet, it is interesting to note that there are distinct differences in the potential for various hedging strategies throughout the three

Exhibit 1 - Potential Hedging Objectives Among Space, Time and Product Form Combinations

Contract Combination	Potential Objective	Supporting Evidence
Cottonwood Slaughter Bulls,		
April Contract	Utility Maximization	High VR, systematic basis
October Contract	Limited potential for utility max	High VR, High correlation, systematic basis
Cottonwood Slaughter Cows,		
April Contract	Utility maximization	High VR, systematic basis
October Contract	Utility maximization	High VR, systematic basis
Cottonwood Feeder Steers,		
April Contract	Risk minimization	Low VR, High correlation, non-systematic basis
October Contract	Utility maximization	High VR, systematic basis
Cottonwood Feeder Heifers,		
April Contract	Both objectives possible, but risk minimization may dominate	Low VR, High correlation, systematic basis
October Contract	Utility maximization	High VR, Low correlation, systematic basis
Stockton Slaughter Steers,		
April Contract	Utility maximization, but only limited potential	High VR, Low correlation, non-systematic basis
October Contract	Utility maximization	High VR, Low correlation, systematic basis
Stockton Slaughter Heifers,		
April Contract	Limited potential for hedging	High VR, non-systematic basis
October Contract	Utility maximization	High VR, Low correlation, systematic basis
Stockton Feeder Steers,		
April Contract	Utility maximization	High VR, systematic basis
October Contract	Utility maximization	High VR, Low correlation, systematic basis
Stockton Feeder Heifers,		
April Contract	Utility maximization, but only limited potential	High VR, High correlation, systematic basis
October Contract	Utility maximization	High VR, Low correlation systematic basis
Visalia Slaughter Steers,		
April Contract	Limited potential for hedging	High VR, non-systematic basis
October Contract	Utility maximization	High VR, Low correlation systematic basis
Visalia Slaughter Heifers,		
April Contract	Utility maximization, but only limited potential	High VR, Low correlation non-systematic basis
October Contract	Utility maximization	High VR, Low correlation systematic basis
Visalia Feeder Steers,		
April Contract	Utility maximization	High VR, Low correlation systematic basis
October Contract	Limited potential for hedging	High VR, High correlation
Visalia Feeder Heifers,		
April Contract	Risk minimization, but only limited potential	Low VR, High correlation non-systematic basis
October Contract	Both objectives are possible	Low VR, systematic basis

regional markets included in this study, as well as among product forms and seasons.

Cottonwood

The Cottonwood region illustrates how independent a local market's prices can be from futures prices determined at a distant, centralized market. This independence is realistic since Cottonwood is the most remote of the three California delivery points and because this local market deviates from the futures contract with respect to product form. In the case of slaughter cattle, Cottonwood trades utility beef from slaughter cows and bulls instead of higher grade beef from steers and heifers. This deviation also may account for the weak relationship between local cash and futures prices.

Among the different product forms (feeder vs. slaughter) and delivery dates (October vs. April) there are few differences in the potential for different hedging objectives by players in the cattle futures market. With the exception of the April contract for Feeder Steers and Feeder Heifers, potential hedging objectives focus on utility maximization. As evident by the high variance ratio and systematic nature of the basis in the majority of contracts, seasonal basis patterns dominate the relationship between cash and futures prices.   In this case, hedging would not guarantee a fixed price at the local market, so utility maximization, rather than risk minimization, is the only potential objective.

It is interesting that the two exceptions to the norm in the Cottonwood market occur in the April feeder markets. The market conditions surrounding these two contracts allow for hedgers to effectively minimize their risk. Theoretically, the potential to minimize risk using the April contract for both feeder markets is primarily based on the low variance ratio, which shows that the hedger's basis is less volatile than the cash market.

In terms of product form, it is possible to retain feeder cattle until they reach slaughter weight, unlike slaughter cattle that will only slightly increase (or possibly decrease) in value if left in the feedlot. The option to process feeder cattle into a different product form (slaughter cattle) makes another cash market available in the future, if local cash prices are not favorable. This is especially true in the case of April contracts as many cattle producers only have resources to feed out during the summer season when grazing land is available.

Cottonwood offers good potential for hedgers in general. The opportunities for utility maximizing hedgers are strong in all but three cases evaluated here. Two of the exceptions are the April Feeder Heifer and Steer contracts which demonstrate good potential for risk averse hedgers. The other anomaly, the October Slaughter Bull contract, is the only case with limited potential for any hedging objective.

Stockton

Stockton is similar to Cottonwood in that the prevailing potential objective for hedgers is utility maximization. However, the Stockton market offers no potential for the producers who use hedging as a risk minimization tool, and offers only limited potential for utility maximization in several specific contracts. The majority of the contracts demonstrate low correlation, as well as high variance ratios between cash and futures prices. These market conditions make it possible for hedgers to maximize profit, but not to effectively minimize risk, meaning that relatively sophisticated hedging strategies are needed.

Further, the April Slaughter cattle contracts and April Feeder Heifer contracts display limited potential for either hedging objective. The most clear case is the April Slaughter Heifer contract where the market conditions make it difficult for a hedger to benefit from using the futures market. The April Feeder Heifer and April Slaughter Steer contracts have limited potential for utility maximization by hedgers for two separate reasons. April Feeder Heifer cash and futures prices have a strong and predictable relationship. However, the basis is more variable than the relatively stable cash price which indicates little potential for profiting from hedging and the chance of increasing the hedger's risk. The April Slaughter Steer futures and cash prices have a weak and unpredictable relationship which allow for little profit maximizing or risk minimizing potential.

Stockton offers good opportunities for utility maximization in some cases, but there are several markets where limited potential for either objective exist. In sum, hedging in these markets may not be advisable except for the most experienced of traders. Price risk may be better managed using forward contracts, if available.

Visalia

The Visalia markets have the most diversity with respect to the availability and type of objective available to hedgers. There appears to be some similarities among seasonal contracts and product forms. The April Slaughter contracts have potential for profit maximization, whereas April Feeder contracts have potential for risk minimization. The October Slaughter contracts present opportunities for profit maximization, whereas October Feeder Heifers may be effective for both objectives and Feeder Steers have limited opportunities for either objective.

Similar to the Cottonwood market, the April Feeder contracts both offer an effective means for hedgers to minimize risk. The strong, yet unpredictable, relationship between cash and futures prices, as well as the relatively low variability of basis, makes risk minimization possible. The market conditions which may affect the relationship between cash and futures prices are explained above in the Cottonwood section.

Similar to the Stockton case, the Visalia October Slaughter contracts offer hedgers the ability to maximize profits. On the other hand, the April Slaughter contracts and the October Feeder Steer contracts have only limited potential for either objective because of weak, unpredictable relationships between futures and cash prices. The most general case is the October Feeder Heifer contract where both hedging objectives may be viable because local cash price changes are seasonally correlated with changes in the futures market.

In general, Visalia has a diverse set of opportunities for hedgers. Similar to Cottonwood, April Feeder contracts offer risk minimizing hedgers good potential and October Slaughter contracts present hedging possibilities to utility maximizing hedgers. The October Feeder Heifer is unique in that it is the only case which offers good potential to both risk minimizing and utility maximizing hedgers. The remaining cases are not reliable markets for hedgers to participate in as they offer little potential for either objective.

There are also some similarities across hedging seasons. Hedging in October is best for traders pursuing the broader objective, utility maximization, because the chance of hedging failures is lower.

Across locations, Cottonwood has the best potential for successful hedging, while Stockton offers little potential for risk minimization, and Visalia has volatile potential. The totals for the four product forms clearly indicate that feeder markets offer more hedging potential than do markets for slaughter animals. Risk minimization may be pursued successfully in either feeder animal market while California slaughter animal markets offer no apparent potential for risk minimization and significant chances of hedging failure.

Conclusions

The California cattle industry provides a unique opportunity to examine the potential for hedging by producers for whom delivery to the futures market is not practical. Although there is evidence of correlation between futures and local cash market prices, this relationship varies across time, space, and product form. The variable nature of the futures-cash price movements reduces the potential for successful hedging for California cattle producers pursuing price risk minimization. While potential for utility maximization (which requires sophisticated hedging strategies) is widely offered by the markets analyzed, the more restrictive objective of risk minimization can be pursued successfully much less often.

These results may provide insight to the issue of why producers have been reluctant to use the futures market for hedging. If risk minimization is the objective of hedgers who are aware that achieving it is questionable in these markets, then it is reasonable for them to avoid hedging. Ultimately, the results of this study imply that increased hedging activity will occur more rapidly if producers are educated as to how a broader definition of hedging, that involved in utility maximization, can be incorporated into their business decision making.

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LIVESTOCK HEDGING USING FUTURES OR OPTIONS

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Livestock Futures and Options

Commodity options and futures are two of the tools producers can use to reduce the price risks they face in agricultural markets. Whereas futures markets are familiar to many livestock producers, options require some explanation. This paper will introduce options trading by describing the advantages and disadvantages of this marketing tool compared to those of hedging with futures. First, futures trading is described briefly. Then, options on futures are discussed and their use as a hedging tool is illustrated. Finally, the processes of hedging with futures and options are compared.

Hedging With Futures

Hedging normally refers to holding positions in both cash and futures markets simultaneously. The goal of a hedger is partly to reduce the risk of holding a cash inventory by "locking in" the price to be received or paid. For a livestock producer, hedging usually involves locking in the value of animals to be sold in the cash market some time in the future by selling futures contracts in the present. The hedging process is illustrated later in this paper in an example.

Trading futures contracts is simple with the assistance of a broker. To place a hedge, a livestock producer must only make one telephone call to the broker handling his account. The quantity of cattle, delivery date and location are standardized on each futures contract, thus making trading easy. The producer tells the broker how many pounds of live beef is to be sold and the month in which they are to be delivered and the broker relays that information on to the futures exchanges in the form of a trade order. Live cattle futures contracts, for example, are available with delivery dates in February, April, June, August, October, and December of each year. Each contract covers a standardized quantity of 40,000 pounds and specifies quality requirements. Standardized delivery locations are specified also, however, none of those locations are in California, thus hedgers here must close their futures market positions by making an equal and offsetting trade. For example, if a producer established a hedge by selling a December 1996 live cattle futures contract, he must *buy* a December 1996 live cattle contract to close his futures hedge position. The hedge's net effect would be to add to (or subtract from) the cash market receipts, making the final value of the inventory approximately equal to what it was at the time the hedge was placed, thus reducing the risk of decreases in that inventory value.

What is an Option?

An option is a contract that gives the buyer the right, but not the obligation, to buy or to sell a futures contract at a specific time period. The right to sell at a fixed price is a "put" option and the right to buy at a fixed price is a "call" option. The price at which the underlying futures contract may be bought or sold is the "exercise" or "strike price".

Although most option positions are closed when the buyer makes an offsetting trade, option contracts can be *exercised*. For example, assume that the right to sell one February live-cattle futures contract at 80 cents/lb is available from an option seller for 5 cents/lb. Such an option would be a put option (the right to sell) with an 80-cent *strike price* and a premium of $2,000 (5 cents/lb times 40,000 lbs). A cattleman who purchased such a put option could exercise the right to sell at 80 cents any time up to the expiration date.

Assume February live-cattle futures are 72 cents/lb during December and the rancher exercises the put option. The broker is so instructed and the commodity exchange assigns the rancher one short (sell) position in February live-cattle futures at the strike price. To complete the transaction, the rancher immediately buys back the futures contract at the current market price of 72 cents, making an 8-cent/lb gross profit (3-cent net profit after subtracting the 5-cent price of the option).

On the other hand, if February live-cattle futures rise above 80 cents/lb at marketing time, the rancher will not exercise the option since the market price is higher than the option exercise price. In this situation, the rancher lets the option expire. In either situation, the seller of the option keeps the premium.

Similarly, a cattle buyer could pay $2,000 for a call option—the right to *buy* February live-cattle futures at a price of 80 cents/lb at any time between the purchase and expiration date of the option. The buyer would let the option expire if cash prices stayed below the strike price until February because cattle could be purchased cheaper in the cash market. However, if cattle futures prices are more than 80 cents/lb at the time of the desired purchase, the buyer would exercise the option to purchase cattle futures at 80 cents/lb, thus saving the difference between the available cash price and the lower option price (minus the premium).

Comparing Options and Futures

The two illustrations above point out the major differences between options and futures contracts.

- A *put* option establishes a minimum selling price but does not eliminate the opportunity to receive higher market prices.
- A *call* option establishes a maximum buying price but does not eliminate the opportunity to pay lower market prices.
- A *futures* contract sets a relatively fixed net cash price since futures market gains or losses are approximately offset by cash market losses or gains.

Options, therefore, permit producers to establish desired selling prices without sacrificing their potential to benefit if market prices increase after the put option is purchased. If prices rise, the option is not exercised and the user loses only the premium. If prices fall, the user can exercise the put option and obtain a price higher than what the market is offering. Thus, with a put option, a user eliminates most downside market risk while retaining the opportunity to benefit from higher prices.

With a call option, a user eliminates price risk above the exercise price while retaining the opportunity to buy at lower market prices. Therefore, options provide ranchers and other users with insurance against undesirable price changes while allowing them to benefit from favorable price changes.

The degree to which ranchers and other agribusiness people will use options depends largely upon the cost of the option (the premium). As in any other "insurance policy," agricultural commodity options offer a possible benefit at a definite cost. If potential users do not feel the value of the possible benefit exceeds the cost, they will not buy the insurance.

Mechanics of Options Trading

Options trading is permitted only at exchanges approved by the Commodity Futures Trading Commission (CFTC). As in the futures market, trading in options is conducted in a pit by open outcry and hand signals. Trading is observed and regulated by the exchanges and the CFTC. All trades are reported to and cleared by a clearing corporation, which makes sure each option contract has a buyer and a seller at the same price and that all margin requirements are met. This process guarantees performance on all contracts.

For options *buyers*, the premium payment is the largest amount that can be lost, regardless of the price movement of the underlying futures contract. Hence, buyers of commodity options do not receive margin calls. The option *seller* (also called the *writer*) must deposit a margin and may receive margin calls because he or she has the potential liability to provide a futures contract to the option buyer should the buyer elect to exercise the option.

This margin procedure assures the buyer that the seller will always have sufficient funds on deposit with the clearing corporation to pay the difference between the option strike price and current market price should the buyer exercise the option. If the option price never increases, the option writer will receive no margin calls and the option will expire worthless. If the option expires "out of the money," the buyer will lose the premium and the option writer will keep it as payment for providing the buyer with price insurance.

In addition to the premium, option buyers and sellers pay small commissions to their brokers. There is great variability in the level and manner in which commissions are charged: some brokers charge a separate commission for each purchase and sale; they may establish commissions as a fixed rate or a percentage of the price with a minimum fee; some may assess an additional charge when an option is exercised.

American options can be bought and sold on any business day. Therefore, an option holder can always trade out of (offset) an options position before the option expires. Due to this feature, an option buyer does not need to exercise the option in order to realize a profit. The trader can simply liquidate the option position by making an offsetting trade, without having to become involved in trading the underlying futures contract. The ability to trade in and out of options on a daily basis means that users can buy and sell price insurance as they deem it desirable.

The decision to exercise an option lies with the buyer. If, for example, a cattle rancher decides to exercise a put option rather than to offset the position in the options market, the following should happen. For a put, the clearing corporation assigns the buyer a "short" (sell) position in the futures market at the strike price. Simultaneously, the writer of the option is assigned a "long" (buy) position in the futures market using that day's futures settlement price. At this point, the option contract has been terminated and both parties are free to trade their futures positions as they see fit.

Hedging Examples: Options vs. Futures

The following example illustrates how option pricing strategies work and how their results compare with those of hedging with futures. For ease of exposition, the put option contract is exercised rather than sold at the time of cash market delivery. In practice, most options will be sold rather than exercised, thus yielding larger returns.

Selling Futures Contracts

In December a feedlot operator takes delivery of a lot of feeder cattle to go on feed until April, at which time the total weight of the animals is expected to be 40,000 pounds. The cattleman, expecting the cash price to be 75 cents/lb in April, can sell one April live-cattle futures contract at 75 cents/lb to lock in that cash price.[1]

If futures and cash prices fall to 65 cents/lb between December and April, the futures gain of 10 cents/lb will compensate for the lower cash price received, resulting in a net price received of 75 cents/lb. The same net price would have been received if cash and futures prices had both risen 10 cents/lb over the same period. In this latter case, a futures loss of 10 cents/lb would have reduced the cash price of 85 cents/lb to give the same net price. Subtracting an estimated $50 for commission on the futures contract leaves a total net revenue of $29,950 for the sale of the cattle.

Buying Put Options

Now assume the cattleman buys one April put option with a strike price of 75 cents/lb instead of hedging with futures. Assume that the price of this option is 5 cents/lb for a premium of $2,000. With a 0 (zero) basis, the minimum cash price assured to the cattleman is 75 cents/lb. However, if prices increase, the cattleman can let the option expire and sell at the higher cash market price (85-75=10 cents/lb = $4,000 gross increase, minus the premium and commissions, leaves a net return of $31,950). If prices fall at least 5 cents/lb, the option would be exercised, giving the minimum net return of $27,900, no matter how far prices fall.

As this comparison shows, three factors will influence the relative attractiveness of options over futures: (1) the size of the premium, (2) the probabilities of a price rise or decline, and (3) the magnitude of price changes over time. The minimum return in the example is lower for options than it is for futures by an amount equaling the premium and commission. This will be true generally. Therefore, the desirability of options strategies depends greatly on premium levels.

Also, the net returns from a futures hedge will always be greater than those from options strategies if the price falls during the trading period. This means that the higher the probability of price decline, the more desirable are futures and the less desirable are options. Finally, the buyer will consider the magnitudes of potential price increases and decreases. If over a number of years the magnitude of price increases is substantially larger than the price declines, then option strategies will be more profitable than futures strategies.

Even if the average returns are lower for the option strategy in a particular case, some livestock producers may prefer it because it involves no margin calls, while futures strategies may involve margin calls. The possibility of margin calls requires that hedgers have a credit reserve or an arrangement with a lender for financing margin calls. Some livestock producers may feel that the

[1] This assumes that the cash and futures market prices will come together at the time of the futures contract's maturity — that there is a "basis" (defined as the difference between futures and cash prices) of zero. In most locations, such as California, this is not likely to happen; there is usually some transportation cost between the local market and the nearest delivery point for the futures contract, as reflected in a positive basis.

potential costs involved in meeting margin calls more than offset the larger returns from futures.

One final note: The example assumes that the option contract is held until it is exercised or expires worthless. In fact, the original options position can be offset on any business day until the expiration date, thus recapturing part of the premium cost.

The decision to offset an options position will depend on expectations concerning the price level of the underlying futures contract. The added flexibility of being able to trade options any time means that users may be able to have price protection when they need it without losing the entire premium, hence reducing the cost of the option strategy.

Advantages and Disadvantages: Options vs. Futures

In summary, the basic advantages and disadvantages of options vs. futures are:

Buying Put Options

Advantages:

- Permits establishing a minimum selling price while retaining the opportunity to benefit from higher cash prices.
- Option buyers does not receive margin calls.
- Maximum loss is equivalent to original premium cost.

Disadvantages:

- Option premiums may be relatively expensive.
- In most years, the option will expire worthless.

Selling Call Options

Advantages:

- Cash market returns can be increased by the amount of the premium received.

Disadvantages:

- The call option seller does not have price insurance against falling prices.
- Maximum return is equivalent to the option premium. Losses can be virtually unlimited if prices go up.
- Options sellers receive margin calls if premiums increase after the option is written (sold).

Selling Futures

Advantages:

- Establishes a selling price within a narrow range bounded by basis change.
- Commissions are relatively inexpensive compared to premium for options.

Disadvantages:

- Eliminates the opportunity to participate in higher cash market prices.
- Requires a margin deposit, and margin calls may occur if prices move higher.

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USING OPTIONS TO CONTROL LIVESTOCK FEED COSTS

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Feeding livestock is a risky business. To deal with the various types of risks faced, livestock feeders should make use of all available risk management tools. One valuable tool which can reduce the risk from volatile input prices is hedging with commodity options. This paper describes how feed costs can be controlled by using options to both raise average profits and reduce input price risk.

Feed costs are second only to feeder animal costs in terms of operating expenses incurred by a livestock feeder. Therefore, a feeder should pay close attention to feed prices when making production decisions. For example, the National Cattlemen's Association's Cattle-Fax produced Table 1 to show the impact of corn prices on the break-even purchase price for feeder cattle. According to Cattle-Fax, with cattle on feed for about four months feedlot operators expect to finish three lots of cattle each year. Such a constant feeding operation requires a constant flow of feed grain, regardless of feed prices. Table 1 shows that with corn at $2.50 per bushel and a $74/cwt price expected for finished cattle, feeders can break even paying $82.80/cwt for feeder calves. However, if corn goes to $3/bu before operators contract for that batch of feed, the break-even point moves out to $78.68. In other words, operators that have paid $82.80 for feeder cattle would lose almost $4/cwt if corn prices rose $.50 without being hedged.

Table 1. Break-even Purchase Price

Assumptions

In weight	750			Conversion rate	8.5
Out weight	1,150	Average daily gain	3.0	Interest rate	11.5

Corn price (dollars per bu.)	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50
Finished price	Break-even feeder purchase price (750 lbs.)								
64.00	76.48	74.42	72.35	70.29	68.23	66.17	64.11	62.05	59.98
66.00	79.39	77.33	75.27	73.21	71.14	69.08	67.02	64.96	62.90
68.00	82.30	80.24	78.18	76.12	74.06	72.00	69.94	67.87	65.81
70.00	85.22	83.16	81.10	79.03	76.97	74.91	72.85	70.79	68.73
72.00	88.13	86.07	84.01	81.95	79.89	77.82	75.76	73.70	71.64
74.00	91.05	88.98	86.92	84.86	82.80	80.74	78.68	76.62	74.55
76.00	93.96	91.90	89.84	87.78	85.71	83.65	81.59	79.53	77.47
78.00	96.87	94.81	92.75	90.69	88.63	86.57	84.50	82.44	80.38
80.00	99.79	97.78	95.66	93.60	91.54	89.48	87.42	85.36	83.30
82.00	102.70	100.64	98.58	96.52	94.46	92.39	90.33	88.27	86.21

Source: Cattle-Fax

Producers can "lock in" their feed price using either forward or futures contracts, but that may not be the most profitable course of action. Hedging with options enables cattlemen to lock in feed costs to protect against market price increases, but with flexibility which may allow feeders to pay lower prices if the market price decreases. An example of the weaknesses of forward and futures pricing is presented below, followed by an illustration of how options hedging avoids these weaknesses.

Forward and Futures Contract Inflexibility

Hedging using either forward cash or futures contracts locks in a feed price, but gives the hedger no flexibility to take advantage of lower market prices which might be available at a later date. Consider the case of a cattleman who thinks that the current price of corn, trading at $2.50/bu, could go up to $3/bu by the time he needs to lay in additional supplies.

He could lock in the $2.50 market price using a forward cash contract. This guarantees his feed cost, no matter what feed prices do in the future. However, if prices fell after the forward contract was signed the cattleman would still be obligated to pay the contract price of $2.50.

If the cattleman used a futures hedge he would lock in the current $2.50 price, plus or minus any change in basis.[1] The hedge would be placed by buying a corn futures contract with a delivery date on or after the date he actually intended to take delivery of cash grain. If he was right and both cash and futures prices go to $3 before the hedge is liquidated, he would have a $.50/bu profit on his futures position to compensate for the higher cash price which is paid; the net price paid is still the $2.50 his hedge locked in ($3 - .50 = $2.50). He would capture the futures profit by liquidating the futures position by making an equal and opposite transaction in the futures market. In this case it would be to sell a futures contract identical to the one he purchased when placing the hedge. The hedge would be closed on about the same day the cash feed price is set. If the cattleman was wrong and prices fell after the hedge was placed the net price does not change (assuming no basis change). If cash and futures prices fell to $2/bu the hedger would be able to buy cash corn for $2, but he would have a $.50/bu loss on his futures position which raises the total cost of the hedged corn to the price locked in: $2.50 (= $2 + .50). In this situation, the inflexibility of the futures hedge and forward contract led to a higher net price than would have been paid by the cattleman if he had hedged using options.

Options Hedging

If the same cattleman had placed a hedge using options, he would have benefitted from any price decreases which occurred while the hedge was in place, yet he would have received the same protection against price increases as that provided by futures hedging. The simplest option strategy would be to buy a call option on corn prices. A "call option" gives the option buyer the right, but not the obligation, to buy the commodity at a specified *exercise price* any time before the option expires. An example of hedging with calls follows.

If the cattleman believes that the current corn market price of $2.50/bu could rise, he could hedge by buying a call option with an exercise price of $2.50. For that option the hedger will have to pay a *premium* of, say $.10 in

[1] "Basis" is simply the difference between futures and local cash prices for the same product. Even though the two prices will move in the same direction over time, they will not always move in the same amounts, thus basis will change.

this case.[2] If market prices never change during the time period in which the option can be exercised the hedger would not "exercise his option", thus it would expire worthless just like other insurance policies. However, if corn price increase during the option's life, the hedger would exercise the call. For example, if market prices rise to $3/bu the hedger would profit by $.50. Exercising the call in this case enables the hedger to purchase a corn futures contract at the exercise price of $2.50/bu, and he could instantly sell it in the futures market at the going market price of $3, netting the difference as a profit to compensate for the rise in cash corn prices paid. The net price paid for corn would be $2.60: $3 (from the cash market) minus the $.50 options profit, plus the $.10 premium paid to get the option, or the $2.50 he intended to lock in with the hedge plus the option premium paid.

If corn prices fell during the life of an option, the flexibility of options hedging becomes clear. Options give the buyer the right, but not the obligation, to make a transaction at the exercise price. For a cattleman using calls to hedge against feed price increases, no options would be exercised in a falling price market. If corn prices fell to $2/bu, for example, the hedger would pay $2 for cash corn plus the premium, $.10 in this case. Thus, the cattleman would pay $.40/bu less for his feed if he hedged using options rather than forward cash or futures contracts in this falling price market. To gain this potential benefit, the hedger did have to pay an extra cost, the option's premium. However, in volatile markets, such as this example, the cost proved to be a good investment.

[2] The "premium" is the amount paid by an option buyer to get the option. This amount is determined by market and can go up or down over the short run. As the option approaches its expiration date, the premium will decrease because part of its value is determined by the amount of "time" before it expires; the more "time" before an option expires, the more "time value" it has in its premium. At the date an option expires it obviously has no "time" left, so its time value decreases to zero. At that point, an option's premium will equal its "intrinsic value", which is the value of the option if it were exercised at that point in time. A call option will have intrinsic value only if the current market price is above the option's exercise price. If an option has no intrinsic value, it will be worthless at the time it expires. If it does have some intrinsic value, the option buyer will exercise the option to capture the intrinsic value at that time.

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BEEF COW SHARE LEASE ARRANGEMENTS

James Oltjen,[1] Daniel Drake [2] and Mark Nelson[3]

Leasing arrangements between ranch operators and cattle owners are being used more in livestock production today than ever before. Leasing has long been used to acquire control of land, but now it is being used with livestock. It is used for a number of reasons—it allows one with little capital to lease cows and, perhaps, land as well; it allows for intergenerational transfers of the cow herd. Cow leasing is not new, but there is relatively less historical precedent compared to other agricultural leases. What is fair is still a common question.

This publication discusses the practice of leasing a cow herd. The owner of the cow herd is referred to as the owner and the party who leases the cow herd is referred to as the operator.

Purpose of Leasing Arrangements

Ranching requires control of large amounts of capital if the operator is to have adequate net income for a comfortable living. It is difficult, if not impossible, for ranch operators to acquire adequate capital without borrowing.

Leasing livestock is a form of acquiring control of additional capital. However, rather than borrowing this capital from a bank or lending institution, the operator borrows from another individual or firm. The operator acquires the use of a cow herd and shares the costs and returns of the cow herd operation with the owner. Borrowing may still be required for short term operating expenses.

Advantages of Leasing Arrangements

1. Allows the operator to acquire the use of resources without making a direct monetary investment in the assets.
2. Allows the risk and profit associated with livestock production to be shared.
3. Can provide a more efficient use of resources (land, labor and capital).
4. Can allow the owner to spread the sale of a cow herd, and avoid potentially large capital gains.
5. Can allow the owner to convert taxable income from “self-employment earnings” to “non-participation income.”

Disadvantages of Leasing Arrangements

1. Both owner and operator give up some individual control and income earning potential.
2. Takes more time, effort and records.
3. Could be difficult to prove that the owner is not materially participating.

“Cow Herd” Versus “Cow” Leases

The first step in developing a lease between two individuals is to decide whether the lease is for a cow or a cow herd. For the purposes of this paper, let's define a "cow" lease as one where no one furnishes replacements. The lease, then is viewed as a single cow lease, when the cow is culled, the owner receives the income. When the entire herd is sold, the lease is over. This type of lease works well for producers who wish to get out of business, yet spread the sale of the cow herd over a period of years. It also provides for ownership transfer between generations.

A "cow herd" lease is viewed as an on-going business arrangement whereby the owner is responsible for providing replacements. The replacements may be purchased from outside the lease arrangement, or can be raised within the leased cow herd by the operator but subtracted from the owners "share." In either case, the owner would receive all cull income.

What Is a Fair Leasing Agreement?

In developing a lease, owners and operators want an arrangement that is fair to both parties. As a rule, leasing arrangements are considered fair if the parties involved each receive approximately the same percent of income as the percent of costs they contribute. Bargaining may have an important influence on the value placed on contributions.

Forms can be used to determine the basic contributions of both owner and operator. These are especially helpful when working out a leasing arrangement for the first time. In such cases there may be no past record of expenses involved in production.

It is best if an owner and operator can work together in determining their respective contributions. They might work independently at first; then they will be better prepared to resolve any differences.

Costs To Be Considered

There are two types of costs to consider when determining the amount that each party contributes towards an operation. These are fixed and variable costs.

Fixed costs are incurred due to owning property, and are often referred to as ownership costs. Usually these costs are called the DIRTI five - depreciation, interest, repairs, taxes, and insurance. It is assumed that these costs are incurred regardless of operating levels and returns.

Variable costs are incurred in day-to-day operations. In a livestock operation, variable costs include feed, labor, veterinary, drugs, trucking, and marketing, as well as miscellaneous costs. These costs are sometimes called operating costs.

In most leasing agreements, the owner is responsible for fixed costs of the livestock and perhaps for some variable costs. The operator is generally responsible for most of the variable costs, and may also furnish some fixed costs. In a cash lease, the operator may pay the owner cash rent equal to the owner's fixed costs.

Other Factors To Consider

Other factors besides fixed and variable costs also need to be considered when preparing a livestock leasing agreement. In the case of a cow herd, some other factors include:

1. Who provides/pays the breeding bill?

2. Contingencies (e.g. drought, death loss): how will they be handled?

3. Who makes which management decisions (e.g. culling, sale time)?

4. The lease itself: length, renewability, termination?

5. How is income divided?

6. How will price be set if one party purchases the other's share?

Determining Sharing Arrangements

Three things need to be determined for an equitable leasing arrangement. These need to be done by the operator and owner working together:

1. Determine the costs to be considered.

2. Determine the contributions of each party.

3. Determine the percent of costs contributed by each party.

When these three factors are determined, the operator and owner should share in income in the same proportion as they contribute to the operation.

Evaluate the leasing agreement occasionally to assure an equitable arrangement over time. Fluctuating prices and management changes can cause the proportion of the contributions to shift over time.

Costs for a Cow Herd

A worksheet (Table 1) can be used to estimate the various costs involved in the operation of a cow herd. The amount each party contributes can be credited to the party making the contribution. A short explanation of each cost item may help in arriving at an equitable figure.

When historical costs are well documented, proposed new contributions by each party may be set based on historical costs. In such cases, validation of the proportions with current records is important.

Consider these estimates (Example 1) valid only under the costs, production level, and prices specified. Individuals or groups using the information provided should substitute costs, production levels, and prices valid for the locality, management level to be adopted, and marketing circumstances for the location and time period involved.

Variable Expenses

<u>Feed</u>

1. Pasture is a feed cost. If the pasture is owned by the party providing it, the pasture cost could be a reasonable rate of return (2 to 6 percent) based on its value, or it could be the amount for which it could be rented to someone else. If the pasture is rented by the party providing it, then his contribution is the actual cash rent.

2. Supplemental pasture in the form of crop or pasture residue or other grazing is a contribution towards feed costs and credit should be given to the party who provides this feed.

3 & 4. Hays are considered as feed costs and should be valued at market prices.

5. If grain is used in the operation, value at market price.

6. Protein, mineral, and vitamins are valued at market price. These items should be furnished by the same party

who provides hay and forage so there will be no conflict concerning rations.

Other Expenses

7 - 11. Other expenses should include the costs of the cow herd. For example, the cost of operating capital for the operator may be a significant expense. Sources of information include tax returns and detailed financial analysis (e.g. SPA, FINPACK).

12. Labor is a contribution of the party who provides it. If labor is hired, its cost is the actual cost to the party who pays for it. If labor is furnished by one or both parties, then labor should be valued at the current cost of labor as though it had to be hired. Labor required per cow per year will vary with the size of the herd. For herds of less than 30 cows, 10 to 15 hours per cow per year may be required. Large herds will require 5 to 6 hours per cow per year. Use actual costs, if available.

13. Management of a cow herd should be the responsibility of both parties. The owner of the cow should decide which cows to cull and the operator should be responsible for the day-to-day decisions involved in managing the cow herd to produce optimum returns. Placing a dollar figure on the value of good management is difficult, but no other factor is more critical when determining overall cow herd profit. Helpful guides include 5 to 8 percent of gross income or 1 to 2 percent of total capital managed.

Fixed Expenses

Cows and Bulls

14. Interest on cows as an investment contribution of the owner. The interest rate used should be the approximate interest rate that could be earned if money were invested in other alternatives. If interest rates are 5 percent and the average value of a cow is $600, then the annual contribution of the owner is 5 percent of $600 for 12 months or $30. Cow value for one-year leases is her market value minus capital gains taxes; for longer term leases it is balance sheet value (a conservative base value or cost less depreciation).

15. Depreciation on cows is a contribution of the owner because he is responsible for providing replacements. It is the difference between the value of the cow when she is placed in the herd and her salvage value when she is removed from the herd. To arrive at annual depreciation, divide this figure by the number of years the cow is expected to remain in the herd. If a cow going into the herd is valued at $600 and you expect her to be worth $350 when she is removed from the herd in 7 years, then annual depreciation is $600 minus $350 divided by 7 or $35.71 per cow. Depreciation is also a contribution of the owner in the typical “cow” lease arrangement, because the cow is usually worth more at the beginning of the lease than she will be when culled.

16. Insurance on livestock will usually be about .1 to .25 percent of the value of the breeding herd. Bull value is estimated by dividing its cost by the number of cows serviced, e.g. $2,500 ÷ 25 cows/bull = $100.

17. Death loss of cows should be considered a contribution of the owner. Death loss is usually computed at 1 to 2 percent of the value of the breeding herd. There should be contingencies written in the lease for cases where actual death losses are greater than the percent used in the lease worksheet.

18 & 19. Annual interest and depreciation on bulls are determined the same as for cows (items 14 & 15) except bull value is estimated by dividing bull cost by the number of cows serviced. This determines the amount to charge against each cow.

<u>Buildings and Equipment</u>

20 & 21. Interest and depreciation on buildings and equipment used in the operation is a contribution of the party who owns the buildings and equipment. Again, figure the interest on the value of the buildings and equipment according to an interest rate that approximates investment returns. Depreciation is the decrease in the value of the property in a year's time.

22. Taxes and insurance on buildings and equipment is the cost for taxes and insurance incurred against property used for livestock during the year. This will amount to 1 to 1.5 percent of the current value of buildings and .5 to 1 percent of the current value of livestock equipment.

Determining Contribution of Each Party

After it has been determined which costs each party contributes, list these amounts in the appropriate column on the worksheet. The totals of the owner and operator columns will show the total contribution of costs for each party.

These totals might make both parties concerned as to the profitability of the cow herd operation. This is the risk that each party assumes. If returns per cow exceed the value of all contributions, then each party will get full value of all contributions. If contributions are greater than the returns, then each party will not receive full value of his contributions. However, this does not mean that each party does not benefit from the operation. There are benefits such as capital gain advantages, way of life, and pride of ownership realized by the owner. There may also be advantages in the use of otherwise unsalable feed and in the use of off-season labor for the operator.

Determining Percent Contributed by Each Party

As illustrated in Example 1, a simple way to calculate the percent contributed by each party is to separate the total contributions into the amount contributed by each party and then divide by the total contribution.

In Example 1, the owner receives 22.07% of the calf crop and all of the cull income from sale of cows (7 year life, 100 cows ÷ 7 years = 14.29 cows/ year) and bulls (6 year life, 100 cows ÷

25 cows/bull = 4 bulls, 4 bulls ÷ 6 years = .6667 bulls/year). If 100 cows had been exposed to a bull and a 85% calf crop was weaned, the owner would receive:

85 calves (550 lb. @ $.90/lb.) x .2207	**9,285**
14.29 cull cows (@ $350)	**5,000**
.6667 cull bulls (@700)	**467**
	$14,752

In addition it is important to note, the owner would be responsible for replacing the 14.29 culled cows, the 1 dead cow (100 cows @ 1% death loss), the .6667 culled bulls, and the .04 dead bulls (4 bulls @ 1% death loss).

The operator would receive 77.93% of the calf crop:

85 calves (550 lb. @ $.90/lb.) x .7793	**$32,790**

Profit or Loss?

In this example, the operator's costs are $31,930 ($319.30 x 100 cows), resulting in a profit of $860 ($32,790 - $31,930).

The owner's calculated costs from Example 1 are $9,041 ($90.41 x 100 cows), but his total estimated expenses include replacing the cull animals since he is providing the cow herd. These expenses are $14,508 which include replacing the salvage value of what was sold ($5,467). His out of pocket expenses are:

15.29 replacement cows @ $600	**9,171**
.7067 bulls @ $2,500	**1,767**
Total other costs of $35.70 X 100 cows	**3,570**
	$14,508

The $35.70 per cow cost is $30 interest on cows + $5 interest on bulls + $.70 insurance. The owner's net result is a profit of $244 ($14,752 - $14,508). Another way to consider or check profit is to exclude cull and death income and expenses. Then the owner would have an income of $9,285 and expense of $9,041 for a net gain of $244.

Thus, each party receives the same proportion of net returns as they contribute in costs. Total returns are $42,075 (85 calves x 550 lb @ $.90/lb); total costs are $40,971 ($409.71/cow x 100 cows). Total net returns are thus $1,104 ($42,075 - $40,971). The operator nets $860, or 77.93% of $1,104; the owner nets $244, or 22.07% of $1,104.

Accounting Procedures for Raising Replacements Within the Cow Herd

When the owner is furnishing replacements to replenish the cow herd, and they are selected and raised from the calf crop, the value and cost to raise these replacements must be subtracted from the owner's share. In Example 1, the owner's share of income could be amended to include the value of the replacements:

Income	
85 calves (550 lb. @ $.90/lb.) x .2207	**9,285**
14.29 cull cows (@ $350)	**5,000**
.6667 cull bulls (@700)	**467**
	$14,752
Costs	
15.29 replacement heifers (550 lb. @ $.90/lb.)	**7,566**
Growing phase cost estimate, pay to operator	**2,136**
.7067 bulls @ $2,500	**1,767**
Total other costs of $35.70 X 100 cows	**3,570**
	$15,039
Amended Income	**(-$287)**

The costs to grow the replacement heifers from weaning age to 15 months for breeding is estimated by using a monthly charge (based on the annual cost per cow adjusted to 3/4 of an animal unit) times the number of months from weaning to breeding age (3/4 X 15.29 females X $319.30 annual cost / 12 months X 7 months). In the example, heifers are weaned at 8 months of age and grown for 7 months before reaching breeding age at 15 months. Specific growing period costs should be used when available.

If additional replacements are saved for later culling, their costs and cull income would be assigned to the owner.

In the above example, from a strictly out-of-pocket cash basis, raising replacements is clearly less profitable compared to purchase of breeding age females. The additional cost is $1,136 ($7,566 + $2,741 - $9,171). However, long-term genetic gains, improved animal health, and pride of ownership are possible offsetting benefits, which may also improve income from future calf and cull sales.

In the event the owner purchases replacements of under-breeding age, growing costs from purchase until attainment of breeding age should be assigned as in the example above.

Conclusions

The methods described in this publication are not the only ones available, but these are accepted as fair for the assumptions stated. Other lease options available include cash leases, fixed percent of calf crop, and lease with the option to buy. In all cases, records are important to both establish a lease, as well as to evaluate it through time. Current estimates and projections are needed to adjust the lease as described above, and historical analyses allow one to factor risk and temper any changes. Communication and negotiation between the two parties is important for keeping this form of lease equitable.

For Further Reading

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Example 1. Beef "Cow" Lease or "Cow Herd" Lease with replacements purchased outside the arrangement ($/cow).

	Total Contribution	Owner's Share	Operator's Share
Variable Expenses			
FEED:	$ / cow		
1. Pasture	82		82
2. Crop residue pasture	16		16
3. Hay: ________	90		90
4. Hay: ________			
5. Grain			
6. Protein, minerals and vitamins	5		5
OTHER EXPENSES:	$ / cow		
7. Veterinary and drugs	7		7
8. Fuel, oil and utilities	11		11
9. Repairs and supplies	9		9
10. Marketing and trucking	6		6
11. Miscellaneous: operating capital	4		4
12. Labor 7 hrs @ $6.00 /hour	42		42
13. Management 475.42 gross income/cow @ 5 %	23.77		23.77
Fixed Expenses			
COWS AND BULLS:	$ / cow		
14. Interest on cows 600 @ 5 %	30	30	
15. Depreciation on cows (600 - 350) / 7 years	35.71	35.71	
16. Insurance on herd (600 + 100) @ .1 %	.70	.70	
17. Death loss (600 + 100) @ 1 %	7	7	
18. Interest on bulls 100 @ 5 %	5	5	
19. Depreciation on bulls (2,500 - 700)/ 6 years/ 25 cows	12	12	
BUILDINGS AND EQUIPMENT:			
20. Interest on buildings and equipment - value 230 /cow @ 5 %	11.5		11.5
21. Depreciation on bldgs. and equip. ($/cow)	10		10
22. Taxes & insurance, bldgs. and equip. 120 @ 1.25 % + 70 @ 0.75 %	2.03		2.03
TOTAL CONTRIBUTIONS (sum of lines 1-22)	409.71	90.41	319.30
PERCENT OF TOTAL CONTRIBUTIONS		22.07 %	78.93 %

Table 1. Fill in values in the worksheet to evaluate possible arrangements ($/cow).

	Total Contribution	Owner's Share	Operator's Share
Variable Expenses			
FEED:	$ / cow		
1. Pasture			
2. Crop residue pasture			
3. Hay: ________________			
4. Hay: ________________			
5. Grain			
6. Protein, minerals and vitamins			
OTHER EXPENSES:	$ / cow		
7. Veterinary and drugs			
8. Fuel, oil and utilities			
9. Repairs and supplies			
10. Marketing and trucking			
11. Miscellaneous: operating capital			
12. Labor _____ hrs @ $______ /hour			
13. Management _______ gross income/cow @ ____ %			
Fixed Expenses			
COWS AND BULLS:	$ / cow		
14. Interest on cows _____ @ ____ %			
15. Depreciation on cows (_____ - _____) / _____ years			
16. Insurance on herd (_____ + _____) @ ____ %			
17. Death loss (_____ + _____) @ ____ %			
18. Interest on bulls _____ @ ____ %			
19. Depreciation on bulls (_____ - ____)/____ years/ ____ cows			
BUILDINGS AND EQUIPMENT:			
20. Interest on buildings and equipment - value _______ /cow @ ______%			
21. Depreciation on bldgs. and equip. ($/cow)			
22. Taxes & insurance, bldgs. and equip. ______ @ ____ % + ______ @ ______%			
TOTAL CONTRIBUTIONS (sum of lines 1-22)			
PERCENT OF TOTAL CONTRIBUTIONS		%	%

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VALUE OF PREGNANCY TESTING

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An earlier article in this Ranchers' Guide investigated optimal culling decisions for range cows given cow age, pregnancy status, and market prices (i.e., Optimal Economic Range Cow Culling Decisions: Biological and Market Factors Combined by Tronstad and Gum). The analysis found conditions where it was optimal to keep a sound cow even if the cow was open. This result indicates that pregnancy testing doesn't always have economic merit. The economic value of pregnancy testing is quantified in this article for different biological and market conditions.

Biological, market, and cost information on which these pregnancy test and culling alternatives are evaluated include: cow age, recent history of calf fertility, replacement cost of bred heifers, calf prices, cull cow values, and the cost differential (feed and/or performance cost) between spring and fall calving. Biological productivity estimates were taken from a prior article in this Guide entitled, "Range Cow Culling: Herd Performance." Market price relationships estimated in the prior article of "Market Impacts on Culling Decisions" were updated to reflect more recent prices and to categorize prices in narrower intervals. The cost differential between spring and fall calving is considered since the analysis has allowed for spring and fall calving. Biannual calving was found to be an important factor for culling decisions since a cow has the potential to be productive six months earlier than under a strict annual calving system.

Management Alternatives

Range cow culling and replacement decisions are driven by future cow productivity, feed costs, and the market value of replacements, calves, and slaughter cows. As the spread between market prices changes through time the value of pregnancy testing and optimal culling decisions also change. To simultaneously evaluate the dynamics of physical productivity, market prices, and production costs a computer model is used to evaluate the culling decision. The model incorporates statistical price relationships while evaluating the long-term economic implications of decision alternatives. Decision alternatives evaluated are:

1. Whether to keep or cull a cow without a pregnancy test? Economics may conclude that older cows should be replaced or younger cows should be kept, irrespective of pregnancy status. If young cows are open, should they be bred immediately or at a later period?

2. If pregnancy testing has economic justification, what should be done with cows that are open? Should they be culled and replaced with a bred heifer now or at a later time in the future? Do market factors justify maintaining, expanding, or contracting herd size?

Table 1. Fertility Rates for Cows with Sale Calf at Side.

Cow Age	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
					%						
Pregnant	86.20	85.73	85.13	84.41	83.57	82.61	81.54	80.34	79.02	77.59	76.03
Open	13.80	14.27	14.87	15.59	16.43	17.39	18.46	19.66	20.98	22.41	23.97

Table 2. Fertility Rates for Cows with No Calf at Side.

Cow Age	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
					%						
Pregnant	74.03	74.03	74.03	74.03	74.03	74.03	74.03	74.03	74.03	74.03	74.03
Open	25.97	25.97	25.97	25.97	25.97	25.97	25.97	25.97	25.97	25.97	25.97

Comparing Alternatives

In order to assess the value of pregnancy testing, the economic returns from making decisions with pregnancy test information is compared to returns generated without pregnancy test information. Without pregnancy test information, the likelihood that a cow is open or pregnant is made solely on the basis of cow age and recent calving history. These estimates were made from data collected on the San Carlos Apache Experimental Research Registered Herd, located at Arsenic Tubs, AZ. The odds that a cow was pregnant or open with a sale calf at side were found to be influenced by cow age (see Table 1). If a cow had no calf at her side because she was previously open or lost her calf, cow age was not found to be a factor that influenced whether the cow would be open or pregnant (see Table 2).

In calculating the value of pregnancy testing, the economic value associated with applying the same culling decision to all cows of a given age and calf status was first obtained. Say the decision under consideration is to keep and allow for immediate breeding of all cows 7.5 years of age that have a sale calf at their side. Given the information in Tables 1 and 2, 83.57% are expected to be pregnant and 16.43% open. The economic value of making a keep decision is made by multiplying the value of keeping a pregnant cow by 83.57% and adding the value of keeping an open cow by 16.43%. Four non-pregnancy test alternatives for a given cow age and calf status are compared: (a) keep all and allow for immediate breeding, (b) replacing all with a bred heifer, (c) keep all cows but don't allow for breeding any open cows until 6 months from now, and (d) cull all cows and don't replace with a bred heifer this period. The highest value from the four non-pregnancy testing alternatives is the best decision one can make without any information regarding pregnancy status. This value is compared to the best decision possible with pregnancy testing. Two economically viable options under pregnancy testing are; (a) keep all pregnant cows and replace open cows with a bred heifer, or (b) keep all pregnant cows and cull the open cows without replacing them with a bred heifer. The optimal decision is the highest value attained from evaluating all options. The model assumes a cost of $2 per head for pregnancy testing.

Table 3. Long-term Probability Price Levels Estimated for May.

Replacement			Calf Prices ($/cwt.)				
Prices ($/head)	**< 64**	**64-72**	**72-80**	**80-88**	**88-96**	**96-104**	**> 104**
< 465	0.0507	0.0345	0.0248	0.0138	0.0065	0.0025	0.0008
465 - 555	0.0234	0.0324	0.0358	0.0267	0.0158	0.0076	0.0035
555 - 645	0.0148	0.0276	0.0406	0.0403	0.0300	0.0176	0.0109
645 - 735	0.0070	0.0168	0.0313	0.0400	0.0383	0.0283	0.0234
735 - 825	0.0024	0.0074	0.0172	0.0277	0.0338	0.0319	0.0370
825 - 915	0.0006	0.0023	0.0066	0.0132	0.0201	0.0243	0.0428
> 915	0.0001	0.0005	0.0019	0.0050	0.0096	0.0151	0.0547

Table 4. Long-term Probability Price Levels Estimated for November.

Replacement			Calf Prices ($/cwt.)				
Prices ($/head)	**< 64**	**64-72**	**72-80**	**80-88**	**88-96**	**96-104**	**> 104**
< 465	0.0863	0.0227	0.0139	0.0069	0.0026	0.0007	0.0001
465 - 555	0.0592	0.0325	0.0259	0.0164	0.0080	0.0027	0.0007
555 - 645	0.0451	0.0381	0.0389	0.0307	0.0186	0.0079	0.0026
645 - 735	0.0250	0.0298	0.0390	0.0392	0.0298	0.0159	0.0066
735 - 825	0.0103	0.0164	0.0270	0.0348	0.0340	0.0228	0.0124
825 - 915	0.0030	0.0063	0.0127	0.0206	0.0266	0.0235	0.0171
> 915	0.0006	0.0018	0.0047	0.0096	0.0164	0.0219	0.0318

The value of pregnancy testing is determined by subtracting the best uniform culling decision from the highest of the two pregnancy test alternatives. The value of pregnancy testing varies depending on market prices, cow age, calving season (spring or fall), the cost differential between spring and fall calving, and recent cow fertility. Whether a cow has a sale calf at her side or no calf at side is the information used for recent cow fertility. Cows that were sound with a newborn calf at side were automatically kept in the herd and thus not pregnancy tested.

Market Prices

Market prices for replacements (2.5 year old bred heifers), calves, and slaughter values are considered in the analysis. Table 3 gives long-term price probabilities of replacement and calf prices for May based on biannual prices from 1971 through 1991. These probabilities are for a range of prices rather than for an exact price. For example, historical prices indicate that for any year in May the odds that calf prices are between $80 to $88 per cwt. while replacement prices are between $555 to $645 per head is 4.03 percent. However, as shown in Table 4 for the month of November, the odds of this price combination are lower at 3.07%. Historical prices show sale calves to be lower for November than in May. On average, $6.66/cwt. lower in the fall than spring using long-term price probabilities.

Prices have been observed to follow predictable patterns from one period to the next for shorter time intervals. These patterns are highly dependent on the level of current

Table 5. Six Month Transition Probabilities Given November Calf Price<$64 per cwt. and Replacement Price Between $555-$645 per Head.

Replacement Prices in May ($/head)	**May Calf Prices ($/cwt.)** < 64	**64-72**	**72-80**	**80-88**	**88-96**	**96-104**	**> 104**
< 465	0.1272	0.0221	0.0053	0.0006	0.0000	0.0000	0.0000
465 - 555	0.1120	0.0615	0.0266	0.0054	0.0005	0.0000	0.0000
555 - 645	0.0776	0.0887	0.0651	0.0227	0.0037	0.0003	0.0000
645 - 735	0.0264	0.0580	0.0721	0.0426	0.0119	0.0016	0.0001
735 - 825	0.0042	0.0171	0.0362	0.0363	0.0172	0.0039	0.0004
825 - 915	0.0003	0.0023	0.0082	0.0140	0.0113	0.0043	0.0008
> 915	0.0000	0.0001	0.0009	0.0026	0.0038	0.0027	0.0012

prices. Table 5 illustrates how price levels in November influence where prices will be in the following May. Given a November calf price less than $64 per cwt. and replacement costs between $555 - $645 per head, the odds of going to the price category described above (calf prices of $80 to $88 per cwt. and replacement prices between $555 to $645) is only 2.27 percent rather than the long-term odds of 4.03 percent. The odds are lower because current calf prices are low. The value of pregnancy testing is based most heavily on current price levels since the impact of distant prices is reduced by a discount rate. Future returns are discounted at a real discount rate of 6 percent. Because current prices play the biggest role in determining the value of pregnancy testing, the value of pregnancy testing and optimal culling decisions are not very sensitive up to a 4 point increase or decrease in the discount rate.

Costs of Production

Costs directly influence the bottom line of profitability and the differential in feed costs for a replacement versus an older cow impacts the culling decision. Added feed costs of a first calving replacement heifer need to be evaluated against the performance of an older cow with lower feed costs. The model uses a feed cost of $100 per head every six months except for replacements during their first year. An additional feed cost of $25 per head every six months was added for replacements in the period that they gave birth and the following nursing period.

Costs of production are allowed to vary for spring versus fall calving. In general, spring calving is the norm since most areas can better match their forage availability with nutritional demands associated with a spring calving season. Lower calf prices in the fall than spring reflect this seasonal phenomena. In total, 11 different cost differentials of $0.0, $10, $20, $30, $40, $55, $75, $100, $130, $165, and $205 were evaluated. A cost differential of $30 implies that it costs $30 more to calve a cow in the fall than the spring. The highest cost differential implies a spring only calving system. The cost differential can be associated with more feed requirements, more labor, lower fertility, and/or lower calf weights.

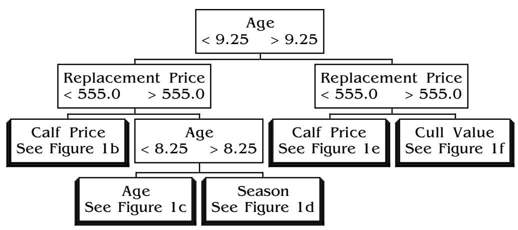
Culling Decisions and Value of Pregnancy Testing

The number of possible price combinations (49, 7•7), age (20), calf or no calf at side (2), spring or fall (2), and cost differentials (11) considered for evaluating culling decisions number 43,120 possibilities. Because this number is unduly large, these decisions have been categorized into a decision tree framework. Figures 1a through 1f describe the 43,120 different possibilities into 110 categories or terminal nodes. The six possible culling decisions are defined as: 1) K - keep and breed immediately, 2) R - replace with a bred heifer, 3) K6 - keep and breed in 6 months, 4) RN - cull and don't replace, 5) PR - pregnancy test cows, keep pregnant cows and replace open cows with a bred heifer, and 6) PN - pregnancy test cows, keep pregnant cows and don't replace open cows that are culled at this time.

Condensing 43,120 decisions into 110 general categories comes with a cost since most of the nodes are not classed 100% correctly. In technical terms they have some "node impurity." In order to assess how much node impurity exists, average one period cost of mistake

Figure 1. Culling Rule Recommendations of Decision Tree by Terminal Nodes.

Figure 1a.



Legend

K - Keep and breed immediately
R - Replace with a bred heifer
K6 - Keep and breed in 6 months
RN - Cull and don't replace
PR - Pregnancy test cows replace open cows with a bred heifer
PN - Pregnancy test cows, don't replace open cows that are culled.

Figure 1b.

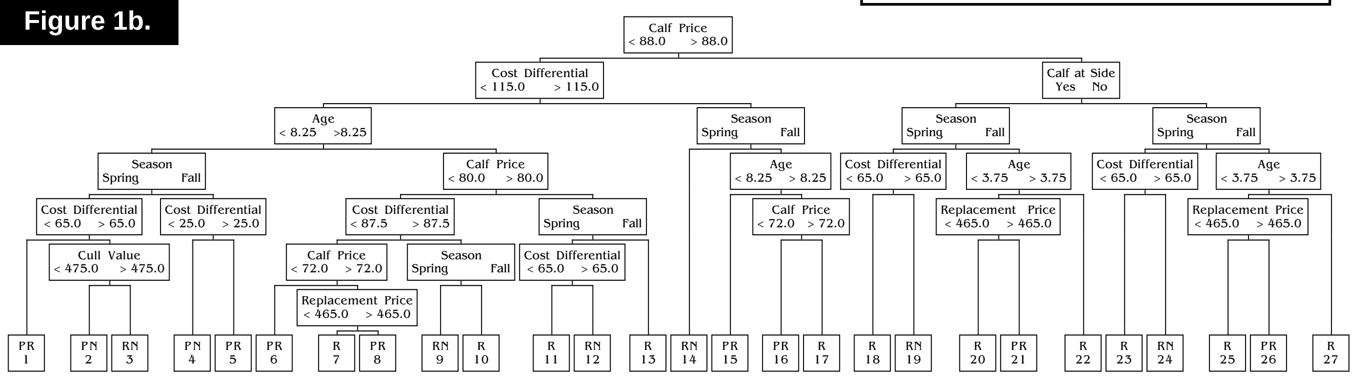


Figure 1c.

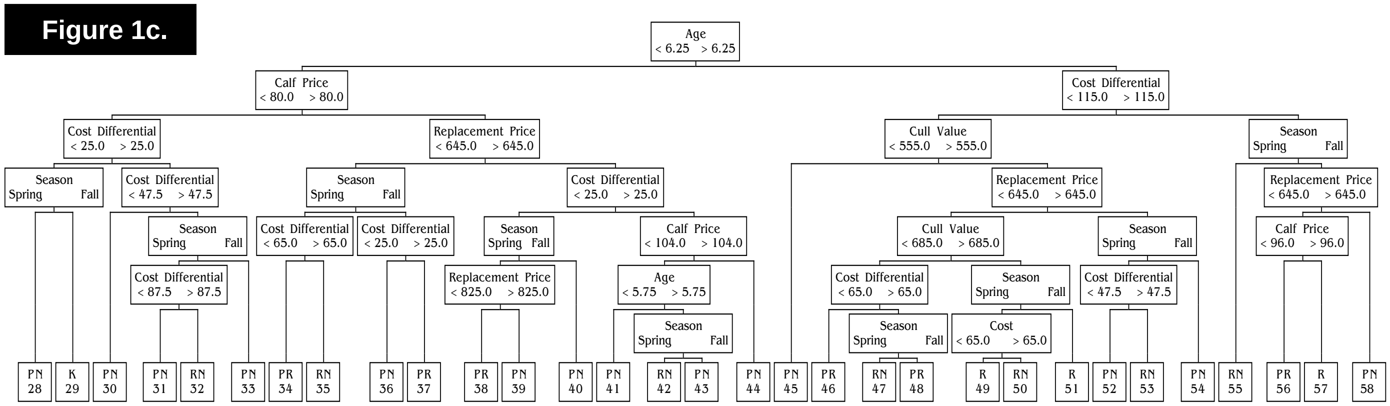
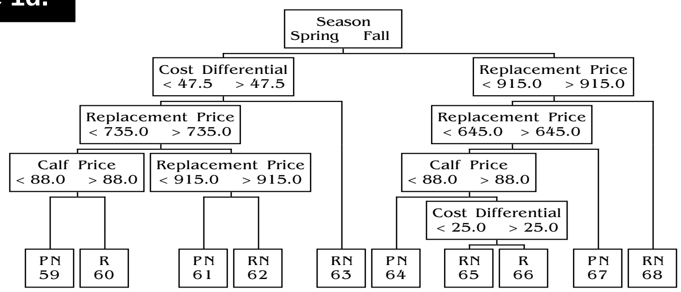


Figure 1 (cont.)

Figure 1d.



Legend

K - Keep and breed immediately

R - Replace with a bred heifer

K6 - Keep and breed in 6 months

RN - Cull and don't replace

PR - Pregnancy test cows replace open cows with a bred heifer

PN - Pregnancy test cows, don't replace open cows that are culled.

Figure 1e.

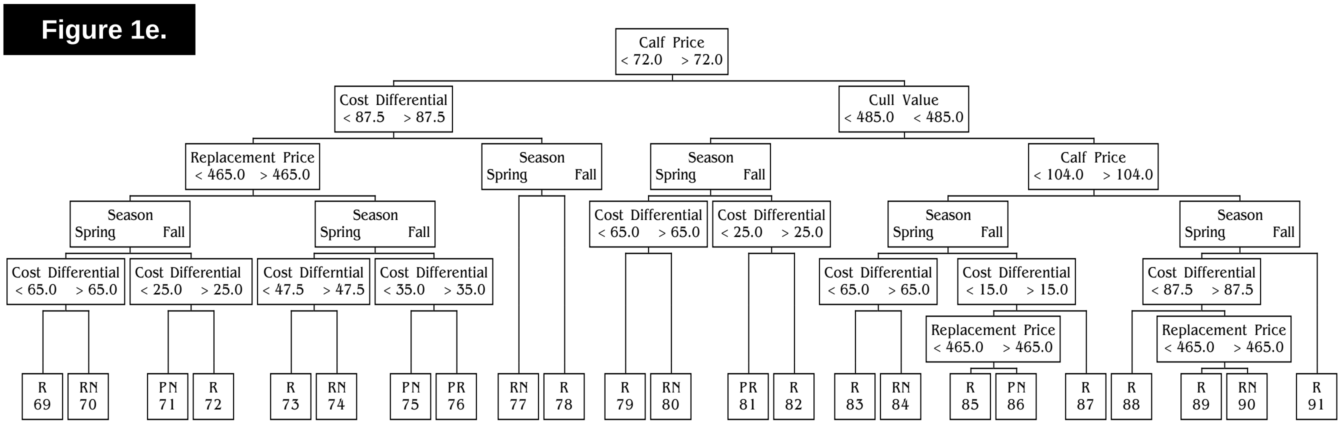
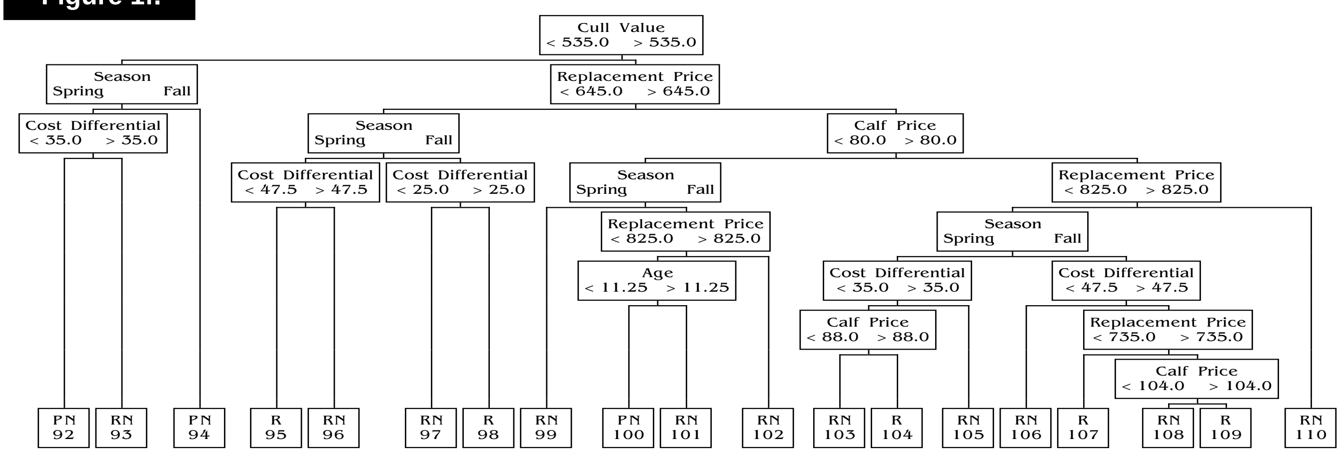


Figure 1f.



values are given in Table 6. One period cost of mistake values are determined by comparing a non-optimal decision one period followed by optimal culling decisions to a continuous stream of optimal culling decisions. All splits and categories were selected on the basis of minimizing average one period cost of mistakes for each category. For example, the first split at the top of Figure 1a was selected on the basis of splitting all decisions into two categories or nodes so that the average cost of mistake for all decisions is minimized. All variables and levels were numerically searched. Cow age of 9.25 years is the variable and level identified that splits all 43,120 culling decisions into two groups so that the average cost of mistake is minimized. Subsequent splits were

Table 6. Value of Pregnancy Testing, Present Value, and Cost of Mistake Values for Terminal Nodes in Figure 1.

Term-inal Node Number	Recommended CART Decision	Average Value of Preg Testing by Node	Average Present Value by Node	Average Cost of Mistake Values For Different Decisions* K Decision 1	R Decision 2	K6 Decision 3	RN Decision 4	PR Decision 5	PN Decision 6
1	PR	$31.8	$1965.2	-$35.9	-$46.5	-$46.0	-$135.3	-$4.2	-$22.4
2	PN	$6.4	$1403.2	-$9.1	-$106.9	-$23.2	-$21.6	-$20.2	-$2.7
3	RN	-$10.3	$1447.4	-$33.8	-$79.2	-$42.6	-$3.5	-$29.5	-$13.8
4	PN	$2.5	$1897.1	-$5.0	-$75.1	-$9.1	-$53.3	-$7.0	-$2.5
5	PR	$23.5	$1645.2	-$34.6	-$49.8	-$26.3	-$131.9	-$2.8	-$19.7
6	PR	$23.9	$1723.8	-$31.8	-$33.0	-$30.6	-$66.7	-$6.7	-$14.1
7	R	-$20.1	$1834.5	-$68.0	-$8.4	-$65.9	-$92.0	-$28.5	-$46.9
8	PR	$8.8	$1779.1	-$44.0	-$20.8	-$42.1	-$51.5	-$12.0	-$18.8
9	RN	-$21.9	$1335.0	-$47.2	-$112.6	-$49.7	-$0.1	-$46.8	-$22.0
10	R	-$2.9	$1439.8	-$64.6	-$9.0	-$42.5	-$110.0	-$11.9	-$34.2
11	R	-$46.3	$1958.6	-$105.0	$0.0	-$107.6	-$117.4	-$46.3	-$72.2
12	RN	-$42.2	$1440.8	-$76.6	-$55.8	-$77.6	$0.0	-$54.6	-$42.2
13	R	-$13.1	$1886.5	-$58.6	-$9.8	-$49.5	-$79.9	-$22.9	-$38.4
14	RN	-$33.0	$1446.8	-$48.2	-$127.0	-$58.5	-$0.4	-$59.8	-$33.4
15	PR	$30.1	$1573.2	-$67.8	-$48.1	-$33.4	-$162.6	-$3.3	-$26.9
16	PR	$8.3	$1319.2	-$69.0	-$13.6	-$32.2	-$101.6	-$5.3	-$24.7
17	R	-$34.9	$1565.9	-$113.3	$0.0	-$76.5	-$141.0	-$34.9	-$66.0
18	R	-$48.4	$2361.8	-$97.6	-$2.1	-$100.4	-$163.4	-$50.4	-$75.7
19	RN	-$57.1	$1822.9	-$83.4	-$37.5	-$86.0	-$4.1	-$66.5	-$61.2
20	R	-$31.7	$2179.6	-$71.3	-$0.6	-$62.0	-$157.0	-$32.4	-$53.8
21	PR	$13.8	$2100.2	-$37.5	-$18.7	-$29.1	-$120.5	-$4.8	-$18.8
22	R	-$39.7	$2246.3	-$84.9	-$2.9	-$73.1	-$132.0	-$42.6	-$63.2
23	R	-$43.1	$1849.7	-$123.9	-$1.7	-$128.8	-$163.1	-$44.9	-$86.8
24	RN	-$50.6	$1310.8	-$92.0	-$37.5	-$96.8	-$4.1	-$63.3	-$54.7
25	R	-$27.5	$1688.5	-$103.6	-$0.5	-$85.9	-$156.9	-$28.0	-$68.6
26	PR	$11.6	$1609.1	-$68.2	-$16.0	-$52.3	-$117.8	-$4.4	-$30.8
27	R	-$35.5	$1733.6	-$107.8	-$2.5	-$88.7	-$131.7	-$38.1	-$71.6
28	PN	$17.1	$1804.7	-$18.1	-$226.4	-$28.7	-$125.2	-$21.5	-$1.1
29	K	-$1.5	$1734.2	-$1.9	-$263.1	-$16.9	-$76.4	-$41.2	-$3.5
30	PN	$11.2	$1517.4	-$11.4	-$244.8	-$21.9	-$91.0	-$31.3	-$0.2
31	PN	$13.1	$1407.6	-$15.0	-$275.6	-$32.1	-$35.2	-$50.6	-$2.0
32	RN	-$41.8	$1401.4	-$55.7	-$349.8	-$72.9	-$0.9	-$113.3	-$42.7
33	PN	$13.3	$1436.4	-$36.5	-$243.6	-$13.7	-$107.4	-$28.0	-$0.4
34	PR	$39.8	$2233.1	-$41.9	-$42.0	-$51.5	-$118.6	-$2.1	-$17.6
35	RN	-$38.4	$1742.8	-$62.1	-$126.2	-$74.3	-$1.7	-$65.3	-$40.1
36	PN	$11.5	$2126.2	-$12.1	-$67.6	-$16.0	-$29.4	-$8.4	-$0.6
37	PR	$31.2	$1872.8	-$50.5	-$47.4	-$32.4	-$125.9	-$1.2	-$17.0
38	PR	$34.3	$2177.0	-$35.7	-$94.4	-$44.7	-$127.6	-$1.3	-$8.1
39	PN	$32.3	$2132.2	-$32.3	-$187.4	-$41.7	-$98.1	-$18.1	-$0.1
40	PN	$9.2	$2090.2	-$9.6	-$180.0	-$20.2	-$51.8	-$26.2	-$0.3
41	PN	$27.3	$1791.2	-$40.7	-$214.6	-$41.5	-$70.4	-$42.4	-$13.4
42	RN	-$21.2	$1789.8	-$66.8	-$227.8	-$76.4	-$12.5	-$78.3	-$33.7
43	PN	$18.6	$1766.5	-$39.2	-$140.7	-$19.9	-$67.7	-$16.3	-$1.2
44	PN	$33.3	$1888.1	-$51.6	-$145.6	-$49.5	-$55.9	-$34.3	-$16.2
45	PN	$17.5	$1731.4	-$19.1	-$130.2	-$18.6	-$55.5	-$17.0	-$1.1
46	PR	$22.2	$2113.5	-$38.1	-$28.1	-$38.5	-$51.4	-$5.9	-$10.9
47	RN	-$24.9	$1641.6	-$57.3	-$116.2	-$63.0	$0.0	-$49.7	-$24.9
48	PR	$4.2	$1702.3	-$59.8	-$10.9	-$41.1	-$99.9	-$6.6	-$25.6
49	R	-$37.5	$2240.1	-$101.8	$0.0	-$103.3	-$104.8	-$37.5	-$59.9
50	RN	-$48.5	$1749.8	-$90.4	-$65.5	-$91.9	$0.0	-$62.5	-$48.5
51	R	-$22.6	$2131.0	-$71.5	-$7.8	-$62.9	-$55.1	-$30.4	-$40.5
52	PN	$30.6	$2179.3	-$44.4	-$128.4	-$47.9	-$34.8	-$24.1	-$4.1

* See Figure 1 for a description of decisions.

Table 6. (cont.)

Term-inal Node Number	Recommended CART Decision	Average Value of Preg Testing by Node	Average Present Value by Node	Average Cost of Mistake Values For Different Decisions* K Decision 1	R Decision 2	K6 Decision 3	RN Decision 4	PR Decision 5	PN Decision 6
53	RN	-$26.8	$1743.3	-$66.6	-$237.3	-$71.8	-$1.1	-$78.3	-$27.9
54	PN	$20.4	$2095.4	-$29.3	-$158.3	-$22.4	-$24.3	-$30.6	-$2.0
55	RN	-$79.1	$1749.2	-$115.6	-$305.1	-$121.0	$0.0	-$144.2	-$79.1
56	PR	$19.0	$1602.2	-$56.0	-$52.9	-$20.5	-$84.8	-$1.5	-$8.3
57	R	-$29.5	$1805.3	-$111.2	$0.0	-$75.7	-$121.8	-$29.5	-$55.5
58	PN	$19.7	$1748.6	-$57.3	-$142.3	-$21.8	-$38.5	-$24.2	-$2.1
59	PN	$33.2	$1844.9	-$37.1	-$53.0	-$40.5	-$42.3	-$6.3	-$3.9
60	R	-$32.1	$2231.5	-$96.3	-$0.7	-$97.5	-$83.2	-$32.8	-$51.0
61	PN	$7.3	$2111.4	-$50.4	-$102.2	-$51.9	-$12.8	-$25.2	-$5.5
62	RN	-$20.7	$2054.7	-$72.5	-$194.9	-$73.2	-$0.6	-$64.2	-$21.3
63	RN	-$65.4	$1766.9	-$108.8	-$256.5	-$111.0	-$0.3	-$122.3	-$65.7
64	PN	$13.7	$1818.4	-$32.8	-$57.7	-$16.7	-$40.5	-$6.8	-$3.0
65	RN	$8.4	$2121.5	-$33.1	-$33.0	-$30.9	-$1.3	-$16.7	-$9.7
66	R	-$36.5	$1868.1	-$99.7	-$0.3	-$77.6	-$89.1	-$36.7	-$56.3
67	PN	$11.9	$2085.9	-$42.0	-$108.4	-$25.8	-$16.6	-$25.0	-$4.7
68	RN	-$15.1	$2022.3	-$58.2	-$222.9	-$41.9	$0.0	-$64.3	-$15.1
69	R	-$34.1	$1712.3	-$81.3	-$0.2	-$84.0	-$101.9	-$34.3	-$58.0
70	RN	-$14.4	$1228.7	-$40.0	-$46.9	-$40.6	-$0.2	-$25.5	-$14.6
71	PN	$9.4	$1653.5	-$12.3	-$47.1	-$10.0	-$33.7	-$3.8	-$0.6
72	R	-$21.5	$1386.3	-$64.1	-$1.8	-$52.5	-$86.4	-$23.4	-$43.1
73	R	-$6.9	$1657.3	-$52.9	-$4.8	-$55.6	-$61.6	-$11.7	-$24.9
74	RN	-$18.2	$1235.2	-$48.3	-$69.9	-$49.4	-$0.6	-$34.9	-$18.8
75	PN	$13.6	$1625.2	-$16.9	-$66.1	-$13.6	-$20.6	-$10.6	$0.0
76	PR	$1.3	$1295.4	-$42.0	-$7.3	-$28.8	-$46.9	-$6.0	-$15.2
77	RN	-$29.4	$1229.0	-$56.9	-$138.6	-$57.7	$0.0	-$61.8	-$29.4
78	R	-$20.4	$1308.5	-$90.1	-$2.6	-$55.1	-$90.7	-$23.1	-$43.6
79	R	-$74.2	$1876.8	-$136.1	$0.0	-$138.0	-$127.3	-$74.2	-$104.1
80	RN	-$45.1	$1359.0	-$78.9	-$69.4	-$79.1	$0.0	-$61.4	-$45.1
81	PR	$14.8	$1831.7	-$20.1	-$21.5	-$17.8	-$24.0	-$3.0	-$3.5
82	R	-$62.7	$1592.5	-$131.1	$0.0	-$107.5	-$129.9	-$62.7	-$93.3
83	R	-$85.5	$2208.3	-$155.3	-$0.4	-$156.4	-$129.7	-$85.9	-$116.0
84	RN	-$64.8	$1670.1	-$105.7	-$68.5	-$105.9	-$0.7	-$81.3	-$65.5
85	R	-$18.0	$2111.8	-$47.2	-$2.4	-$46.0	-$43.4	-$20.3	-$29.9
86	PN	$3.6	$2039.8	-$23.5	-$28.6	-$22.3	-$6.6	-$8.1	-$3.0
87	R	-$67.2	$1934.5	-$136.7	-$0.8	-$115.6	-$127.9	-$68.0	-$97.5
88	R	-$127.6	$2335.6	-$209.8	-$0.6	-$210.0	-$157.7	-$128.1	-$164.8
89	R	-$85.9	$1779.6	-$132.2	$0.0	-$132.2	-$15.0	-$85.9	-$89.4
90	RN	-$88.4	$1745.4	-$136.0	-$48.7	-$136.0	$0.0	-$99.7	-$88.4
91	R	-$102.3	$2220.3	-$178.9	$0.0	-$161.3	-$142.5	-$102.3	-$135.5
92	PN	$20.9	$1642.0	-$38.9	-$41.1	-$40.9	-$26.9	-$9.3	-$6.0
93	RN	-$35.9	$1285.3	-$70.3	-$195.7	-$71.6	-$0.8	-$82.3	-$36.7
94	PN	$11.9	$1669.3	-$37.8	-$83.5	-$20.3	-$13.7	-$18.2	-$1.8
95	R	-$56.2	$2213.0	-$121.5	-$0.6	-$122.5	-$82.4	-$56.8	-$75.9
96	RN	-$74.1	$1748.5	-$121.2	-$116.6	-$121.5	-$0.8	-$101.9	-$75.0
97	RN	-$11.3	$2104.1	-$39.3	-$42.1	-$36.9	-$1.2	-$22.0	-$12.5
98	R	-$47.1	$1850.7	-$113.5	-$1.4	-$90.2	-$75.2	-$48.5	-$65.8
99	RN	-$51.3	$1685.6	-$96.7	-$268.2	-$97.5	-$1.0	-$114.6	-$52.3
100	PN	$5.2	$1661.1	-$38.2	-$121.1	-$21.1	-$6.4	-$27.5	-$1.2
101	RN	-$8.9	$1609.3	-$52.4	-$106.8	-$34.3	$0.0	-$34.6	-$8.9
102	RN	-$16.2	$1654.1	-$60.2	-$253.5	-$42.8	-$0.1	-$75.5	-$16.3
103	RN	-$11.0	$1777.6	-$66.1	-$29.0	-$66.9	-$7.1	-$23.2	-$18.1
104	R	-$38.5	$2151.9	-$104.4	-$3.5	-$104.7	-$44.6	-$42.0	-$51.6
105	RN	-$76.3	$1778.2	-$129.1	-$157.6	-$129.5	-$1.2	-$113.9	-$77.4
106	RN	-$19.8	$2068.1	-$54.3	-$63.3	-$49.7	-$1.3	-$35.6	-$21.1
107	R	$30.5	$1726.6	-$97.6	-$1.8	-$69.3	-$43.0	-$32.2	-$41.8
108	RN	-$8.0	$1578.3	-$65.8	-$31.5	-$37.5	-$1.8	-$16.7	-$9.7
109	R	-$35.0	$1669.7	-$102.6	$0.0	-$74.3	-$16.6	-$35.0	-$38.9
110	RN	-$55.6	$2034.4	-$110.8	-$176.4	-$102.1	$0.0	-$96.8	-$55.7

* See Figure 1 for a description of decisions.

made below each category until the average cost of mistake for a node was less than $5 or a split could not be found such that the number of cases in the smaller branch was at least 10 percent of the number of cases to be split at this point in the tree.

Terminal node 1 gives a culling recommendation of pregnancy test and replace open cows with a bred heifer. This category describes cows that are less than 8.25 years in age, replacement prices less than $555/head, calf prices less than $88/cwt., spring decision period, and a cost differential for spring calving that is $65/head less than fall calving. The amount of node impurity associated with this decision is identified by looking at the cost of mistake value for the recommended decision. This value is $4.17 (cost of mistake value for PR), about $17 less than the next best decision of pregnancy test and not replacing open cows (PN). Under the conditions described, the decision of cull all and don't replace (RN) is the worst decision one could make. The average cost of mistake for RN is $135.30, significantly more than all the other possible decisions. Terminal node 17 has an average cost of mistake of $0.00 for the decision R since none of the decisions are incorrectly classified.

Table 6 also gives the present value for an animal unit that is classed into each terminal node (20 year planning horizon). The category with the highest present value is node 18, at $2,362. This node represents the following; a cow less than 9.25 years of age with a sale calf at side, spring season, an operation where the cost of fall calving is not $65/head more than spring calving, calf price is greater than $88/cwt. and replacement prices less than $555/head. This cow and calf are not worth $2,362 but expected future returns from this starting point and subsequent optimal replacement decisions for a 20 year planning horizon yield a present value of $2,362 (6% real discount rate utilized).

The value of pregnancy testing for one period is determined by subtracting the lowest cost of mistake value for pregnancy testing (i.e., PR, or PN) from the lowest uniform culling decision (i.e., K, R, K6, or RN) cost of mistake. For example, for node 1 the lowest uniform cost of mistake value is K at $35.93. The lowest pregnancy test cost of mistake is PR at $4.17. Subtracting $4.17 from $35.93 yields a value of pregnancy testing of $31.76. Node 11 has a value of pregnancy testing equal to -$46.28. The value of pregnancy testing can go much lower than -$2/head or the assumed cost of pregnancy testing each cow. This is because cows that test open are always culled from the herd even if market prices and age indicate that these cows should be maintained in the herd. And pregnant cows are always maintained in the herd, even if market prices and biological factors are conducive to replacing these cows with a bred heifer or culling them and not replacing them in the current period. The lower limit of -$2/head would only occur if cows that tested open or pregnant were kept or culled according to optimal culling decisions.

Figure 2 compares the long run economic merits that accrue to (i.e., present

Figure 2. Present Value of Selected Culling Strategies.

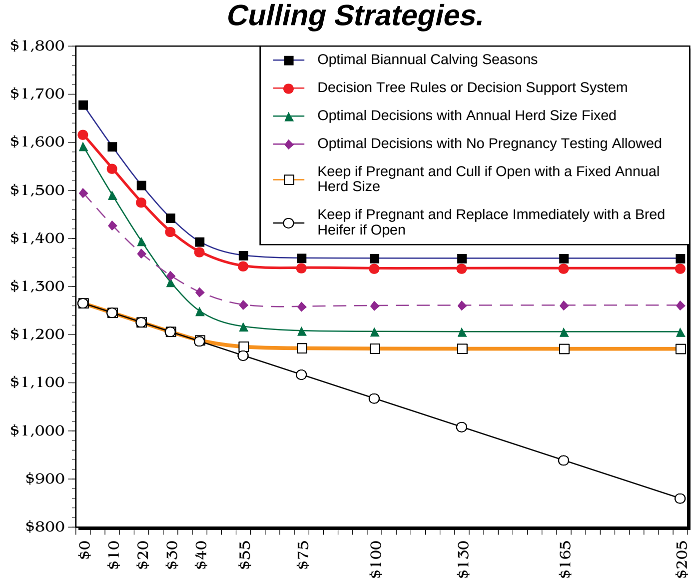
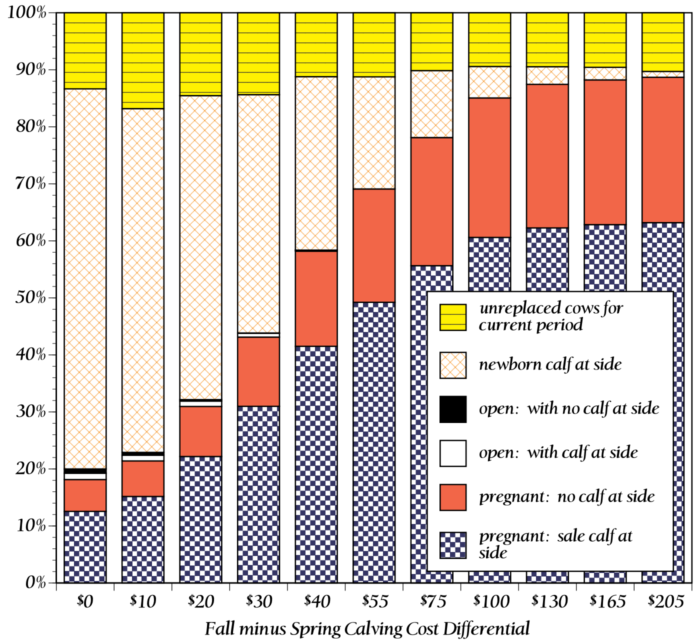


Figure 3. Long Term Status of Herd in the Fall for Different Calving Cost Differentials.



value of a 20 year planning horizon) six different culling strategies. The strategies considered are: 1) optimal culling decisions with pregnancy testing allowed and herd size variable, 2) decision tree rule presented in Figure 1 that simplifies the 43,120 decisions from the dynamic programming model (decisions used to obtain 1), 3) optimal culling decisions with a fixed annual herd size, 4) optimal culling decisions made with herd size variable and no pregnancy test information, 5) keep if pregnant and cull if open culling decisions with a fixed annual herd size, and 6) keep if pregnant and replace open cows immediately with a bred heifer. The present value of a slot in the herd is at a maximum of $1,678 if the cost differential between spring and fall calving is $0.0 and optimal culling decisions are made with a variable herd size and pregnancy testing is allowed. The present value falls quite rapidly as the cost differential increases to $55 and then levels off to a value of $1,359 with a spring only calving season. A biannual calving season has an expected net worth of $319 ($1,678-$1,359) more than a spring only calving season when the cost of spring and fall calving are equal. Two items contribute to this increase in profitability. First, sale calf prices have been historically higher in the spring than fall. As described in Figure 3, on average around 70% of the herd should have a newborn calf at side in the fall. These calves will be sold in the spring at a relatively higher price than if they were sold in the fall. Second, open cows can be brought back into production six months earlier (by allowing the cow to switch calving seasons) than with a spring only calving system. As described in Figure 3, a small percentage of open cows are maintained in the herd when the cost differential of fall minus spring calving is less than $40 or when biannual calving seasons are viable. Figure 3 indicates that about half of the calves should be born in the spring and the other half in the fall if the cost of fall calving is $30 to $40 greater than spring calving.

The decision tree culling rules shown in Figure 1 capture anywhere from 96.4% of the optimal returns with a $0.0/head calving cost differential to 98.5% with a calving cost differential above $40/head. The third management alternative evaluated is a biannual calving season with a fixed herd size. As shown in Figure 3, around 10% of the slots in a herd are not replaced immediately in the current period. This means that on average price conditions are often not conducive for immediately bringing a replacement into the herd. The impact of not allowing herd size to vary can be seen by comparing the present value of optimal decisions with herd size variable (strategy 1) and annual herd size fixed (strategy 3). The fixed herd size is 5% less profitable over the long run than optimal culling decisions with a $0.0/head calving cost differential and decreases to over 13% less cumulative profit with a calving cost differential greater than $75/head. Size is fixed in an annual sense because replacements are not forced to take the place of a cow that may die or be determined physically unfit in the spring. That is, replacements are not forced into the herd to calve in the fall when the cost of fall calving is not economically viable.

Table 6 describes the value of pregnancy testing for one season. Figure 2 quantifies the long run value of pregnancy testing by comparing the optimal returns generated when pregnancy testing is allowed (strategy 1) to those when pregnancy testing is not allowed (strategy 4). The fourth management strategy considered allows for biannual calving and a variable herd size, but optimal culling decisions are made on the basis of not having the ability to obtain any pregnancy test information. The long run value of pregnancy testing is estimated at $183 when the differential is $0.0/head. This value falls to $105 with a $40/head calving cost differential and levels off at around $98 with a cost differential above $100/head. Although pregnancy testing is not always profitable, having the technology to obtain pregnancy status information at $2/head allows for increasing long term ranch profitability from 7% to 11%.

The fifth management strategy keeps all cows that are pregnant and culls all open cows. Open cows must be replaced within a year since annual herd size is fixed. As seen in Figure 2, this strategy yields $413 less expected wealth with a $0 cost differential than optimal biannual calving seasons. As the calving cost differential increases above $55, expected wealth is $188 or about 13% less than optimal biannual calving seasons. Clearly, pregnancy testing alone is not the answer to increasing ranch profitability. In fact the more traditional management strategy of pregnancy testing all cows and culling all open cows (strategy 5) results in anywhere from 8% to 18% less profit than optimal culling decisions made without any pregnancy test information. The last management strategy considered forces open cows to be replaced with a bred heifer immediately. Plus cows that test pregnant must be maintained in the herd. Cows that die or are determined to be unfit in the spring, must be replaced with a bred heifer even if the cost of fall calving is $100/head greater than spring calving. This strategy illustrates the impact that bringing cows into the herd to calve in the fall has when the cost of fall calving escalates. As the cost of fall calving exceeds spring calving costs by over $55, profits plummet in almost direct proportion to the increase in the cost of fall calving.

Age Distribution

Figures 4 and 5 give the anticipated age distribution in the fall under optimal biannual culling decisions (strategy 1). Panel b gives a cumulative age distribution from the percentages in panel a.

Figure 4. Long Term Age Distribution in the Fall with a $0 Cost Differential.

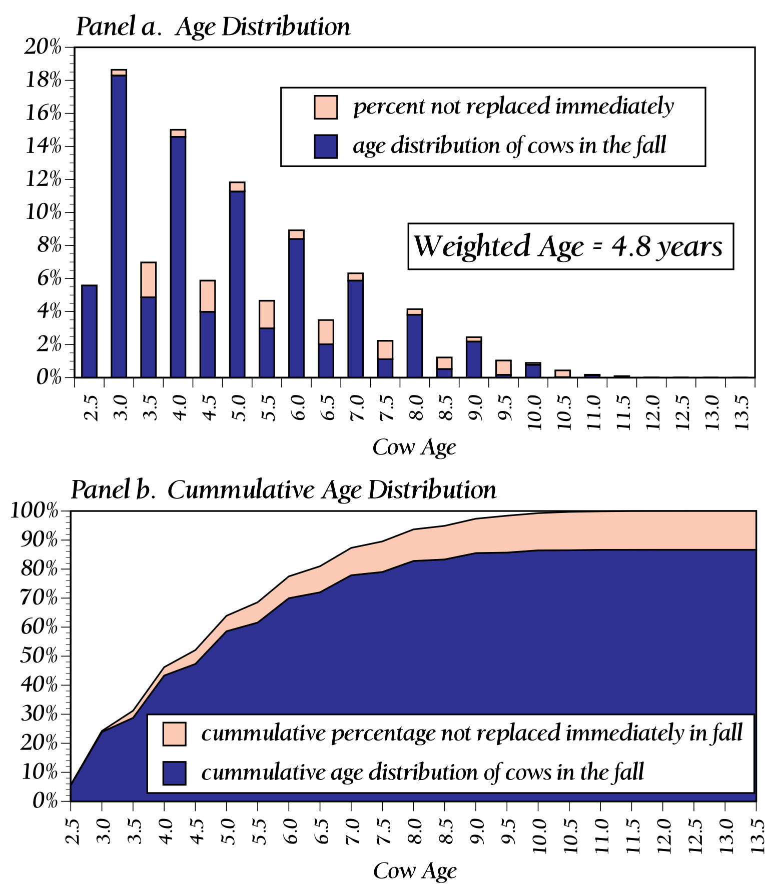
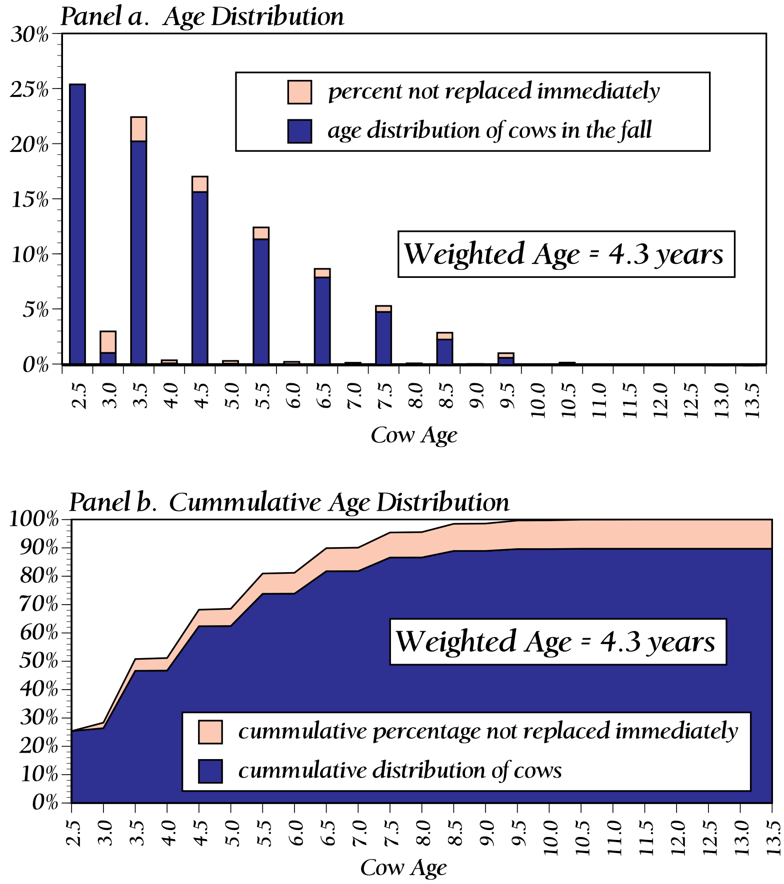


Figure 5. Long Term Age Distribution in the Fall with a $250 Cost Differential.



The cost of spring and fall calving are equal in Figure 4, whereas the cost of fall calving exceeds spring calving costs by $205 in Figure 5. Cow age is slightly higher for the $0 than $205 calving cost differential. In the fall, an average cow age of 4.8 years is expected with a $0 cost differential, one-half a year more than when fall calving costs exceed spring calving by $205. Cow age is determined after replacement decisions have been made. With essentially a spring only calving season, about 25% of the herd is expected to be composed of 2.5 year old bred heifers after culling decisions have been made. This greatly contributes to a relatively young cow age.

A $205 calving cost differential implies that essentially all bred heifers will enter the herd in the fall to coincide with a spring calving cycle. Whereas with a $0 cost differential, bred heifers are more likely to enter the herd in the spring so that sale calves can be sold at a relatively higher spring market the subsequent spring. During the spring season, the average age for a $0 and $205 cost differential is 4.5 and 4.6, respectively. When averaging age across seasons, $0 and $205 cost differentials have a combined fall-spring average age of 4.65 and 4.45 years, respectively. Biannual calving with no cost penalty for fall calving increases the optimal age of the herd by about 1/5 of a year. All cows are culled by 12 years of age with a $0 calving cost differential. When the calving cost differential increases to $205, essentially all cows are culled before they reach 11 years of age.

The analysis assumes that the cost of bringing a bred heifer replacement on the ranch is the market price plus $10/head for veterinary costs and $10/head for trucking costs. Feed and/or management costs were increased by $50/head over older cows for bred heifers during their first year of ownership. A 4% shrink, 1.5% sale commission and $.01/lb. in trucking costs were deducted from the revenues obtained from selling cull cows. Any increase in these transaction costs of replacing culled cows with replacements would increase the long term age of the herd. Also, replacement prices may be relatively high for some remote local areas. If this were true, this would also increase the long term age distribution of the herd. However, results suggest that a relatively young and thrifty herd is the most economically viable management strategy.

Conclusions

A good culling strategy has the potential to increase your long run ranch profitability to the tune of 7 to 10 percent over many of the simple strategies used in the past. The following questions are critical to ask about your culling strategy:

1. Should I preg test. If so which cows?
2. Should I maintain a constant herd size?
3. Should I calve in the spring, fall or both?

These are not simple questions. The results presented for our biological data suggest that in general you should preg test, not maintain a constant herd size, and depending on your cost differential between fall and spring calving, calve part of your herd in spring and fall. The specific recommendations change as market conditions change. This reaction to market conditions is in one of the keys to increasing profits by using our culling strategy system.

To simplify the development of culling recommendations for situations similar to our baseline herd we have set up a World Wide Web (WWW) site with an interactive version of our decision tree that will give you culling recommendations for specific market conditions. Check it out at http://ag.arizona.edu/AREC/cull/culling.html.

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FROM:

Arizona Ranchers' Management Guide
Russell Gum, George Ruyle, and Richard Rice, Editors.
Arizona Cooperative Extension

IS A BED AND BREAKFAST RANCHING?

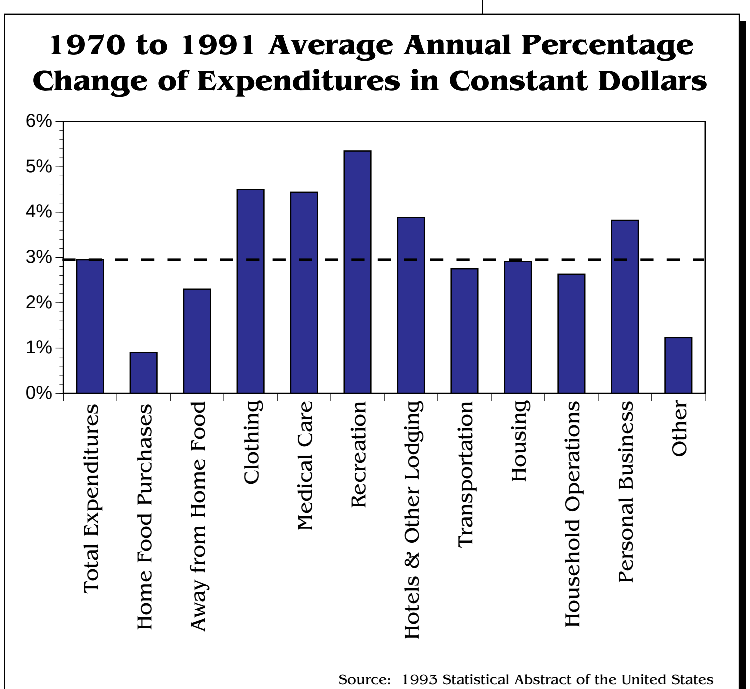
Russell Tronstad[1]

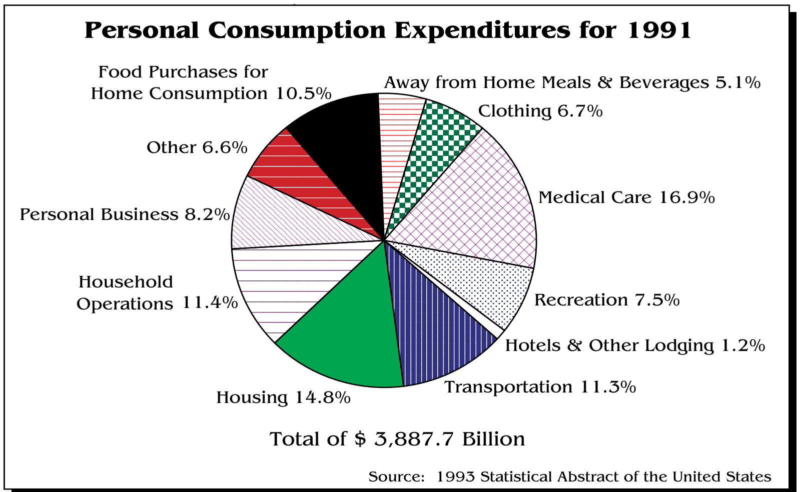
Situation

Ranchers have heard for years that the demand for beef has been slipping due to perceived health concerns and increased competition from other meat products. With cattle numbers increasing and prices looking bearish many ranchers may be wondering if they are in the right business. In general, food products haven't faired as well at fetching consumers' dollars as other industries.

As shown in the accompanying bar chart, consumer expenditures of food purchases for home consumption have increased at an annual rate of less than 1% since 1970 after adjusting for inflation. Even restaurant food and beverage purchases have not kept up with average expenditure increases. Annual consumer purchases of all goods have increased slightly under 3%. Not surprisingly, the medical care industry has been a big growth industry by increasing 4.3% annually and accounting for 16.9% of all consumer expenditures in 1991, as shown in the pie chart on the following page. But an industry that has grown more rapidly than health care is recreation. After adjusting for inflation, Americans have increased their expenditures on recreation activities and goods more than 5.3% annually since 1970. Other expenditure groups above average are clothing, hotel and other lodging purchases, and personal business expenses. Some of the items and activities included in recreation are expenditures on books, magazines, video and audio products, amusement park fees, flowers, lottery purchases, pets and pet care services, golf fees, boats, pleasure aircraft, and many other recreational services.

Many ranchers have recognized that recreation is a growth industry and they been complimenting their existing operation by offering ranch tours, big game hunting, horse back riding, cattle drives, and Bed & Breakfasts (B&B) with various amenities. Other ranchers have indicated that getting people on their ranches is the best way to educate the public. Public education may be key to the survival of many ranches that have public land grazing rights. If people can see first-hand how they run their operation and depend on the land for their living they will see that ranchers are not out to exploit the land. Public land manage-





ment issues will continue to be debated over what is the most appropriate stocking rate and fee for grazing public lands.

Strategies

Some ranchers have been able to educate the public first-hand on how they operate their ranch while capitalizing on some of the recreational demands that tourists are demanding. For example, Peggy Monzingo of Benson, Arizona started up a ranch B&B a few years ago in order to educate the public on environmental and public land issues. "Ranchers need to do their part in educating the public first-hand and correctly since so many are misinformed," says Peggy. She has a love for the land and a concern for how encroaching urbanization and public policies can disrupt an ecosystem. These factors ultimately impact both the aesthetic appeal and economic viability of the land. The B&B has given her an opportunity to educate individuals one-on-one in the field, meet many interesting people, and receive some "positive cash flow" for the first time in her life. Positive cash flow is non-existent in the checkbook ledger of most ranchers.

Wyoming has an established ranch B&B industry with over 60 registered in the 1994 Wyoming Homestay & Outdoor Adventures (WHOA) guide. Wyoming has set their own regulations and definitions for a ranch B&B. A ranch B&B is defined as "a private home which is used to provided temporary accommodations for a charge to the public with not more than four lodging units or not more than a daily average of eight persons per night during a thirty day period and in which no more than two family style meals are provided per 24 hour period. A minimum of 160 acres is needed to qualify for a ranch recreation enterprise. These operations are definitely not "dude ranches," and virtually all are businesses that earn most of their living through livestock or crops. Although B&B rates are seasonal, the most common price charged falls between $50-$75 per night.

As with any business, you must decide what audience you want to attract and tailor your business for that group. Identifying the natural resources on your ranch and the people skills you possess will help determine what audience you want to target. If you are located near a large urban population you can probably attract many families that want to get-away and relax for the weekend. Note that most people are looking for space and the more emptiness you have to offer, the better. Remember that you are selling an experience that goes beyond sleeping quarters and meals. If you have a trout stream that runs through your property you might tailor your operation for fishing. But again remember that you are probably selling an experience that allows a father and son to fish in solitude rather than just selling fish. National parks and monuments, and other tourist attractions nearby can be an asset for you in attracting customers to a ranch B&B. B&Bs allow travelers the opportunity to experience a new flavor of vacationing that deviates from what they may be accustomed to. While today's travelers may want to taste a bit of the roughing and romance that goes with some experiences like ranch chores and branding, most want a private bath, soft bed, and hot shower every morning.

Having something unique to offer is a definite plus for selling a recreational experience. J. Irwin Young of Alamosa, Colorado decided to concentrate on raising tilapia fillets in the geothermal waters of southern Colorado in 1987. He didn't like the idea of throwing all the bones and other fish remains away so he got the idea that he would use this as feed for alligators. But once people found out that alligators were alive in the Rocky Mountains it wasn't long before they were spending more time giving tours than raising fish. That's when J. Irwin decided they needed to start charging for their farm tours. Last year they had over 30,000 tourists and charged $2.00 per person for tourists to view their alligators and fish ponds.

Implications

Ranch B&Bs are continuing to grow as an industry as consumers lure to the appeal of open space and new adventures. Recreation expenditures continue to show that recreation is a high growth industry. Although "ranch recreation" is definitely not in the personality genes of all ranchers, ranch recreation should not be ignored as being a viable tool for enhancing ranch income, improving cash flow, educating the public, and meeting interesting people. Testing the waters by starting small and using existing facilities is a good strategy. Word of mouth from satisfied customers is commonly the most effective advertisement for "recreation experiences." Many people find B&Bs by calling the chamber of commerce before they go to visit an area. The typical ranch B&B consumer is interested in what you grow, how it grows, and why your operation grows it. This consumer differs remarkably from the traveler that pulls into a Motel 6 off the freeway at 10:00 o'clock at night and is ready to hit the road again at 6:00 a.m.

Competition is often an element of concern for ranch B&Bs. But two neighboring ranches starting a B&B at the same time may be more complimentary than competitive. Overflow customers can be forwarded to the neighboring ranch rather than to the nearest town. As mentioned above, the beauty and desirability of your area is often best spread by word of mouth. Recreation ranches benefit from more first-hand exposure by being in the same general area than if they are in two different locations.

Liability insurance is a concern of all individuals involved with ranch recreation. First, make sure that you identify dangerous situations on your operation and eliminate these conditions where possible. If a dangerous condition cannot be eliminated then restrict the accessibility of this area. Make sure that your employees are alert and trained to identify situations that are potentially dangerous. After informing individuals through a checklist of the risks inherent in an activity they are contemplating, have individuals acknowledge in writing that they were informed of these risks. Finally, liability insurance has no good substitute and should be included in your costs of providing "recreational experiences." Insurance carriers may limit the activities that you can provide and still maintain coverage with them.

Opening your ranch to the public is definitely not for everybody. How much you enjoy people and are able to deal with a group of "greenies" on your property is the first resource needed to be successful at ranch recreation. As Jeff Powell of Wyoming notes, "you may not have to be friendly to your cows all the time but with visitors you have to or they won't come back." Jeff Powell and Susan Rottman of Laramie, Wyoming have established RLS International (307-635-5746), a business that specializes in giving seminars and workshops on "recreational ranching." They discuss various aspects from marketing, advertising, and liability insurance to planning menus. Some ranching communities in the Western States have brought in this kind of expertise to access and help develop their recreation potential.

Another source for ranch recreation information is the Handbook entitled "Direct Farm Marketing and Tourism," by Arizona Cooperative Extension and Arizona Department of Agriculture. To obtain a copy send a check for $25.00 payable to Arizona Department of Agriculture/DFMT to:

Office of Commodity Development
and Promotion
P.O. Box 234
Phoenix, AZ 85001

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OVERVIEW OF RANCH FINANCIAL ANALYSIS SPREADSHEET

Russell Tronstad[1] and Trent Teegerstrom[2]

INTRODUCTION

This article provides an overview of a spreadsheet template developed to help cow-calf producers in Arizona analyze the profitability of common ranch management decisions. Important requirements for a ranch analysis tool are the ability to easily conduct economic analyses of management decisions and to narrow in on the strengths and weaknesses of a ranching operation. These requirements are satisfied in the spreadsheet template presented through a compilation of several worksheets linked together. For example, cash expenditures and revenues are linked with biological livestock inputs, such as cow fertility and sale weights, so that biological impacts are incorporated into the economic evaluation of a management practice, such as supplemental feeding.

USING THE TEMPLATE

The following seventeen different worksheets are placed together in the same spreadsheet template file to help analyze ranch profitability.

1) Actual Cash Flow — Allows the user to input monthly cash receipts and expenditures into several categories. Information entered on the actual cash flow spreadsheet occurs at the end of each month throughout the yearly business cycle of the ranch. Actual cash flow values can be used to evaluate historical cash performance per exposed cow or be used as a guide for future cash flow needs.

2) Projected Cash Flow — Cash expenses and revenues are monthly projections rather than actual expenditures and revenues as in the actual cash flow worksheet. The projected cash flow should be completed before the start of the year so that it can show when and where irregular transactions occur throughout the year or identify if total expenditures are increasing at an unanticipated rate.

3) Net Cash Position — Graphical view by month of actual and projected cash positions of the ranch. This worksheet can be used to see how close projections are to actual cash flow values.

4) Biological Cow Data — Worksheet includes total cow numbers by age along with accompanying conception rates, calving percentages, death losses, and percentage of cows culled because they are unfit. Livestock numbers are linked to the planning worksheet of production, health, feed, and grazing.

5) Production Planning Sheet — The herd production planning sheet is basic to developing total revenue and expense figures for the ranch. Livestock categories of steer and heifer calves (spring and fall born), steer and heifer yearlings, cows by age, bulls by age, and horses by working condition are provided. Planned livestock purchases are placed in column E for every livestock category. Heifer calves planned for use as replacements are entered in column F. Death losses for calves between birth and weaning, yearlings, bulls, and horses are entered in column H. Sale weights and prices received (columns L and M, respectively), plus beginning (column C) and ending (column N) year cash values are also entered in this worksheet. From these inputs, the total change in livestock inventories for the year is easily calculated.

6) Fixed Costs Planning Sheet — Vehicle and equipment purchases, fencing, building improvements, grazing

Figure 1. Control Sheet Headings and Decision Control Cell

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	A / C	D	E	F	G	H	I
1–3	ACTUAL CASH FLOW Pg. 1 Prices & Number of Head	Year End Year to Date	Modified Projections	New Total With $ Change	Projected Year End	Dec. Control =1,Activates Planning Sheets	New Total With Planning Sheet
4	# of Spring Calves (Steers)	196		196	199	1	164
5	Spring Calf Price ($ Per Head)	$318.75				1	$333.75
6	# of Spring Calves (Heifers)	161				1	129
7	Spring Calf Prices ($ Hd.)	$280.00				1	$294.00
8	# of Fall Calves (Steers)	10				1	9
9	Fall Calf Price ($ Per Head)	$328.63				1	$348.00
10	# of Fall Calves (Heifers)	11				1	9
11	Fall Calf Prices ($ Hd.)	$287.64				1	$300.00
12	# of Yearling Steers					1	
13	Steer Price ($ Hd.)					1	$390.00
14	# of Yearling Heifers					1	
15	Heifer Price ($ Hd.)					1	$455.00
16	# of Cull Cows	23		23	11	1	24
17	Cull Cow Price ($ Hd.)	$535.87		$535.87	$536.36	1	$534.53
18	# of Cull Bulls	5		5	6	1	5
19	Cull Bull Prices ($ Hd.)	$980.00		$980.00	$950.00	1	$980.00
20	**Operating Receipts**						
21	Spring Calves (Steers)	$62,475.00		$62,475.00	$63,680.00		$54,842.58
22	Spring Calves (Heifers)	$45,080.00		$45,080.00	$46,110.00		$38,020.77
23	Fall Calves (Steers)	$3,286.25		$3,286.25	$4,420.00		$3,005.29
24	Fall Calves (Heifers)	$3,164.00		$3,164.00	$3,720.00		$2,587.77
25	Yearling Steers						
26	Yearling Heifers						
27	Monthly Totals	$114,005.25		$114,005.25	$117,930.00		$98,456.42
28	**Capital Receipts**						
29	Cull Cows			$12,325.00	$5,900.00		$12,828.75
30	Cull Bulls			$4,900.00	$5,700.00		$4,900.00
31	Other Livestock			3		1	3
32	Horses Pric			$600.00		1	$1,400.00
33				$1,800.00			$4,200.00
34	Equipment					1	
35	Monthly Totals	$19,025.00		$19,025.00	$11,600.00		$21,928.75
36	Total Combined Income	$133,030.25		$133,030.25	$129,530.00		$120,385.17

Decision Control cell (type 1 in cell H4) for activating planning sheets.

Tabs below indicate that the worksheet of "Control Sheet" is selected.

FIXED COSTS PLANNING SHEET | CONTROL SHEET | COST & RETURNS | TOTAL DIAGNOSTIC TREE

resources, and other related non-livestock asset costs are entered in this worksheet. This sheet calculates annual payments and depreciation (straightline) utilizing purchase price, estimated useful life, salvage value, down payment, interest rate, and loan term (years) values. Other values entered include the beginning and ending year cash value of the asset. Cash values are used to determine changes in owner's equity.

7) Control Sheet — This sheet is a control sheet for determining whether cash flow values (actual shown in column G or modified as entered in column E of Figure 1) or values associated with all planning sheets feed into the diagnostic worksheets. A value of 1 entered in cell H4 activates values from all planning sheets associated with livestock inventories and fixed asset information to be transferred to the ranch diagnostic and financial sheets.

Note that a value of 1 is placed next to all items in column H that trigger a value to be called from the planning sheet. Values from planning sheets link to column I of the Control Sheet so that year-to-date cash values, projected cash values, and projected totals from the planning sheet can be seen side-by-side. A value other than 1, say 0 in cell H4, will reflect just cash transaction values in the ranch diagnostic and financial sheets. See Figure 3 for a graphical snapshot of how all the sheets link together and note that the Control Sheet is a flow control sheet. Note that throughout all of the worksheets, user input can be provided whenever a cell is shaded inside a line-box—otherwise values are automatically calculated from prior input.

8) Cost & Returns — This report gives a legend summary of total and per unit cash receipts and expenditures by major category. Returns after cash outlays, returns after inventory changes, and returns to unpaid labor, management, and risk are provided. Break-even steer prices ($/cwt.) for each cwt. of steer calf sold are also provided at each level. Note that only gross income less the cash outlay calculations are valid unless cell H4 in the Control Sheet equals 1 or "planning sheets" are in use.

9) Total Diagnostic Tree — Total cash and accrual profit values are decomposed into the general areas of gross sales (calves, yearlings, cows, bulls, and horses), cash production costs, cash overhead costs, depreciation, adjusted cash value of fixed assets, and livestock adjusted inventory income. Note that the accrual profit value is relevant only if the planning sheets are utilized (i.e., cell H4 in the Control Sheet equals 1). This sheet can be used as a visual snapshot to identify critical areas of ranch management depending on how large the expenses and revenues by general category are for the ranch. A management change of building a new tank that increases the grazing capacity of the ranch by 5 AUYs can be easily analyzed from this sheet.

10) Diagnostic Tree Per Exposed Cow — This sheet takes the information from the total diagnostic tree worksheet and displays it on a per exposed cow basis. This sheet has great value for comparing expenditure and revenue performance across categories for different ranches. Management decisions such as creep feeding calves can be easily evaluated from this sheet, while focusing on the final cash and accrual profit per exposed cow. Creep feeding will directly increase labor and feed costs, but it will also impact weaning weights and sale prices. How all of these factors fit together can be easily evaluated by looking at the final cash and accrual profit values per exposed cow in this sheet.

11) Finance Measures — Common financial measures such as current assets and liabilities and owner's equity are reported in this sheet. Financial ratios associated with liquidity and solvency are also presented.

12) Health Expense Planning Sheet — Veterinary expenses associated with pregnancy testing, bull testing, vaccinations, and implants can be itemized out in this sheet for all livestock given in the production planning sheet.

13) Feed Expense Planning Sheet — Cost of supplement, minerals, salt, and hay is calculated from the inputs of cost of the feed ($/ton), pounds of feeding per day, and the number of days on feed. Livestock numbers provided in the production planning sheet are also linked to calculate total feed costs.

14) Grazing Planning Sheet — This sheet is tailored for public grazing fees of Bureau of Land Management, U.S. Forest Service, and State land. Grazing fees for these agencies are generally different, so the number of grazing months for each class of livestock on these different lands, along with any Animal Unit Month (AUM) conversion is required to calculate total grazing costs. Private grazing months and costs should also be included, if applicable. Grazing costs associated with land that is owned comes from the fixed cost planning sheet.

15) Labor Expense Planning Sheet — Hired labor associated with a manager, a bookkeeper, or cowboys is easily input into the labor expenses of the ranch using this sheet. Benefits such as FICA, Workman's Compensation, or other benefits can be easily calculated in this sheet to determine total labor costs.

16) Actual Cash Flow Charts — Several figures display total cash income and expenses, operating receipts, variable costs, and overhead costs by major category and month. These charts display values from the actual and projected cash flow worksheets.

Figure 2. Key Output Associated with Retained Ownership Worksheet

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Note that profit figures do not account for any Commission and Margin Expenses or other costs not listed here

	Expected Sale Price ($/HD)	PROFIT INCLUDING PROF OBJ ($/HD)	PROFIT INCLUDING PROF OBJ (% ret)	PROFIT EXCLUDING PROF OBJ ($/HD)	PROFIT EXCLUDING PROF OBJ (% ret)	Price able to Purchase Feeders at Given the Profit Objective Desired ($/HD)	Price able to Purchase Feeders at Given the Profit Objective Desired ($/lb)	Purchase Date	Purchase Weight (lbs)
40	$710.32	$36.99	19.13%	$61.99	31.63%	$386.49	$0.96623	30-Aug-99	400
41	$727.40	$13.66	7.71%	$38.66	21.50%	$425.53	$0.85106	30-Aug-99	500
42	$777.94	$23.78	13.59%	$48.78	24.62%	$488.03	$0.81339	30-Aug-99	600
43	$793.42	($4.08)	-2.46%	$15.92	9.44%	$527.04	$0.75292	30-Aug-99	700
44	$828.12	($2.74)	-1.97%	$17.26	12.16%	$576.26	$0.72032	30-Aug-99	800
46	$685.36	$0.42	0.21%	$25.42	12.74%	$352.62	$0.88155	30-Sep-99	400
47	$727.40	$2.01	1.12%	$27.01	14.77%	$417.26	$0.83452	30-Sep-99	500
48	$777.94	$11.55	6.49%	$31.55	17.46%	$479.85	$0.79976	30-Sep-99	600
49	$812.09	$2.55	1.51%	$22.55	13.17%	$538.40	$0.76914	30-Sep-99	700
50	$828.12	($15.02)	-10.61%	$4.98	3.46%	$569.38	$0.71173	30-Sep-99	800
52	$685.36	($2.51)	-1.27%	$22.49	11.22%	$352.39	$0.88098	30-Oct-99	400
53	$701.84	($27.19)	-15.01%	($2.19)	-1.19%	$391.44	$0.78288	30-Oct-99	500
54	$750.60	($20.13)	-11.25%	($0.13)	-0.07%	$452.22	$0.75370	30-Oct-99	600
55	$812.09	($2.50)	-1.48%	$17.50	10.16%	$538.08	$0.76868	30-Oct-99	700
56	$847.60	($1.26)	-0.88%	$18.74	12.92%	$588.54	$0.73568	30-Oct-99	800
58	######	#######	#######	######	#######	#######	#######	30-Nov-99	400
59	$701.84	($27.59)	-15.23%	($2.59)	-1.41%	$391.41	$0.78282	30-Nov-99	500
60	$750.60	($20.61)	-11.51%	($0.61)	-0.34%	$452.19	$0.75365	30-Nov-99	600
61	$783.55	($31.60)	-18.64%	($11.60)	-6.73%	$509.50	$0.72786	30-Nov-99	700
62	$847.60	($1.89)	-1.33%	$18.11	12.47%	$588.51	$0.73563	30-Nov-99	800
64	######	#######	#######	######	#######	#######	#######	30-Dec-99	400
65	######	#######	#######	######	#######	#######	#######	30-Dec-99	500
66	######	#######	#######	######	#######	#######	#######	30-Dec-99	600
67	$783.55	($37.06)	-21.71%	($17.06)	-9.83%	$504.04	$0.72006	30-Dec-99	700
68	$817.82	($36.80)	-25.64%	($16.80)	-11.50%	$553.60	$0.69200	30-Dec-99	800

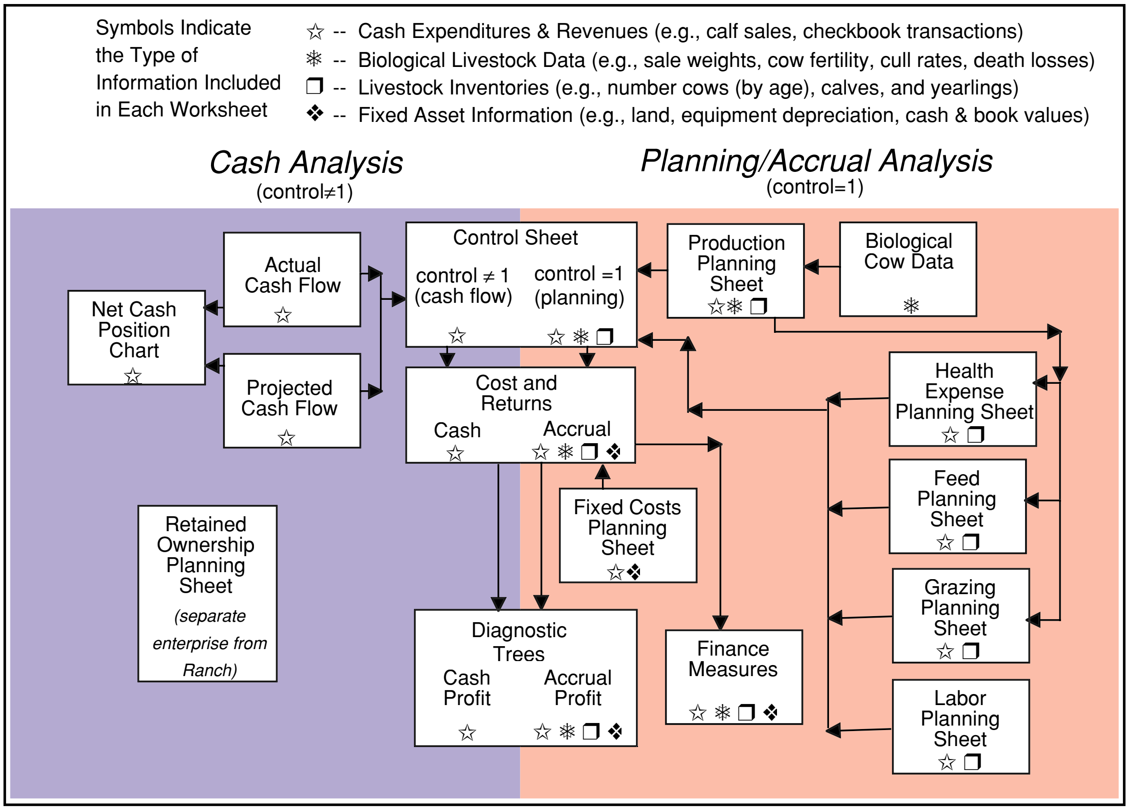
ACTUAL CASH FLOW CHARTS | RETAINED-OWN EVALUATION SHEET

17) Retained-Own Evaluation Sheet — Retained ownership is considered a separate enterprise from the ranch, so this worksheet is not linked to any of the other worksheets given above. This sheet provides the expected return from retained ownership, utilizing future market data available for when animals would be placed in the feedlot. Five different initial feeder weights (i.e., 400, 500, 600, 700, and 800 pounds) are evaluated side by side for five different "purchase dates" or days for entering the feedlot. Most current futures prices (all time horizons), along with expected basis values (cash minus futures) need to be entered. Figure 2 shows some of the key output values, such as: expected profit per head (columns AJ and AM) and annual adjusted percentage rate (columns AK and AN); feed (column AD) and total cost of gain (column AF); and break-even price for purchasing feeders (columns AP and AR). A total of 25 different purchase date and weight combinations are provided. Purchase date and weight combinations that are too far into the future for a feeder to be sold using the fed futures when purchased are displayed with "######".

Figure 3 displays how all the worksheets described above fit together. Four general categories of information are: 1) cash expenditures and revenues (e.g., calf sales, checkbook transactions); 2) biological livestock data (e.g., sale weights, cow fertility, cull rates, death losses); 3) livestock inventory values (e.g., head counts, cash values); and 4) fixed asset information (e.g., land, equipment depreciation, cash and book values). Figure 3 describes how these general categories of information flow from one worksheet to the next. Note that planning sheets must be in use (i.e., cell H4 in the Control Sheet equals 1) for any accrual values associated with livestock inventory or fixed asset information to feed forward into financial measures, costs and returns, and diagnostic tree worksheets.

The spreadsheet template is available from the authors for free, but you still need to input your baseline data. After

Figure 3. Flow Diagram of Excel Ranch Analysis Workbook



entering data from your ranch, you can evaluate your operation using the diagnostic trees and see where you should target changes in your management. Management decisions can be easily evaluated once you have entered your baseline data. For example, if you are considering supplemental feeding as a way of increasing calving rates, you could enter the proposed feeding schedule into the feed expense planning spreadsheet and change the calving rates in the biological cow data spreadsheet. A quick look at either the diagnostic tree per exposed cow or the cost and return worksheet would display the estimated impact on expected profits. Other potential management plans could be evaluated in a similar fashion.

Once a plan has been selected and implemented, it must be monitored. This includes physical aspects, such as calving rates, as well as economic aspects, such as expenses and market prices. When differences occur between the plan and reality, it is time to evaluate the reasons for the differences and possibly develop a revised management plan. At this point, the spreadsheet template presented can again be used as a tool to assist in the planning process.

CONCLUSIONS

Although spreadsheets are not structured to capture all the dynamics that can be associated with management decisions, they are relatively easy to follow and understand. Once a spreadsheet template is developed, it can easily be modified and tailored to a specific situation. Another advantage of using spreadsheets for planning is that you may get new ideas about management strategies by going through the planning process.

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ACTUAL & PROJECTED CASH FLOWS

Trent Teegerstrom[1]

INTRODUCTION

This article describes the actual and projected cash flow worksheets that are included in the ranch analysis spreadsheet template (see previous article).

Cash-flow analysis is an important step in taking control of any agricultural business. This is especially true in the ranching industry. In ranching, expenses happen on a daily basis, but the main income occurs only one or two times a year. The allocation of income to cover expected costs throughout the year will help ensure that all credit obligations are met. It is equally important not only to track current cash flows, but also to project at the start of the production year all expected income and expenditures. Once expected income and expenditures are recorded, comparisons can be made between projected and actual cash flows to help point out any discrepancies.

Actual cash flow allows the user to summarize all cash receipts (inflows) and expenditures (outflows) affecting the ranch during the yearly business cycle. Daily receipts and expenditures are organized into categories and entered on the actual cash flow worksheet for the end of each month. Actual cash flow values can then be used to evaluate historical cash performance of the business, as well as serve as a guide for future cash flow needs throughout the current business year.

The projected cash flow worksheet is a summary of monthly cash receipts and expenditures projected or expected for the upcoming year. The projected cash flow worksheet should be completed *before* the start of the year so that it shows when and where irregular transactions occur throughout the year and identifies if total expenditures are increasing at an unanticipated rate.

The projected cash flow worksheet in the spreadsheet template is linked to the actual cash flow worksheet and provides a monthly and year-end comparison between the two worksheets. Differences between monthly and projected transactions are reported below each of the totals and subtotals. A graphical presentation of the ending monthly cash balance is automatically shown on the net cash position worksheet.

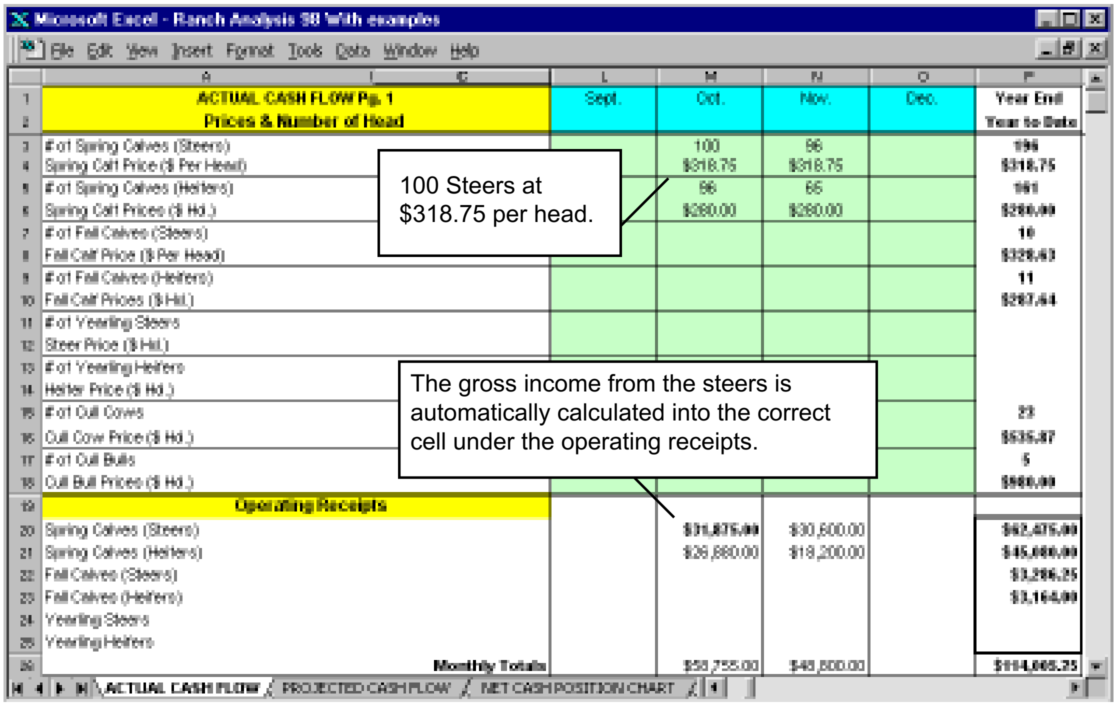
COMPONENTS OF THE WORKSHEETS

Both of the cash flow worksheets are broken up into twelve main areas by type of receipt and expenditure. Under each of the main receipt and expenditure areas are subcategories further defining each cash entry. Each of the twelve main areas is presented below with descriptions of what is contained within the areas and, where appropriate, examples of data entries are presented. Data should only be entered in the areas shaded in green on the worksheets. All other areas are calculated fields and fill in when the information is provided in the green shaded sections.

1) Price and Number of Head—This area is for recording the number of head sold and the price received per head for the different classes of animals sold: fall and spring calves, yearlings, cull cows, and cull bulls. Operating receipts and some of the capital receipts are calculated from this information and reported in the proper area of the worksheets.

Example 1 demonstrates the first two sections of the cash flow worksheet. In this example, a ranch sells 100 spring

Example 1. Operating Receipts



steer calves in October for $318.75 per head. On the worksheet, 100 steer calves is entered in cell M3 for the steers sold in October and then 318.75 is entered in cell M4 for the corresponding price per head.

2) Operating Receipts—Operating receipts are receipts generated from the yearly operation of the ranch, such as calf sales. These receipts are calculated from the information provided in the prices and number of head section. No entry of information is needed in this area.

In Example 1, the total amount received ($31,875.00) for the spring steer calves appears in cell M20.

3) Capital Receipts—Capital receipts are generated from the sale of a capital asset, such as breeding livestock, working horses, or equipment. These capital items are usually part of the business for more than one operating year. Capital receipts from the sale of cull cows and bulls are calculated from the prices and number of head area. However, total monthly receipts from the sale of horses and equipment need to be entered in the shaded sections.

4) Capital (Cash) *Expenditures*—Capital cash expenditures are expenditures on a capital asset such as breeding livestock, working horses, or equipment where no financing is required. Expenditures are recorded in the shaded area for the type and month in which the transaction occurred.

5) Variable Costs—Variable costs are those costs that vary with output for the production period under consideration. There are five subcategories contained under the variable cost heading:

Grazing fee costs include fees associated with grazing permits on BLM, USFS, state, and private lands.

Feed costs include hay, supplements, salt, minerals, and ranch feedlot charges.

Livestock management costs include supplies (tack, shoeing), and veterinarian services (medicine, services, supplies).

Example 2. Variable Costs

Microsoft Excel - Ranch Analysis 98 With examples

File Edit View Insert Format Tools Data Window Help

	A	C	D	E	F	P
1	ACTUAL CASH FLOW		Jan.	Feb.	March	Year End
2						Year to Date
45	Variable Costs					
56	Feed					
57	*Hay*				$4,200.00	$12,700.00
58	*Supplement*					
59	Sub1					
60	Sub2					
61	Sub3					
62	*Salt*					$1,200.00
63	*Minerals*					
64	*On Ranch Feedlot Charge*					
65						
66						
67						
68		Sub Totals			$4,200.00	$13,900.00
69	Livestock Management					
70	*Supplies (Shoeing, tack, non medical, etc.)*		$757.00	$1,352.00	$637.00	$6,997.00
71	Tack Purchases					$1,012.00
72	Tack Repair					$125.00
73	Other		$757.00	$1,352.00	$637.00	$5,860.00
74						
75						
76	*Veterinarian Services*		$111.00	$209.00	$142.00	$2,500.00
77	Phaemaceuticals		$111.00			$411.00
78	Services				$142.00	$1,842.00
79	Supplies			$209.00		$247.00
80						
81						
82		Sub Totals	$868.00	$1,561.00	$779.00	$18,994.00

ACTUAL CASH FLOW / PROJECTED CASH FLOW / NET CASH POSITION CHART

In March, the ranch buys hay for $4,200.

In January, the ranch buys vaccines for $111.00.

Livestock transportation costs include contract trucking and other hauling costs associated with moving animals.

Marketing costs include commissions, inspection fees, checkoff, and any other costs associated with selling animals.

Example 2 shows the Variable Costs area of the worksheet. In this example, the ranch purchased a load of hay for $4,200 in March. In the feed costs section, 4200 is entered into cell F57. This adds $4,200 to variable costs under the subheading “hay” for March. In this same example, the ranch purchased $111.00 worth of vaccines for the herd in January. In the livestock management section, 111 is entered in cell D77. This adds $111.00 to variable costs under the subheading “pharmaceuticals” for January.

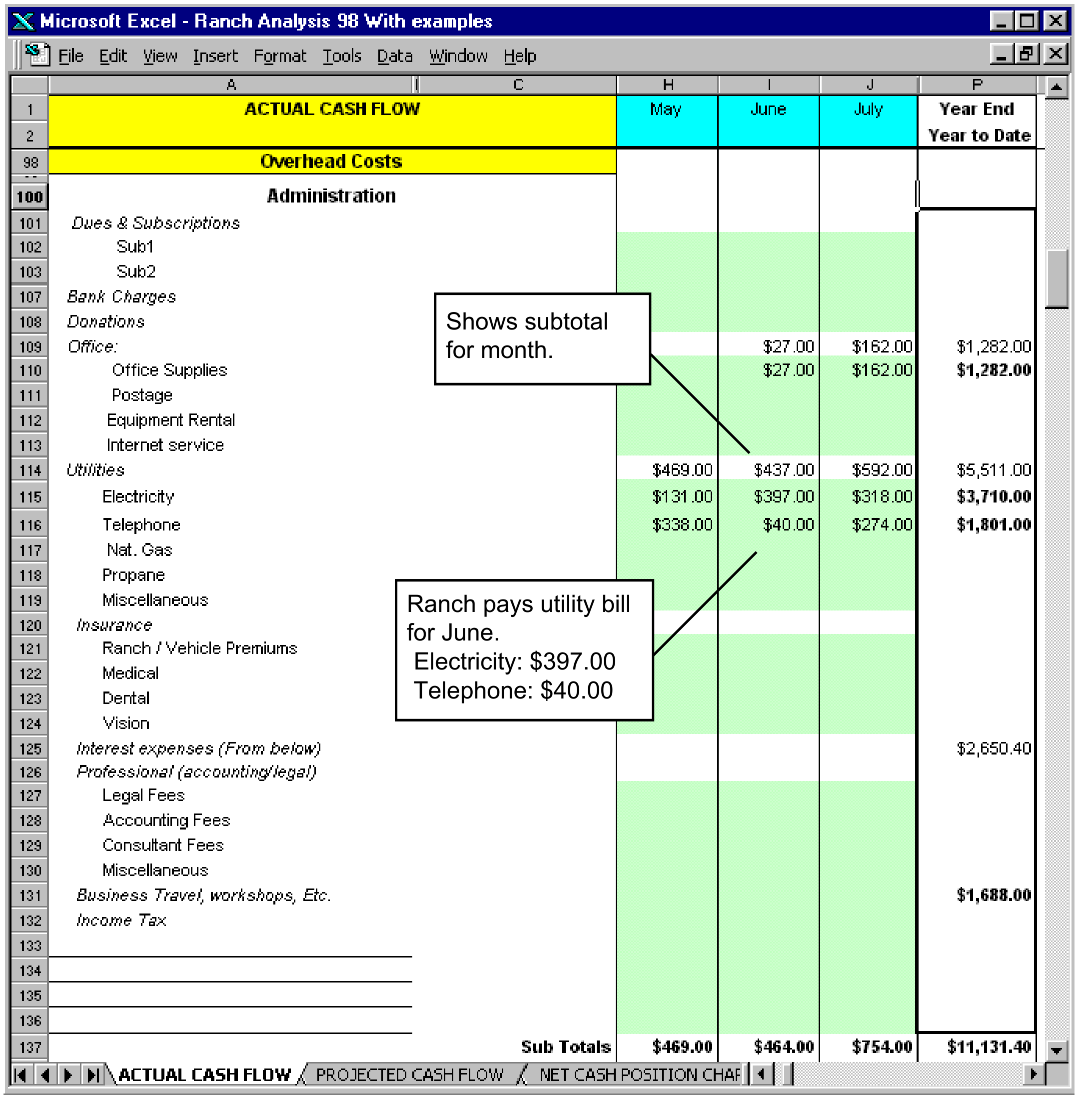
6) Overhead Costs—Overhead costs are those which do not vary with changes in output for the production period under consideration. There are five subcategories contained under the overhead cost heading:

Administration costs include dues and subscriptions, bank charges, advertising/promotion, donations, offices supplies, utilities, insurance, interest expenses, professional (legal & accounting), business travel, and income tax.

Labor costs include state & federal withholding, Medicare, Social Security, contract help, day help, wages, and benefits.

Equipment costs include parts, tires, fuel/oil, and repair/maintenance associated with equipment, such as a bulldozer used for dirt tank repair.

Example 3. Overhead Costs



	A	H	I	J	P
1	ACTUAL CASH FLOW	May	June	July	Year End
2					Year to Date
98	Overhead Costs				
100	Administration				
101	*Dues & Subscriptions*				
102	Sub1				
103	Sub2				
107	*Bank Charges*				
108	*Donations*				
109	*Office:*		$27.00	$162.00	$1,282.00
110	Office Supplies		$27.00	$162.00	**$1,282.00**
111	Postage				
112	Equipment Rental				
113	Internet service				
114	*Utilities*	$469.00	$437.00	$592.00	$5,511.00
115	Electricity	$131.00	$397.00	$318.00	**$3,710.00**
116	Telephone	$338.00	$40.00	$274.00	**$1,801.00**
117	Nat. Gas				
118	Propane				
119	Miscellaneous				
120	*Insurance*				
121	Ranch / Vehicle Premiums				
122	Medical				
123	Dental				
124	Vision				
125	*Interest expenses (From below)*				$2,650.40
126	*Professional (accounting/legal)*				
127	Legal Fees				
128	Accounting Fees				
129	Consultant Fees				
130	Miscellaneous				
131	*Business Travel, workshops, Etc.*				**$1,688.00**
132	*Income Tax*				
133					
134					
135					
136					
137	Sub Totals	**$469.00**	**$464.00**	**$754.00**	**$11,131.40**

Auto/vehicle costs include parts, tires, fuel/oil, and repair/maintenance associated with vehicles used on the ranch.

Land costs include land taxes and repairs/maintenance. For example, the construction of a road on the ranch would be included under this category.

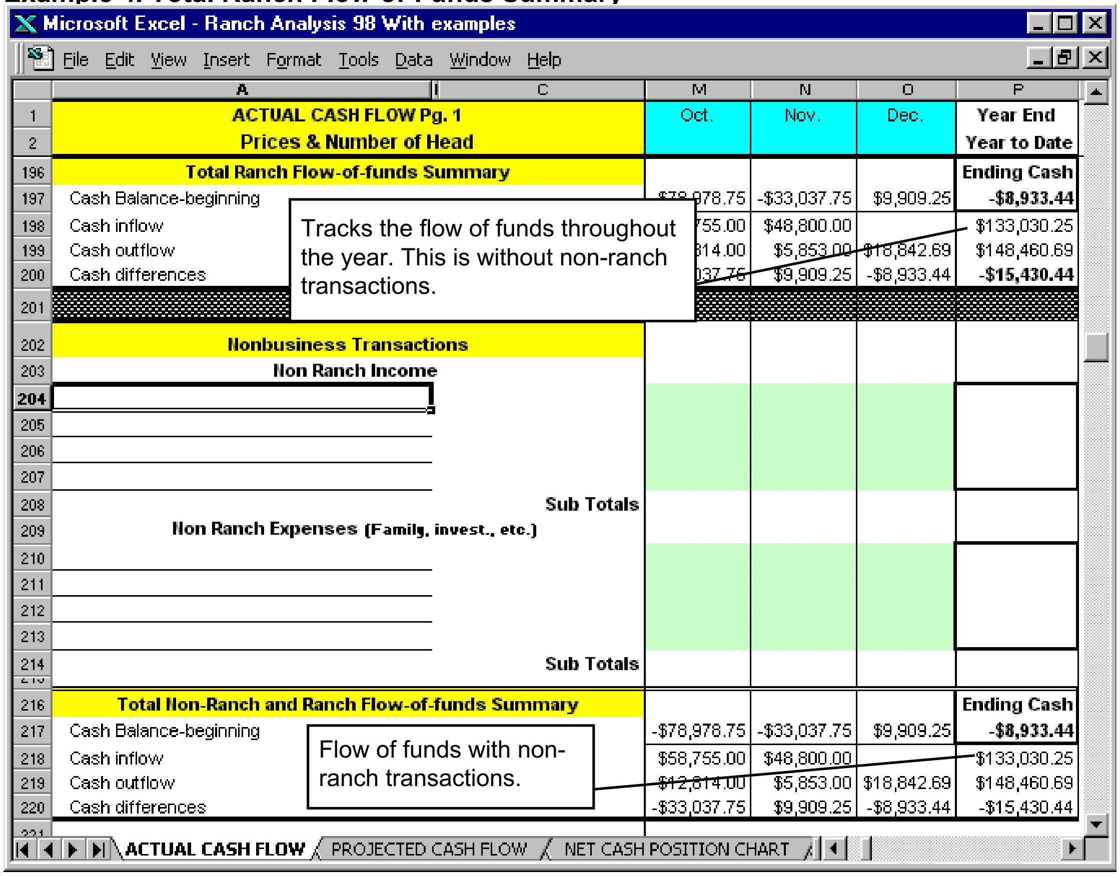
In Example 3, the ranch paid both the electricity bill for $397.00 and the telephone bill for $40.00 in June. In the worksheet, 397 is entered in cell I116 and 40 in entered in cell I117. These transactions are summed up next to the subcategory “Utilities” for June.

7) Debt/Credit Flows—All interest and principal payments are recorded, along with the acquisition of new funds for short, intermediate, and long term loans.

8) Total Ranch Flow of Funds Summary—The difference between all cash receipts (inflows) and expenses (outflows) excluding non-ranch effects are calculated for each month of the production year. This area shows if there is a negative cash balance or positive cash balance.

9) Non-business Transactions—All income generated outside of the ranch and all expenses outside of the ranch are recorded in this area. Income items

Example 4. Total Ranch Flow-of-Funds Summary



may include earnings from a town job, gifts, dividends, and interest. Expense items include food, clothing, home furnishings, and recreation.

10) Total Non-Ranch and Ranch Flow-of-Funds Summary—The differences between all cash inflows and outflows including non-ranch related items are calculated for each month of the production year. This area shows if there is a negative cash balance or positive cash balance (see Example 4).

CONCLUSIONS

While cash flow analysis is an important tool in managing today's ranches, care should be used when interpreting cash-flow analysis. Remember that a cash flow only looks at cash transactions when they are either paid or received, not when they are actually incurred (accrual accounting). Therefore, cash flow is only a measure of cash profits. To get at true profits, accrual accounting is needed to account for not only non-cash items, but also changes in inventories, accounts receivable, and accounts payable. It is a well-known fact that a business can be going broke and still generate a positive cash flow for several years. To overcome the cash flow shortcomings, the spreadsheet template contains many other worksheets to account for information not found on the actual and projected cash flow worksheets.

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FROM:

Arizona Ranchers' Management Guide
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Disclaimer

MODIFIED CASH PROJECTIONS

Trent Teegerstrom[1], Russell Tronstad[2], and Jim Sprinkle[3]

INTRODUCTION

A cash flow budget is needed to assure that daily financial obligations of the ranch can be met just as an individual needs adequate cash reserves to cover daily account withdrawals. Because ranch expenditures and revenues are much more difficult to predict than typical wages or living expenses, a cash flow budget needs to be more thoroughly planned and developed. If available, historical cash flow values can be used as a basis to make cash flow projections. As the year progresses, actual expenses and revenues are likely to deviate from projections, resulting in a need to analyze how these deviations will affect the financial liquidity and economic performance of the ranch. Within the Control Sheet, cash flow projections can be easily modified in a separate column (Column F) so that financial implications can be easily evaluated. Modifications can be made on individual categories that are shaded in light blue. Consistent with the rest of the ranch analysis worksheet, cells that are not shaded are determined from formulas. It is important to note that when the modification column is activated, the projected year end totals are used, not the actual cash year end totals. The following is an example of how the effects of two unforeseen cash flow changes can be evaluated.

EXAMPLE

It is mid-May and you have just been informed that your 4WD ranch truck has had an engine seize up from a hole that was knocked in the oil pan by a ranch employee. A local mechanic quotes you a price of $2,500.00 to put a rebuilt replacement engine in the truck. To top things off, five steer and five heifer calves have been found dead and are believed to have been killed by a lion that recently moved on your ranch. You would like to assess how these items will affect your overall cash profit per cow for the year.

Steps for evaluating these cash flow changes:

1) Go to the Control Sheet and verify that the Decision Control column is not activated. That is, if a “1” appears in cell H4, type a “0” in this cell to deactivate the planning sheets (see Figure 1).

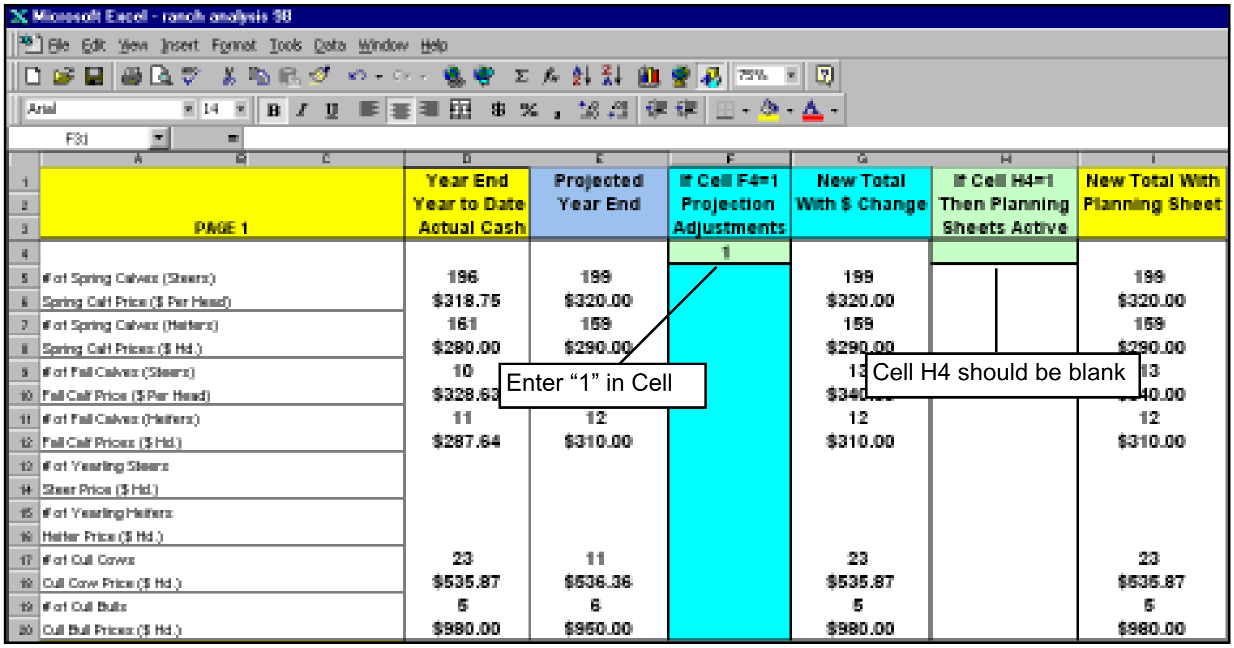
2) Then enter the number “1” in cell F4. This will activate the modified column and override the Actual Cash Flow totals with the Planning Sheet totals.

3) Next record the net cash profit per exposed cow as reported in cell B21 of the Diagnostic Tree Per Exposed Cow. You are now ready to make the changes to the projected cash flow.

4) Return to the Control Sheet and enter -5 in cells F5 and F7, as shown in Figure 2, for the five spring steer and heifer calves lost.

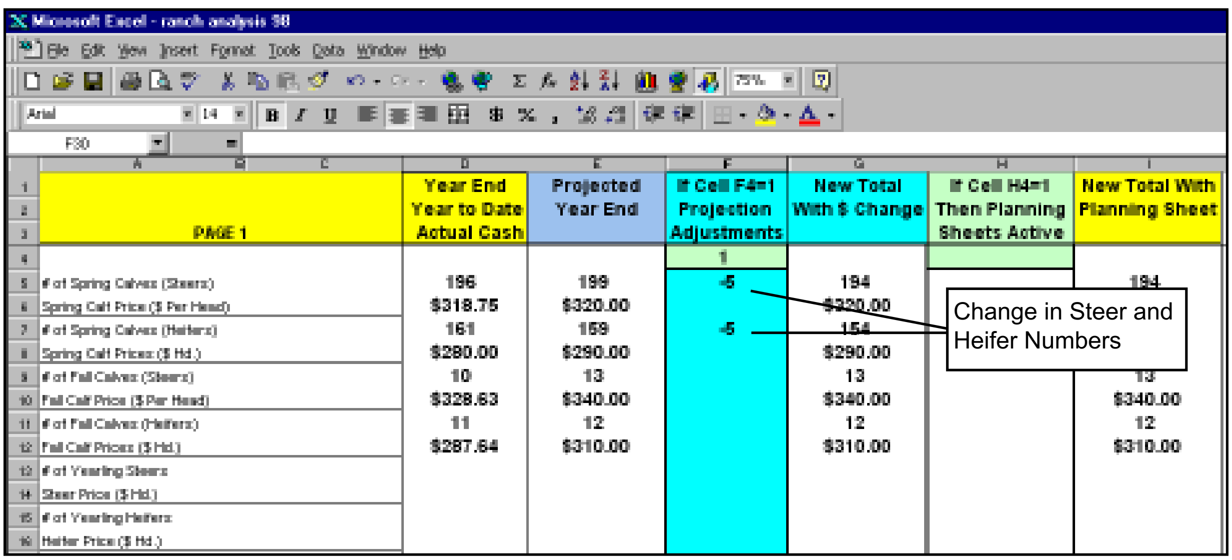
5) The next change needed is the additional cost of the truck engine replacement. Make sure you are still on the Control Sheet. Scroll down to the Overhead Cost section of the Control Sheet until you reach cell F127 and enter $2,500 (see Figure 3). This will be added to the current projected Repairs & Maintenance expenses of $3,282 for a final adjusted total of $5,783. If you would prefer to keep the engine replacement as a separate item, then you could enter the $2,500 in cell F128 (see Figure 4). However

Figure 1. Modified Cash Flow



Row	A–C	D: Year End Year to Date Actual Cash	E: Projected Year End	F: If Cell F4=1 Projection Adjustments	G: New Total With $ Change	H: If Cell H4=1 Then Planning Sheets Active	I: New Total With Planning Sheet
1–3	PAGE 1						
4				1			
5	# of Spring Calves (Steers)	196	199		199		199
6	Spring Calf Price ($ Per Head)	$318.75	$320.00		$320.00		$320.00
7	# of Spring Calves (Heifers)	161	159		159		159
8	Spring Calf Prices ($ Hd.)	$280.00	$290.00		$290.00		$290.00
9	# of Fall Calves (Steers)	10			13		13
10	Fall Calf Price ($ Per Head)	$328.63			$340.00		$340.00
11	# of Fall Calves (Heifers)	11	12		12		12
12	Fall Calf Prices ($ Hd.)	$287.64	$310.00		$310.00		$310.00
13	# of Yearling Steers						
14	Steer Price ($ Hd.)						
15	# of Yearling Heifers						
16	Heifer Price ($ Hd.)						
17	# of Cull Cows	23	11		23		23
18	Cull Cow Price ($ Hd.)	$535.87	$536.36		$535.87		$535.87
19	# of Cull Bulls	5	6		5		5
20	Cull Bull Prices ($ Hd.)	$980.00	$950.00		$980.00		$980.00

Figure 2. Calf Head Changes



Row	A–C	D: Year End Year to Date Actual Cash	E: Projected Year End	F: If Cell F4=1 Projection Adjustments	G: New Total With $ Change	H: If Cell H4=1 Then Planning Sheets Active	I: New Total With Planning Sheet
1–3	PAGE 1						
4				1			
5	# of Spring Calves (Steers)	196	199	-5	194		194
6	Spring Calf Price ($ Per Head)	$318.75	$320.00		$320.00		
7	# of Spring Calves (Heifers)	161	159	-5	154		
8	Spring Calf Prices ($ Hd.)	$280.00	$290.00		$290.00		
9	# of Fall Calves (Steers)	10	13		13		13
10	Fall Calf Price ($ Per Head)	$328.63	$340.00		$340.00		$340.00
11	# of Fall Calves (Heifers)	11	12		12		12
12	Fall Calf Prices ($ Hd.)	$287.64	$310.00		$310.00		$310.00
13	# of Yearling Steers						
14	Steer Price ($ Hd.)						
15	# of Yearling Heifers						
16	Heifer Price ($ Hd.)						

to properly track the expense, you will have to go to the Actual Cash Flow sheet and enter Truck Engine Replacement in cell A165. The new heading will then automatically show on both the Projected Cash Flow Sheet and the Control sheet.

6) Once you have finished adding in the truck engine replacement, return to the Diagnostic Tree Per Exposed Cow and record the net cash profit per exposed cow in cell A19. The new number is -$28.80 per exposed cow. So the net effect of the changes is an additional loss of -$4.88 (-$28.80 minus -$23.92) per exposed cow.

From the example above you can see that the ranch must generate an additional income of $4.88 per exposed cow if it is going to maintain the level of income projected at the start of the

Figure 3. Truck Repair

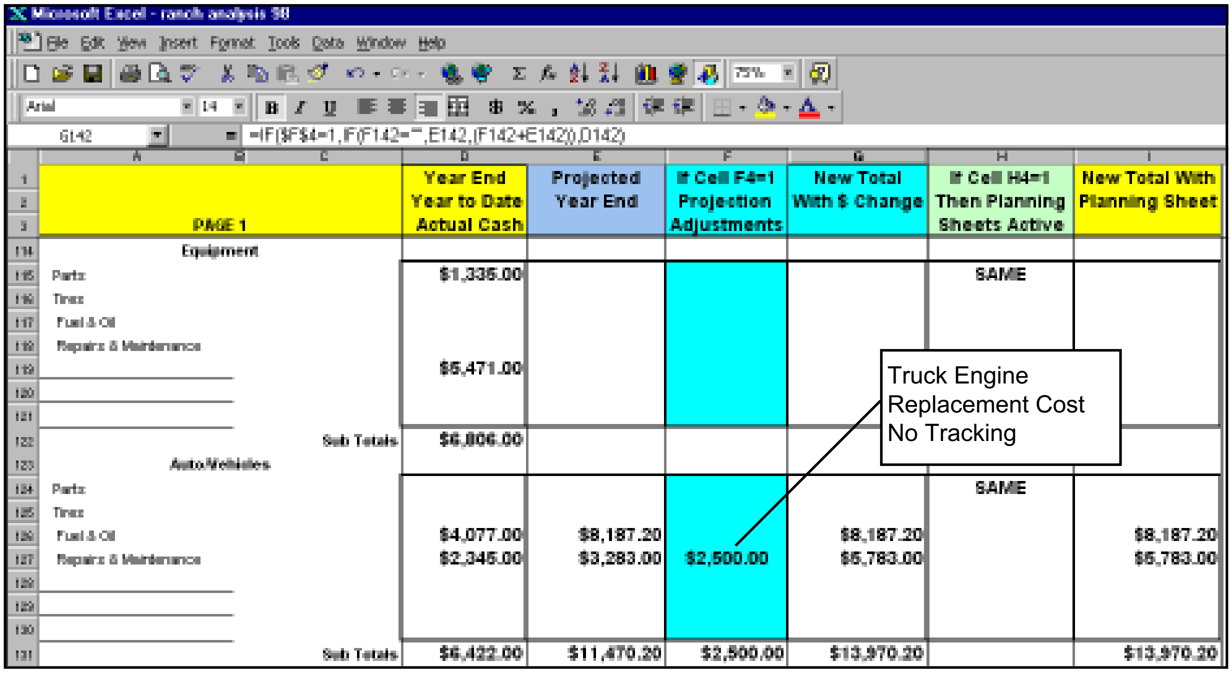
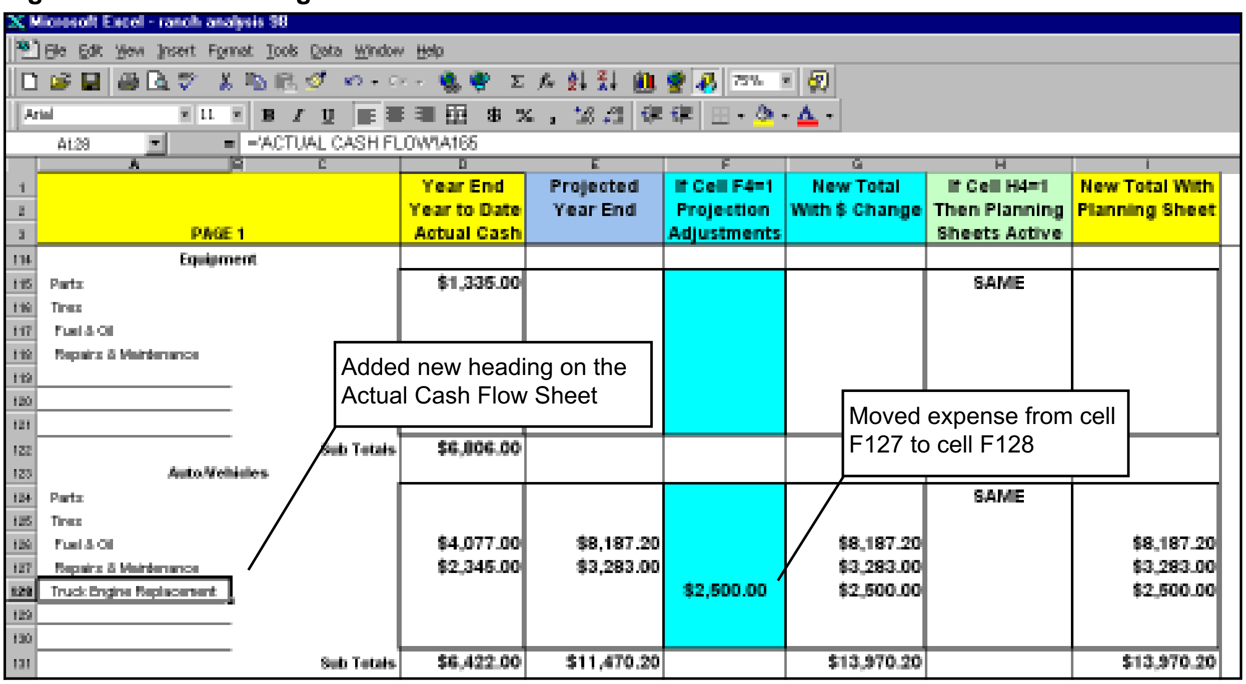


Figure 4. Truck Tracking



year. By determining this shortfall prior to the end of the fiscal year, you can possibly make adjustments to compensate for the shortall and increase the chances of ending the year with a positive cash flow.

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EVALUATING MANAGEMENT DECISIONS

Russell Tronstad[1], Jim Sprinkle[2], and Trent Teegerstrom[3]

INTRODUCTION

One of the main reasons for entering ranch information in a spreadsheet template is to easily evaluate management decisions. A few numbers related to different management decisions can be changed and the computer can instantly provide answers about economic consequences that would most likely take hours to do by hand. This article presents a couple examples on how the ranch financial analysis spreadsheet can be used to evaluate the economic returns of different management decisions. We illustrate how the computer can be used as a tool to answer "what if" questions. An evaluation of decisions before they are actually made allows producers to avoid costly mistakes and hopefully capitalize on the best economic decision. Although the computer can do computations efficiently, quantifying all components of a management decision can be difficult. This is particularly true when dynamics are involved or when a management decision made today impacts future productivity relationships. For these reasons, results from the ranch spreadsheet template need to be interpreted within the context of the management decision under consideration.

Economic returns are calculated for the ranch on a calendar year basis for total and per unit (i.e., exposed cow) returns. Both cash and accrual profits are calculated. An accrual profit measure that accounts for changes in livestock inventories and depreciation of fixed assets is reported in the spreadsheet template. If a management decision does not involve a change in herd composition or animal numbers, the profit per exposed cow should be focused on. An example of this analysis would be supplemental feed to improve weaning weights and possibly herd fertility. Total ranch profit should be analyzed if a management decision involves any change in herd composition or numbers. An example of this type of analysis would be running fewer cows to increase fertility and weaning weights.

In order to compare how much of an impact any management decision will have on ranch profitability, a "base line" of current ranch practices needs to be entered into the ranch financial analysis spreadsheet template. This "base line" of current or normal practices provides a reference point from which alternative management strategies can be evaluated. If one is solely concerned with cash profits, a comparison can be made between alternatives by appropriately modifying cash expenses and revenues in the *Control Sheet*. However, the planning sheets will generally be the easiest and most relevant tool for evaluating alternative management decisions. Expenses and revenues are built from biological relationships and per unit inputs in the planning sheets so that the impact of a change in grazing fee or health expense can be readily evaluated. An example of using the planning sheet for supplemental feeding follows. Please note that to enable the planning sheet, a value of 1 must be entered in cell H4 of the *Control Sheet* (see article entitled, *Overview of Ranch Financial Analysis Spreadsheet*).

SUPPLEMENTAL FEEDING EXAMPLE

The following example assumes that a "base line" has been established or all planning sheets have been filled out to reflect normal practices. Please note that "green shaded" areas of the worksheet indicate areas for the user to provide input, and numbers that are not shaded are determined from formulas that key off entered data. The following example uses data obtained from the University of Arizona, V bar V Ranch for the 1998 calendar year.

Supplemental Feeding Scenario: The proposed management change involves feeding 2 lbs. of protein supplement for 60 days to cows and 80 days to “bred heifers/2-year-olds.” These bred heifers at the beginning of the calendar year turn 2 years old and have a calf before the end of the calendar year. Protein supplement will cost $180/ton and we expect to see an increase in weaning weights of 20 lbs. per calf.

Steps for evaluation of the proposed change**:**

1) Verify that the planning sheets are in use or that cell H4 of the *Control Sheet* equals 1. Then print the sheet of *Diagnostic Tree Per Exposed Cow* or write down the resulting cash and accrual profit values per exposed cow. For the V bar V “base line” example, -$42.37/exposed cow for cash profit (cell B21) and $44.76/exposed cow for accrual profit (cell B23) is calculated.

2) The cost of supplemental feed is entered in the *Feed Expense Planning Sheet*. Under the column heading Supplement (Column G), go to shaded cell G18 (bred heifers/2-year-olds) and enter 2 for 2 lbs. of supplement per day. Now enter 2 in cells G19 through G27. This will feed the entire herd 2 lbs. per day. Next, under Column H (Day), go to cell H18 and enter 80 to feed the bred heifers/2-year-olds for 80 days. Now enter 60 in cells H18 through H28 to feed supplement to the rest of the herd for 60 days. Finally, enter or check that 180 is entered in cell J5 to reflect the cost of supplement at $180/ton. This will calculate the cost of feed for each age group of cows and transfer totals to the rest of the spreadsheet template. Your before and after screens in the *Feed Planning Expense Sheet* should look as depicted in Figure 1.

3) Next, go to the *Herd Production Planning Sheet* and in the shaded cells (L8 through L12) under the column Sale Weight increase each of the sale weights by 20. This will increase the weaning weights for steers and heifers for both the spring born calves and the fall born calves. Figure 2 illustrates these changes to the *Herd Production Planning Sheet.*

4) Finally, go back to the *Diagnostic Tree Per Exposed Cow* and compare the new values in cells B21 and B23 with the original values you wrote down earlier. How have they changed?

As shown in Figure 3, cash and accrual profits both decreased by $1.66 (drop from -42.37 to -44.03 for cash and 44.76 to 43.10 for accrual) per equivalent exposed cow. Equivalent exposed cow is from the *Biological Cow Data* worksheet and accounts for cows exposed to the bull last year and any yearlings that were on the ranch. Because this supplemental feeding example did not affect livestock inventories or depreciation adjusted overheads, the change is the same for both cash and accrual profits.

This example could be further extended by inquiring about additional issues. For example, what is the economic impact if calf prices change due to the 20 lb. increase in calf weights? What is the impact on next year’s profit level if the fertility for the herd improves? Although the spreadsheet template is not dynamic (i.e., one-year snapshot) in nature, the template can be used to gain insights into multi-period decisions such as herd fertility. First, determine the difference in economic return generated by the spreadsheet template from increasing fertility. Then multiply a discount rate (i.e., 1/[1 + interest rate]) to any increase in return from fertility improving. If market prices remain basically the same for the following year, this approximation is fairly accurate.

EXAMPLE THAT EVALUATES OPTIONS AFTER A RANGE FIRE

Range Fire Scenario: A fire recently swept through your USFS allotment, eliminating the ability to use a 7,000-acre pasture you had planned on grazing for 3 months. At the time of the fire, you had 489 cows and 37 bulls. Because of poor precipitation the previous year, other USFS allotments in the vicinity are currently stocked and unavailable for grazing. The USFS range conservation officer says you can use a 5,300-acre pasture on your allotment that was scheduled to be rested this year, but it will only accommodate 369 cows, 120 less than you have, and 37 bulls for the same 3-month period. You have recently culled some open cows and do not wish to sell any more cows at this time. Most of the cows are already bred. You have three different options you wish to evaluate: (1) Leasing Pasture for Extra Cows, (2) Early Weaning Calves, and (3) Drylot Cows on Ranch.

Steps for Leasing Pasture Option evaluation**:**

1a) A contact you have in Nevada has informed you that irrigated pasture is available for 3 months for 120 cows at a price of $15 per month for each cow/calf unit. You would not haul any bulls since cows should already be bred. You will take only cows that have a spring born calf as side to Nevada. Go to the *Grazing Expense Planning* sheet (see Figure 4), and enter the number of cows by age that you expect to take to Nevada (cells K16 to K24). Then enter 3 in cells L16 through L24 for 3 months of grazing. The pasture price of $15/month is entered in cell M4.

1b) The pasture is 500 miles away and trucking costs $2.00 per loaded mile for each semi-load of cattle. It will take 4 semi-loads going to Nevada (30 cows + calves per load) and 3 semi-loads coming back from Nevada (sell calves in Nevada; 40 cows per load return trip). Go to the *Herd Production Planning Sheet* (see Figure 5) under column Q (Paid/Contract Trucking Costs Without Selling) and enter 500 in cell Q8 for the total miles per trip, 7 in cell Q11 for total number of trips, and 2 in cell Q13 for the cost per mile. Total trucking expense of $7,000 is automatically calculated and shown in cell Q6. Calves shipped to Nevada are expected to weigh 20 lbs./head more than those kept on the ranch. This increases the average sale weight of all spring born calves by 7 lbs./head ([120/341] • 20 = 7.0). Increase the sale weight of calves by 7 lbs. in cells L8 and L9.

1c) Finally, go to the *Diagnostic Tree Per Exposed Cow* and record what the cash and accrual profit is for this leasing pasture option.

Cash Profit (Cell B21) ________

Accrual Profit (Cell B23) _______

As another alternative, you may wish to save the entire file with a different name that associates these numbers with the leased pasture option after the fire. This is especially helpful if you also want to study how the financial ratios and cost and return measures compare under different scenarios.

Early Weaning Calves Option. Since a nonlactating cow will eat only about 70% of a cow/calf unit, by early weaning calves you will be able to maintain all your cows on the 5,300 acre pasture for the next 3 months. The USFS range conservation officer is familiar with the concept of reduced forage intake for nonlactating cows and has allowed similar things to be done on other grazing allotments during drought. You will not have to truck cows to Nevada or rent additional pasture, but calves will weigh about 150 lbs. less when you sell them. Because the calves are 150 lbs. lighter and corn prices are relatively low, you also think that you can sell your calves for $20/cwt. more.

Steps for Early Weaning Calves:

2a) Reverse the steps and entries that were made above in the *Grazing Expense Planning* and *Herd Production Planning Sheets* for the leased pasture option so that "after screens" look like "before screens." If you saved the changes made in the leased pasture option under a new file, just open the original file without any of the leased pasture option changes. Before (i.e., base line) and after values in the *Herd Production Planning Sheet* for reducing calf weight by 150 lbs. and increasing the price per lb. received by $.20 are depicted in Figure 6.

2b) Go to the *Diagnostic Tree Per Exposed Cow* and record what the cash and accrual profit is for this early weaning option.

    Cash Profit (Cell B21) ________

    Accrual Profit (Cell B23) _______

    Figure 7 compares cash and accrual profit values in the *Diagnostic Tree Per Exposed Cow* for the leasing pasture and early weaning options. The leasing pasture option is $12.30 (difference of -59.84 and -72.14 for cash or 27.32 and 15.02 accrual profit) per unit more profitable than the early weaning option.

In addition to looking at changes in total profit, financial ratios, and cost and return measures, the spreadsheet template can be used to get an idea of what you could actually afford to pay for pasture. Simply go to the lease pasture scenario and increase cell M4 in the *Grazing Expense Planning Sheet* until profitability is the same from the leasing pasture or early weaning scenarios. The cost of pasture has to exceed $32.53/month before it is more profitable to do early weaning than lease pasture.

Drylot Option. Another option is to put the 120 additional lactating cows and their calves into a drylot and feed them purchased hay for 90 days rather than lease pasture or early wean calves. Hay can be shipped in for $95 per ton and each pair is expected to consume 25 lbs. per day for the 90-day feeding period. Weaning weights are expected to be the same as if they were shipped to Nevada and put on the leased pasture. But there will be some additional health costs for calves under the drylot option due to crowded conditions and dusty corrals. Health costs are expected to be $.80/head more for calves placed in the drylot.

Steps for Drylot Option:

3a) Reverse the steps and entries that were made above for the early calf weaning option. If you saved the changes made to a new file for the early weaning option, just open the original file without any of the early weaning option changes. In the *Feed Expense Planning Sheet*, feed consumption is calculated for all cows in an entire age group. Using a calculator, 25 lbs. per day for 120 cows for 90 days equals 135 tons ([25•120•90]/2000) of hay. Note that in the *Herd Production Planning Sheet*, 175 cows are in the category of "Unknown > 4." We can adjust the hay consumption to 17.14 lbs. per day (i.e., [120/175]•25) for all the cows in this category to get

135 tons total. That is, enter 17.14 in cell B27 and 90 in cell C27; cell D27 reveals that an additional 135 tons are being bought. The price of $95 per ton is given in cell E5. Figure 8 illustrates these before and after changes.

3b) Go to the *Health Expense Planning Sheet* (see Figure 9), and add additional medicine costs for calves by entering the vaccination label of "LA200" in cell N5. Next, enter the cost per head or .80 in cell O5. Enter 60 in both cells N8 and N9 to reflect the number of steer and heifer calves expected to be given this vaccine.

3c) In the *Herd Production Planning Sheet*, weaning weights need to be increased to the same level as the leased pasture option. Calves in the drylot are expected to weigh 20 lbs. per head more than calves on the range. This increases the average sale weight of all spring born calves by 7 lbs./head ([120/341]•20 = 7.0). Increase the sale weight of calves by 7 lbs. in cells L8 and L9. Also, check to see that trucking costs have been reduced to zero (i.e., cells Q9, Q11, and Q13 equal 0).

3d) Go to the *Diagnostic Tree Per Exposed Cow* and record what the cash and accrual profit is for this drylot option.

Cash Profit (Cell B21) ________

Accrual Profit (Cell B23) ________

As described in Figure 11, cash return from the drylot option is -60.85, or $1.01 less per exposed cow than the return associated with the leasing pasture option (-60.85 minus -59.84). The major expense for the hay feeding option is 135 tons of hay at $95 per ton, or $12,825. Major expenses for the leasing pasture option were $7,000 for trucking and $5,400 for pasture for a total of $12,400. Note that the spreadsheet tool can easily determine at what hay price it becomes more economical to drylot than ship to pasture. By changing cell E5 or the price of hay in the *Feed Expense Planning Sheet,* a hay price of $92.19 per ton results in the same cash return of -59.84 as in the leasing pasture option. If hay can be delivered to the ranch for less than $92.19 per ton, 120 pairs in the drylot would then be the most profitable option. Hay quality would also impact the rate of gain and health expenses.

It is very important to keep in mind that the results produced from the spreadsheet template are no better than the inputs behind the results. For example, you may expose your cows to a disease by shipping them to Nevada and this could increase future vaccination costs and even your death losses. Labor costs might increase from feeding hay in the drylot. These factors could be built into your analysis using the spreadsheet template, but it is very important to realize that results produced are no better than the inputs behind the results.

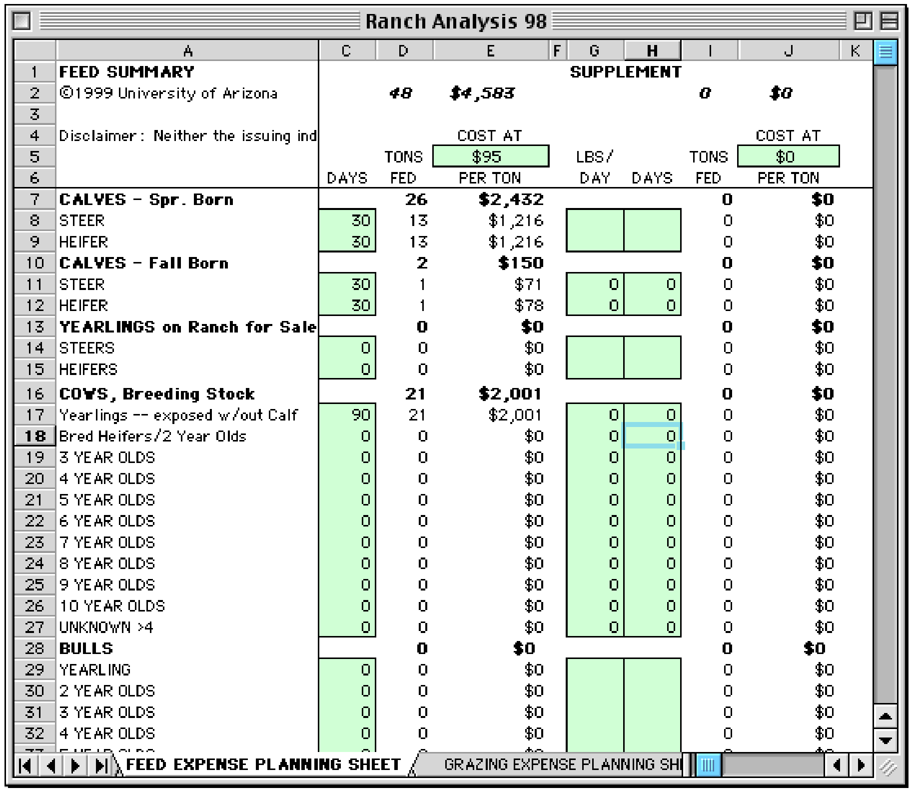
[1]*Associate Extension Specialist, Agricultural and Resource Economics, The University of Arizona*

[2]*Area Extension Agent, Animal Science University of Arizona*

[3]*Research Specialist, Agricultural and Resource Economics, The University of Arizona*

Figure 1. Supplemental Feeding: Feed Expense Planning Sheet Changes

Before

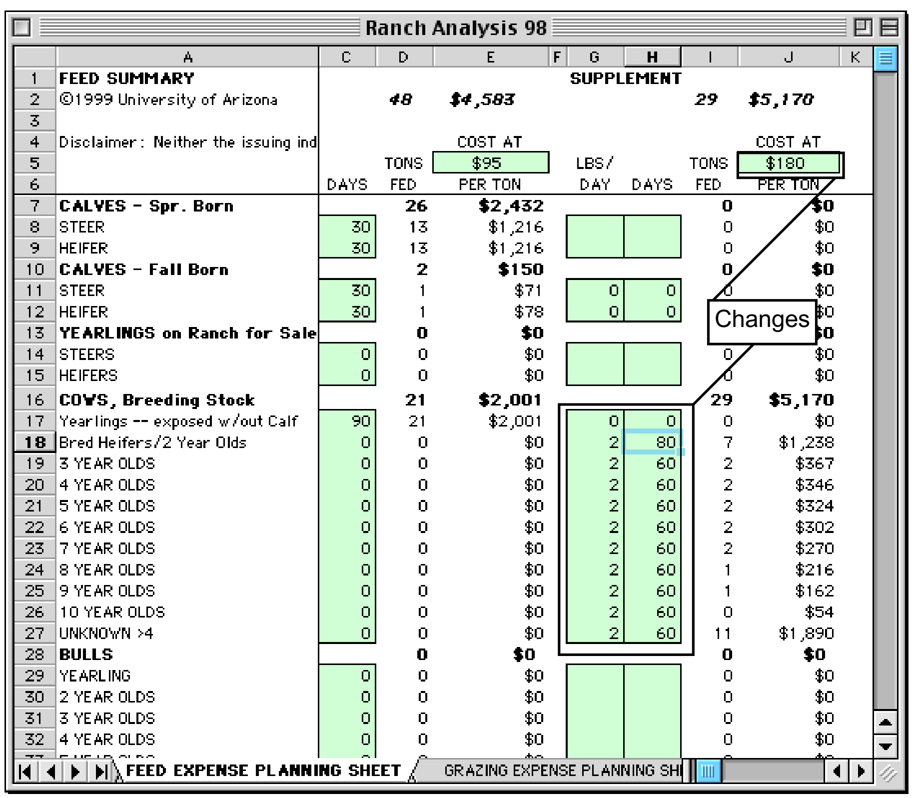


Ranch Analysis 98

	A	C	D	E	G	H	I	J
1	**FEED SUMMARY**				**SUPPLEMENT**			
2	©1999 University of Arizona		*48*	*$4,583*			*0*	*$0*
3								
4	Disclaimer: Neither the issuing ind			COST AT				COST AT
5			TONS	$95	LBS/		TONS	$0
6		DAYS	FED	PER TON	DAY	DAYS	FED	PER TON
7	**CALVES - Spr. Born**		**26**	**$2,432**			**0**	**$0**
8	STEER	30	13	$1,216			0	$0
9	HEIFER	30	13	$1,216			0	$0
10	**CALVES - Fall Born**		**2**	**$150**			**0**	**$0**
11	STEER	30	1	$71	0	0	0	$0
12	HEIFER	30	1	$78	0	0	0	$0
13	**YEARLINGS on Ranch for Sale**		**0**	**$0**			**0**	**$0**
14	STEERS	0	0	$0			0	$0
15	HEIFERS	0	0	$0			0	$0
16	**COWS, Breeding Stock**		**21**	**$2,001**			**0**	**$0**
17	Yearlings -- exposed w/out Calf	90	21	$2,001	0	0	0	$0
18	Bred Heifers/2 Year Olds	0	0	$0	0	0	0	$0
19	3 YEAR OLDS	0	0	$0	0	0	0	$0
20	4 YEAR OLDS	0	0	$0	0	0	0	$0
21	5 YEAR OLDS	0	0	$0	0	0	0	$0
22	6 YEAR OLDS	0	0	$0	0	0	0	$0
23	7 YEAR OLDS	0	0	$0	0	0	0	$0
24	8 YEAR OLDS	0	0	$0	0	0	0	$0
25	9 YEAR OLDS	0	0	$0	0	0	0	$0
26	10 YEAR OLDS	0	0	$0	0	0	0	$0
27	UNKNOWN >4	0	0	$0	0	0	0	$0
28	**BULLS**		**0**	**$0**			**0**	**$0**
29	YEARLING	0	0	$0			0	$0
30	2 YEAR OLDS	0	0	$0			0	$0
31	3 YEAR OLDS	0	0	$0			0	$0
32	4 YEAR OLDS	0	0	$0			0	$0

FEED EXPENSE PLANNING SHEET / GRAZING EXPENSE PLANNING SH

After



Ranch Analysis 98

	A	C	D	E	G	H	I	J
1	**FEED SUMMARY**				**SUPPLEMENT**			
2	©1999 University of Arizona		*48*	*$4,583*			*29*	*$5,170*
3								
4	Disclaimer: Neither the issuing ind			COST AT				COST AT
5			TONS	$95	LBS/		TONS	$180
6		DAYS	FED	PER TON	DAY	DAYS	FED	PER TON
7	**CALVES - Spr. Born**		**26**	**$2,432**			**0**	**$0**
8	STEER	30	13	$1,216			0	$0
9	HEIFER	30	13	$1,216			0	$0
10	**CALVES - Fall Born**		**2**	**$150**			**0**	**$0**
11	STEER	30	1	$71	0	0	0	$0
12	HEIFER	30	1	$78	0	0	0	$0
13	**YEARLINGS on Ranch for Sale**		**0**	**$0**			**0**	**$0**
14	STEERS	0	0	$0			0	$0
15	HEIFERS	0	0	$0			0	$0
16	**COWS, Breeding Stock**		**21**	**$2,001**			**29**	**$5,170**
17	Yearlings -- exposed w/out Calf	90	21	$2,001	0	0	0	$0
18	Bred Heifers/2 Year Olds	0	0	$0	2	80	7	$1,238
19	3 YEAR OLDS	0	0	$0	2	60	2	$367
20	4 YEAR OLDS	0	0	$0	2	60	2	$346
21	5 YEAR OLDS	0	0	$0	2	60	2	$324
22	6 YEAR OLDS	0	0	$0	2	60	2	$302
23	7 YEAR OLDS	0	0	$0	2	60	2	$270
24	8 YEAR OLDS	0	0	$0	2	60	1	$216
25	9 YEAR OLDS	0	0	$0	2	60	1	$162
26	10 YEAR OLDS	0	0	$0	2	60	0	$54
27	UNKNOWN >4	0	0	$0	2	60	11	$1,890
28	**BULLS**		**0**	**$0**			**0**	**$0**
29	YEARLING	0	0	$0			0	$0
30	2 YEAR OLDS	0	0	$0			0	$0
31	3 YEAR OLDS	0	0	$0			0	$0
32	4 YEAR OLDS	0	0	$0			0	$0

FEED EXPENSE PLANNING SHEET / GRAZING EXPENSE PLANNING SH

Figure 2. Supplemental Feeding: Herd Production Planning Sheet Changes

Before

Ranch Analysis 98

	A	J	K	L	M	N
1	**LIVESTOCK PRODUCTION**					
2						
3	**DECSION CONTROL=1**	ACTUAL HEAD				
4	TRUE	SOLD OR CULLED				GROSS
5		FROM ACF	31-Dec-98	SALE	PRICE	SELLING VALU
6		DEFICIENCIES	INVENTORY	WEIGHT	($/CWT)	PER HEAD
7	**CALVES - Spr. Born**	**302**	**0**	**(LBS.)**		
8	STEER	169	0	445	$75	$33
9	HEIFER	134	0	420	$70	$29
10	**CALVES - Fall Born**	**11**	**18**			
11	STEER	10	9	435	$80	$34
12	HEIFER	1	9	400	$75	$30
13	**YEARLINGS on Ranch for Sale**	**0**	**0**			
14	STEERS	0	0	700	$65	$45
15	HEIFERS	0	0	650	$60	$39
16	**COWS, Breeding Stock**	**24**	**454**			**$45**
17	Replacement Calves		45			
18	Yearlings -- exposed w/out Calf	1	38			$40
19	Bred Heifers/2 Year Olds	1	84			$45
20	3 YEAR OLDS	1	32			$45
21	4 YEAR OLDS	1	30			$47
22	5 YEAR OLDS	1	28			$47
23	6 YEAR OLDS	1	26			$47
24	7 YEAR OLDS	1	23			$47
25	8 YEAR OLDS	1	18			$47
26	9 YEAR OLDS	1	14			$45
27	10 YEAR OLDS	5	0			$44
28	UNKNOWN >4	10	161			$46
29	**BULLS**	**5**	**32**			**$98**
30	YEARLING					$80
31	2 YEAR OLDS		0			$1,00

BIOLOGICAL COW DATA | **HERD PRODUCTION PLANNING SHEET**

After

Ranch Analysis 98

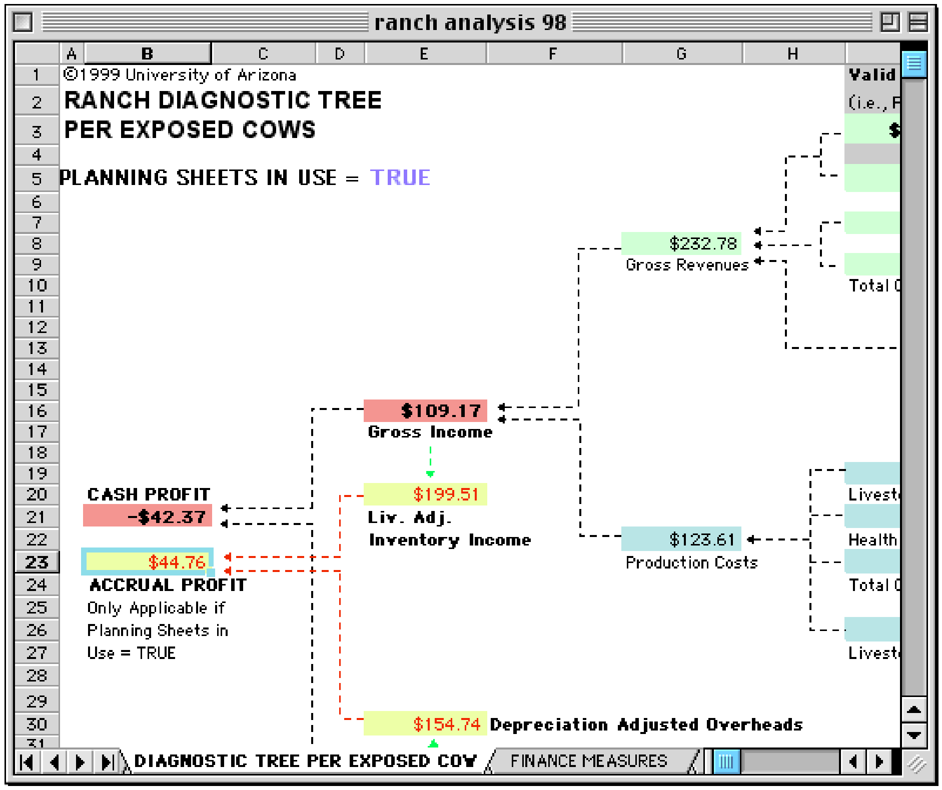
Changes

	A	J	K	L	M	N
1	**LIVESTOCK PRODUCTION**					
2						
3	**DECSION CONTROL=1**	ACTUAL HEAD				
4	TRUE	SOLD OR CULLED				GROSS
5		FROM ACF	31-Dec-98	SALE	PRICE	SELLING VALU
6		DEFICIENCIES	INVENTORY	WEIGHT	($/CWT)	PER HEAD
7	**CALVES - Spr. Born**	**302**	**0**	**(LBS.)**		
8	STEER	169	0	465	$75	$34
9	HEIFER	134	0	440	$70	$30
10	**CALVES - Fall Born**	**11**	**18**			
11	STEER	10	9	455	$80	$36
12	HEIFER	1	9	420	$75	$31
13	**YEARLINGS on Ranch for Sale**	**0**	**0**			
14	STEERS	0	0	700	$65	$45
15	HEIFERS	0	0	650	$60	$39
16	**COWS, Breeding Stock**	**24**	**454**			**$45**
17	Replacement Calves		45			
18	Yearlings -- exposed w/out Calf	1	38			$40
19	Bred Heifers/2 Year Olds	1	84			$45
20	3 YEAR OLDS	1	32			$45
21	4 YEAR OLDS	1	30			$47
22	5 YEAR OLDS	1	28			$47
23	6 YEAR OLDS	1	26			$47
24	7 YEAR OLDS	1	23			$47
25	8 YEAR OLDS	1	18			$47
26	9 YEAR OLDS	1	14			$45
27	10 YEAR OLDS	5	0			$44
28	UNKNOWN >4	10	161			$46
29	**BULLS**	**5**	**32**			**$98**
30	YEARLING					$80
31	2 YEAR OLDS		0			$1,00

BIOLOGICAL COW DATA | **HERD PRODUCTION PLANNING SHEET**

Figure 3. Supplemental Feeding: Diagnostic Tree Per Exposed Cow Changes

Before



After

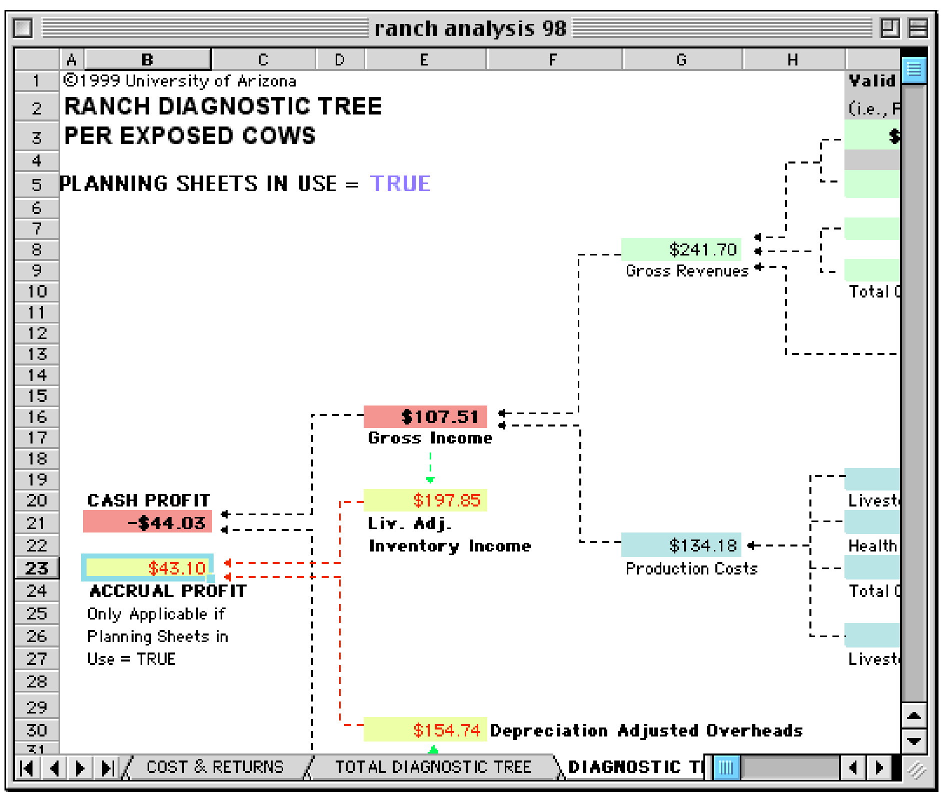
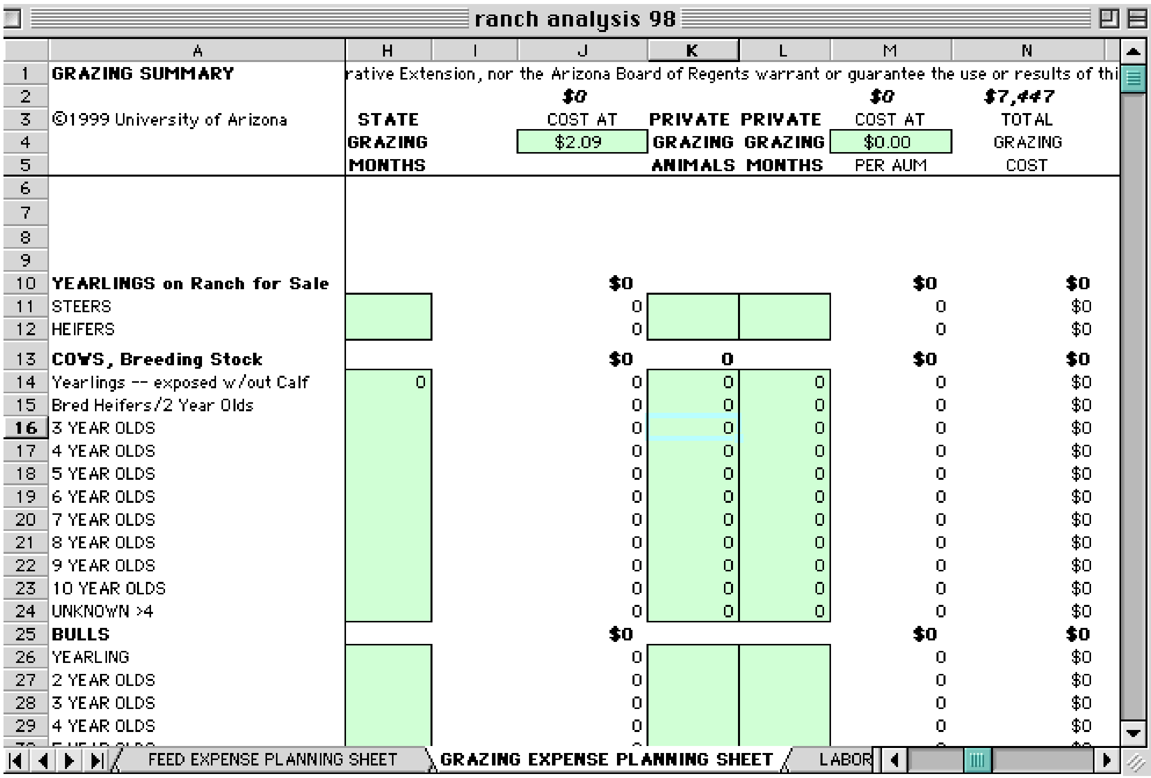


Figure 4. Range Fire (Leasing Pasture Option): Grazing Expense Planning Sheet Changes

Before

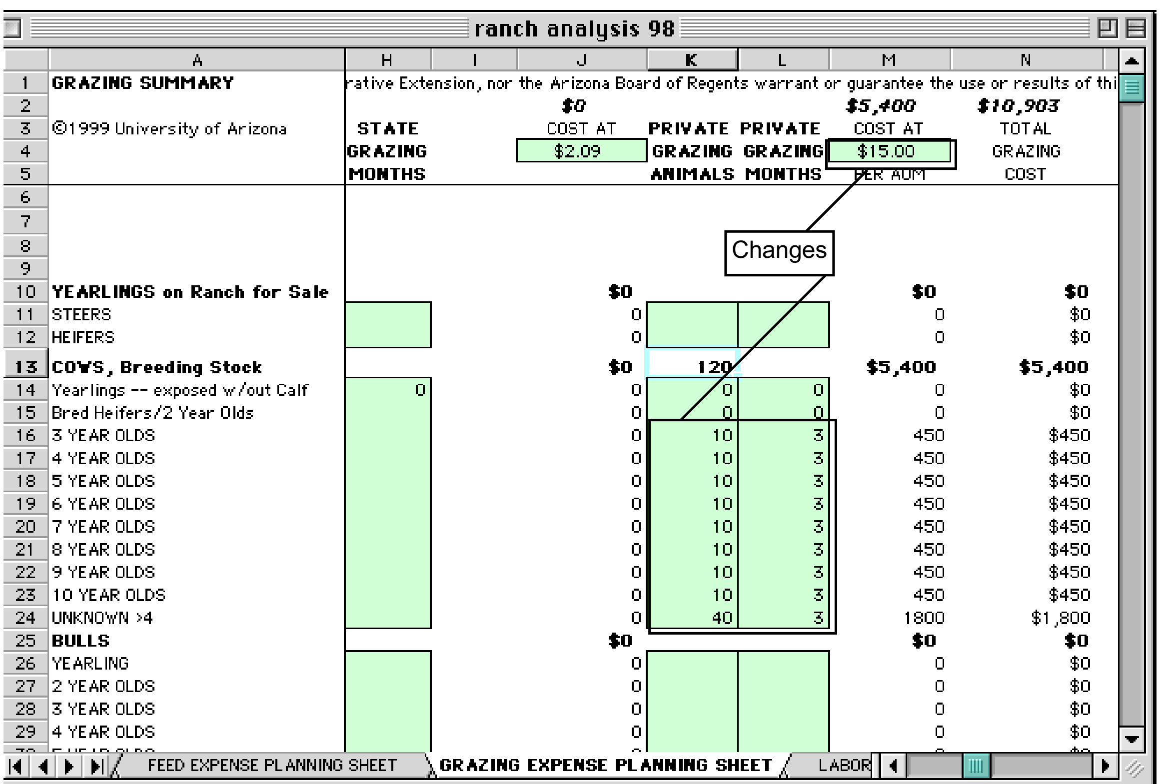


ranch analysis 98

	A	H	I	J	K	L	M	N
1	GRAZING SUMMARY	rative Extension, nor the Arizona Board of Regents warrant or guarantee the use or results of thi						
2				$0			$0	$7,447
3	©1999 University of Arizona	STATE		COST AT	PRIVATE	PRIVATE	COST AT	TOTAL
4		GRAZING		$2.09	GRAZING	GRAZING	$0.00	GRAZING
5		MONTHS			ANIMALS	MONTHS	PER AUM	COST
6								
7								
8								
9								
10	YEARLINGS on Ranch for Sale			$0			$0	$0
11	STEERS			0			0	$0
12	HEIFERS			0			0	$0
13	COWS, Breeding Stock			$0	0		$0	$0
14	Yearlings -- exposed w/out Calf	0		0	0	0	0	$0
15	Bred Heifers/2 Year Olds			0	0	0	0	$0
16	3 YEAR OLDS			0	0	0	0	$0
17	4 YEAR OLDS			0	0	0	0	$0
18	5 YEAR OLDS			0	0	0	0	$0
19	6 YEAR OLDS			0	0	0	0	$0
20	7 YEAR OLDS			0	0	0	0	$0
21	8 YEAR OLDS			0	0	0	0	$0
22	9 YEAR OLDS			0	0	0	0	$0
23	10 YEAR OLDS			0	0	0	0	$0
24	UNKNOWN >4			0	0	0	0	$0
25	BULLS			$0			$0	$0
26	YEARLING			0			0	$0
27	2 YEAR OLDS			0			0	$0
28	3 YEAR OLDS			0			0	$0
29	4 YEAR OLDS			0			0	$0

FEED EXPENSE PLANNING SHEET | GRAZING EXPENSE PLANNING SHEET | LABOR

After



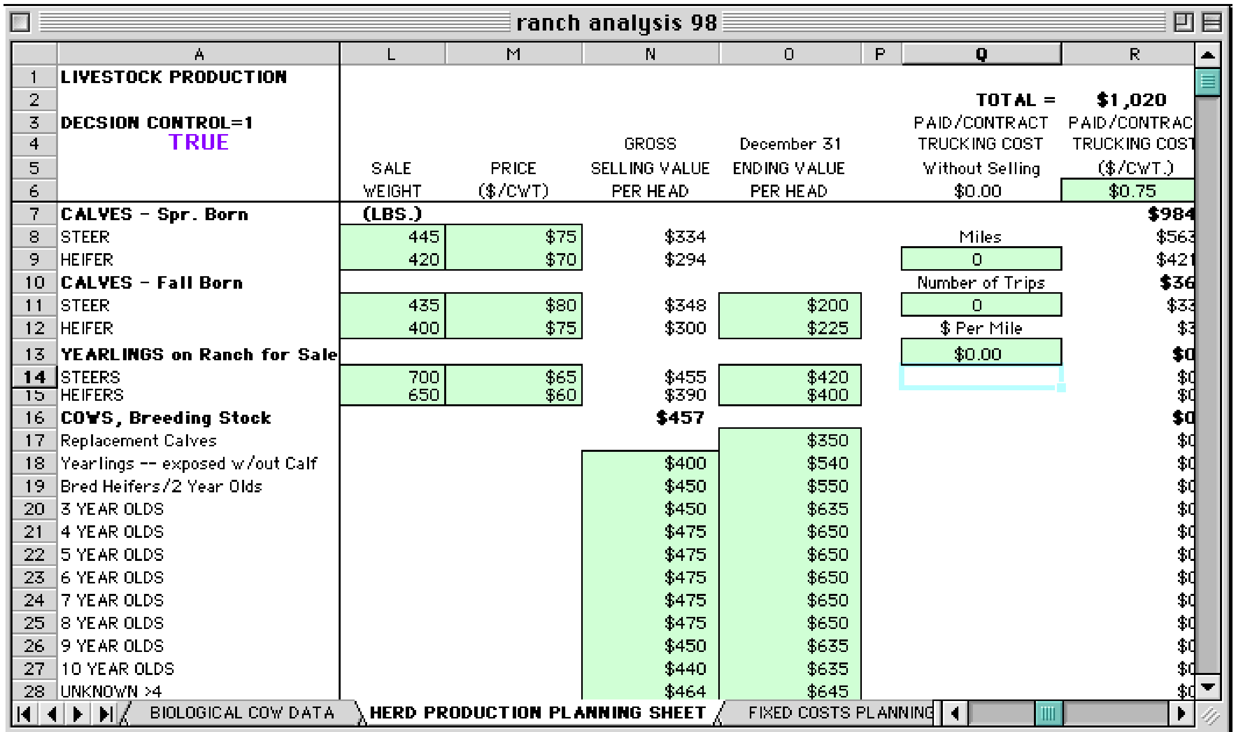
ranch analysis 98

	A	H	I	J	K	L	M	N
1	GRAZING SUMMARY	rative Extension, nor the Arizona Board of Regents warrant or guarantee the use or results of thi						
2				$0			$5,400	$10,903
3	©1999 University of Arizona	STATE		COST AT	PRIVATE	PRIVATE	COST AT	TOTAL
4		GRAZING		$2.09	GRAZING	GRAZING	$15.00	GRAZING
5		MONTHS			ANIMALS	MONTHS	PER AUM	COST
6								
7								
8								
9								
10	YEARLINGS on Ranch for Sale			$0			$0	$0
11	STEERS			0			0	$0
12	HEIFERS			0			0	$0
13	COWS, Breeding Stock			$0	120		$5,400	$5,400
14	Yearlings -- exposed w/out Calf	0		0	0	0	0	$0
15	Bred Heifers/2 Year Olds			0	0	0	0	$0
16	3 YEAR OLDS			0	10	3	450	$450
17	4 YEAR OLDS			0	10	3	450	$450
18	5 YEAR OLDS			0	10	3	450	$450
19	6 YEAR OLDS			0	10	3	450	$450
20	7 YEAR OLDS			0	10	3	450	$450
21	8 YEAR OLDS			0	10	3	450	$450
22	9 YEAR OLDS			0	10	3	450	$450
23	10 YEAR OLDS			0	10	3	450	$450
24	UNKNOWN >4			0	40	3	1800	$1,800
25	BULLS			$0			$0	$0
26	YEARLING			0			0	$0
27	2 YEAR OLDS			0			0	$0
28	3 YEAR OLDS			0			0	$0
29	4 YEAR OLDS			0			0	$0

FEED EXPENSE PLANNING SHEET | GRAZING EXPENSE PLANNING SHEET | LABOR

Figure 5. Range Fire (Leasing Pasture Option): Herd Production Planning Sheet Changes

Before

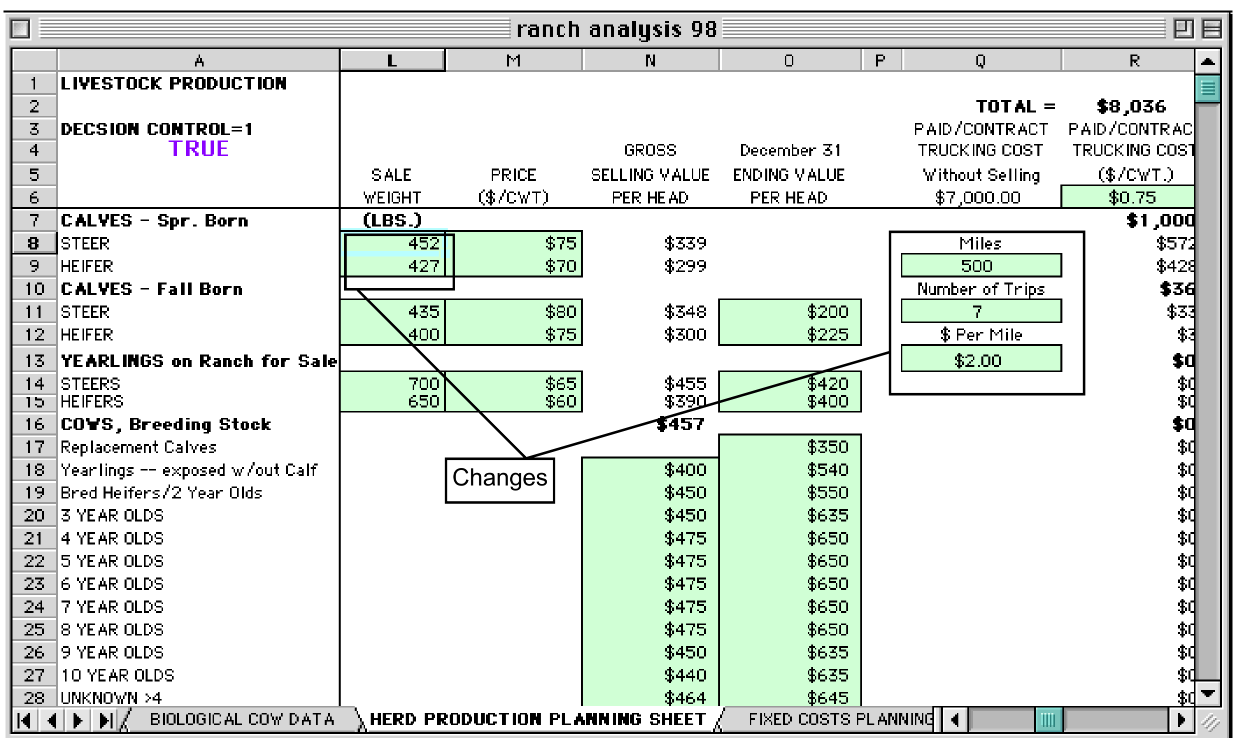


ranch analysis 98

	A	L	M	N	O	P	Q	R
1	LIVESTOCK PRODUCTION							
2							TOTAL =	$1,020
3	DECSION CONTROL=1						PAID/CONTRACT	PAID/CONTRAC
4	TRUE			GROSS	December 31		TRUCKING COST	TRUCKING COST
5		SALE	PRICE	SELLING VALUE	ENDING VALUE		Without Selling	($/CWT.)
6		WEIGHT	($/CWT)	PER HEAD	PER HEAD		$0.00	$0.75
7	CALVES - Spr. Born	(LBS.)						$984
8	STEER	445	$75	$334			Miles	$563
9	HEIFER	420	$70	$294			0	$421
10	CALVES - Fall Born						Number of Trips	$36
11	STEER	435	$80	$348	$200		0	$33
12	HEIFER	400	$75	$300	$225		$ Per Mile	$3
13	YEARLINGS on Ranch for Sale						$0.00	$0
14	STEERS	700	$65	$455	$420			$0
15	HEIFERS	650	$60	$390	$400			$0
16	COWS, Breeding Stock			$457				$0
17	Replacement Calves				$350			$0
18	Yearlings -- exposed w/out Calf			$400	$540			$0
19	Bred Heifers/2 Year Olds			$450	$550			$0
20	3 YEAR OLDS			$450	$635			$0
21	4 YEAR OLDS			$475	$650			$0
22	5 YEAR OLDS			$475	$650			$0
23	6 YEAR OLDS			$475	$650			$0
24	7 YEAR OLDS			$475	$650			$0
25	8 YEAR OLDS			$475	$650			$0
26	9 YEAR OLDS			$450	$635			$0
27	10 YEAR OLDS			$440	$635			$0
28	UNKNOWN >4			$464	$645			$0

BIOLOGICAL COW DATA | HERD PRODUCTION PLANNING SHEET | FIXED COSTS PLANNING

After



ranch analysis 98

	A	L	M	N	O	P	Q	R
1	LIVESTOCK PRODUCTION							
2							TOTAL =	$8,036
3	DECSION CONTROL=1						PAID/CONTRACT	PAID/CONTRAC
4	TRUE			GROSS	December 31		TRUCKING COST	TRUCKING COST
5		SALE	PRICE	SELLING VALUE	ENDING VALUE		Without Selling	($/CWT.)
6		WEIGHT	($/CWT)	PER HEAD	PER HEAD		$7,000.00	$0.75
7	CALVES - Spr. Born	(LBS.)						$1,000
8	STEER	452	$75	$339			Miles	$572
9	HEIFER	427	$70	$299			500	$428
10	CALVES - Fall Born						Number of Trips	$36
11	STEER	435	$80	$348	$200		7	$33
12	HEIFER	400	$75	$300	$225		$ Per Mile	$3
13	YEARLINGS on Ranch for Sale						$2.00	$0
14	STEERS	700	$65	$455	$420			$0
15	HEIFERS	650	$60	$390	$400			$0
16	COWS, Breeding Stock			$457				$0
17	Replacement Calves				$350			$0
18	Yearlings -- exposed w/out Calf			$400	$540			$0
19	Bred Heifers/2 Year Olds			$450	$550			$0
20	3 YEAR OLDS			$450	$635			$0
21	4 YEAR OLDS			$475	$650			$0
22	5 YEAR OLDS			$475	$650			$0
23	6 YEAR OLDS			$475	$650			$0
24	7 YEAR OLDS			$475	$650			$0
25	8 YEAR OLDS			$475	$650			$0
26	9 YEAR OLDS			$450	$635			$0
27	10 YEAR OLDS			$440	$635			$0
28	UNKNOWN >4			$464	$645			$0

BIOLOGICAL COW DATA | HERD PRODUCTION PLANNING SHEET | FIXED COSTS PLANNING

Figure 6. Range Fire (Early Weaning Option): Herd Production Planning Sheet Changes

Before

ranch analysis 98

	A	L	M	N	O	P	Q	R
1	LIVESTOCK PRODUCTION							
2							TOTAL =	$1,020
3	DECSION CONTROL=1						PAID/CONTRACT	PAID/CONTRAC
4	TRUE			GROSS	December 31		TRUCKING COST	TRUCKING COST
5		SALE	PRICE	SELLING VALUE	ENDING VALUE		Without Selling	($/CWT.)
6		WEIGHT	($/CWT)	PER HEAD	PER HEAD		$0.00	$0.75
7	CALVES - Spr. Born	(LBS.)						$984
8	STEER	445	$75	$334			Miles	$563
9	HEIFER	420	$70	$294			0	$421
10	CALVES - Fall Born						Number of Trips	$36
11	STEER	435	$80	$348	$200		0	$33
12	HEIFER	400	$75	$300	$225		$ Per Mile	$3
13	YEARLINGS on Ranch for Sale						$0.00	$0
14	STEERS	700	$65	$455	$420			$0
15	HEIFERS	650	$60	$390	$400			$0
16	COWS, Breeding Stock			$457				$0
17	Replacement Calves				$350			$0
18	Yearlings -- exposed w/out Calf			$400	$540			$0
19	Bred Heifers/2 Year Olds			$450	$550			$0
20	3 YEAR OLDS			$450	$635			$0
21	4 YEAR OLDS			$475	$650			$0
22	5 YEAR OLDS			$475	$650			$0
23	6 YEAR OLDS			$475	$650			$0
24	7 YEAR OLDS			$475	$650			$0
25	8 YEAR OLDS			$475	$650			$0
26	9 YEAR OLDS			$450	$635			$0
27	10 YEAR OLDS			$440	$635			$0
28	UNKNOWN >4			$464	$645			$0

BIOLOGICAL COW DATA | HERD PRODUCTION PLANNING SHEET | FIXED COSTS PLANNING

After

ranch analysis 98

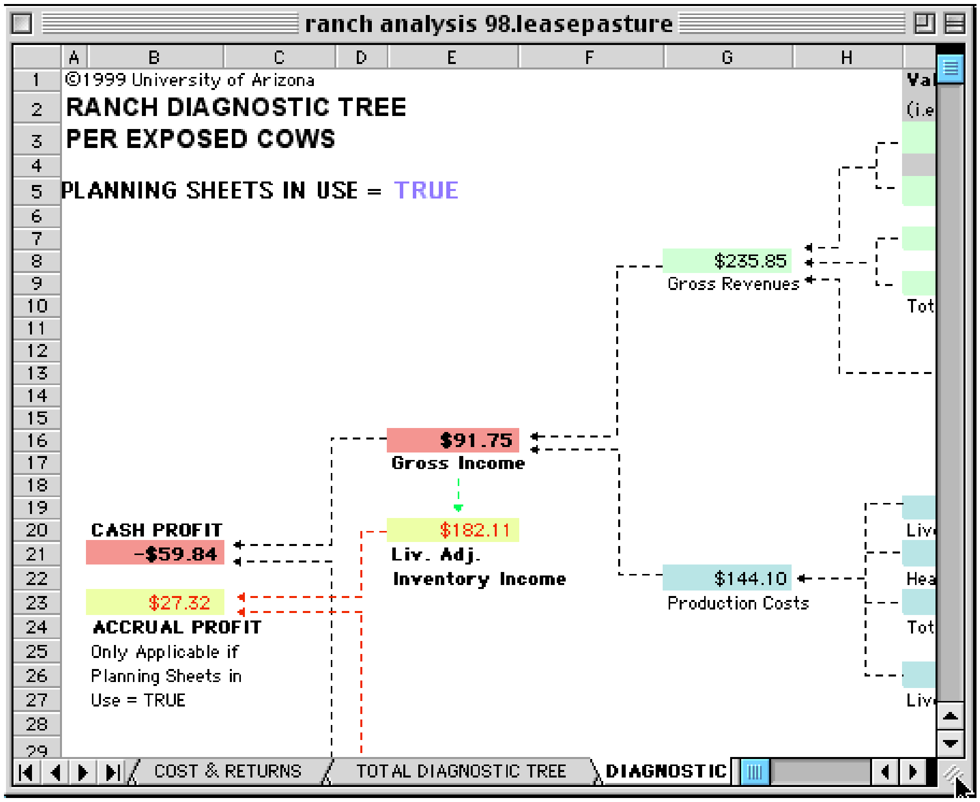
	A	L	M	N	O	P	Q	R
1	LIVESTOCK PRODUCTION							
2							TOTAL =	$680
3	DECSION CONTROL=1						PAID/CONTRACT	PAID/CONTRAC
4	TRUE			GROSS	December 31		TRUCKING COST	TRUCKING COST
5		SALE	PRICE	SELLING VALUE	ENDING VALUE		Without Selling	($/CWT.)
6		WEIGHT	($/CWT)	PER HEAD	PER HEAD		$0.00	$0.75
7	CALVES - Spr. Born	(LBS.)						$644
8	STEER	295	$95	$280			Miles	$373
9	HEIFER	270	$90	$243			0	$271
10	CALVES - Fall Born						Number of Trips	$36
11	STEER	435	$80	$348	$200		0	$33
12	HEIFER	400	$75	$300	$225		$ Per Mile	$3
13	YEARLINGS on Ranch for Sale						$0.00	$0
14	STEERS	700	$65	$455	$420			$0
15	HEIFERS	650	$60	$390	$400			$0
16	COWS, Breeding Stock			$457				$0
17	Replacement Calves				$350			$0
18	Yearlings -- exposed w/out Calf			$400	$540			$0
19	Bred Heifers/2 Year Olds			$450	$550			$0
20	3 YEAR OLDS			$450	$635			$0
21	4 YEAR OLDS			$475	$650			$0
22	5 YEAR OLDS			$475	$650			$0
23	6 YEAR OLDS			$475	$650			$0
24	7 YEAR OLDS			$475	$650			$0
25	8 YEAR OLDS			$475	$650			$0
26	9 YEAR OLDS			$450	$635			$0
27	10 YEAR OLDS			$440	$635			$0
28	UNKNOWN >4			$464	$645			$0

Changes

HERD PRODUCTION PLANNING SHEET | FIXED COSTS PLANNING SHEET | QUICKBOOKS

Figure 7. Range Fire: Leasing Pasture vs. Early Weaning Comparison

Leasing Pasture



Early Weaning

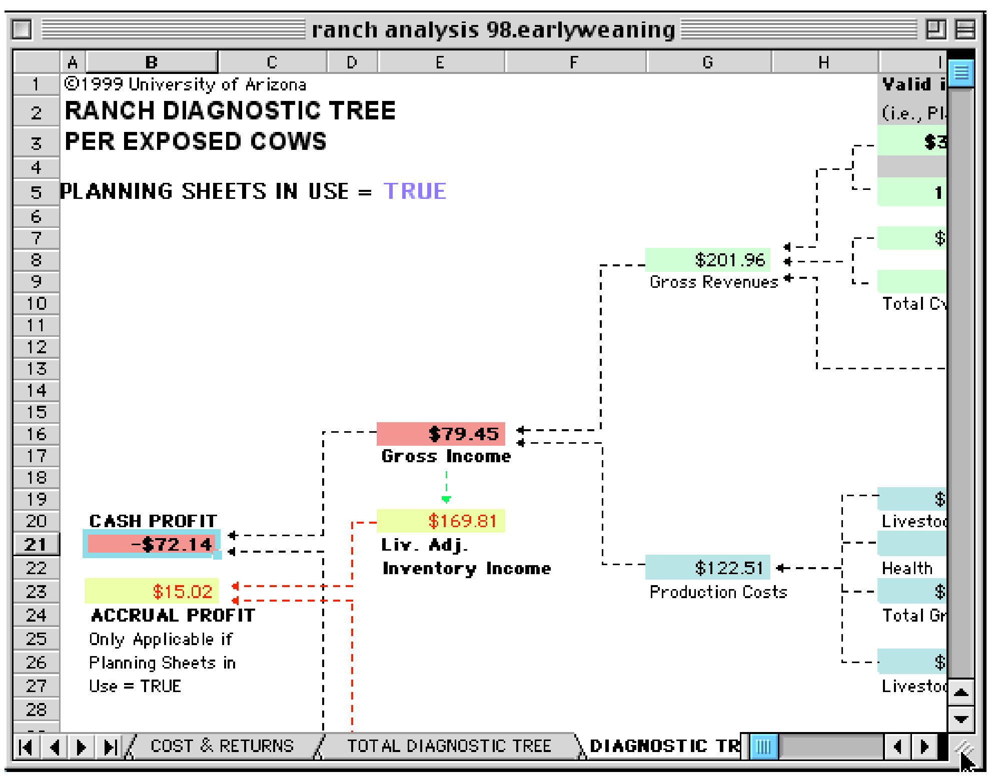


Figure 8. Range Fire (Drylot Option): Feed Expense Planning Sheet Changes

Before

ranch analysis 98

	A	B	C	D	E	F	G	H	I
1	**FEED SUMMARY**	**HAY**					**SUPPLEMENT**		
2	©1999 University of Arizona			***48***	***$4,583***				***0***
3									
4	Disclaimer: Neither the issuing ind				COST AT				
5		LBS/		TONS	$95		LBS/		TONS
6		DAY	DAYS	FED	PER TON		DAY	DAYS	FED
7	**CALVES – Spr. Born**			**26**	**$2,432**				**0**
8	STEER	5	30	13	$1,216				0
9	HEIFER	5	30	13	$1,216				0
10	**CALVES – Fall Born**			**2**	**$150**				**0**
11	STEER	5	30	1	$71		0	0	0
12	HEIFER	5	30	1	$78		0	0	0
13	**YEARLINGS on Ranch for Sale**			**0**	**$0**				**0**
14	STEERS	0	0	0	$0				0
15	HEIFERS	0	0	0	$0				0
16	**COWS, Breeding Stock**			**21**	**$2,001**				**0**
17	Yearlings -- exposed w/out Calf	12	90	21	$2,001		0	0	0
18	Bred Heifers/2 Year Olds	0	0	0	$0		2	0	0
19	3 YEAR OLDS	0	0	0	$0		2	0	0
20	4 YEAR OLDS	0	0	0	$0		2	0	0
21	5 YEAR OLDS	0	0	0	$0		2	0	0
22	6 YEAR OLDS	0	0	0	$0		2	0	0
23	7 YEAR OLDS	0	0	0	$0		2	0	0
24	8 YEAR OLDS	0	0	0	$0		2	0	0
25	9 YEAR OLDS	0	0	0	$0		2	0	0
26	10 YEAR OLDS	0	0	0	$0		2	0	0
27	UNKNOWN >4	0	0	0	$0		2	0	0
28	**BULLS**			**0**	**$0**				**0**

FEED EXPENSE PLANNING SHEET / GRAZING EXPENSE PLANNI

After

ranch analysis 98

	A	B	C	D	E	F	G	H	I
1	**FEED SUMMARY**	**HAY**					**SUPPLEMENT**		
2	©1999 University of Arizona			***183***	***$17,405***				***0***
3									
4	Disclaimer: Neither the issuing ind				COST AT				
5		LBS/		TONS	$95		LBS/		TONS
6		DAY	DAYS	FED	PER TON		DAY	DAYS	FED
7	**CALVES – Spr. Born**			**26**	**$2,432**				**0**
8	STEER	5	30	13	$1,216				0
9	HEIFER	5	30	13	$1,216				0
10	**CALVES – Fall Born**			**2**	**$150**				**0**
11	STEER	5	30	1	$71		0	0	0
12	HEIFER	5	30	1	$78		0	0	0
13	**YEARLINGS on Ranch for Sale**			**0**	**$0**				**0**
14	STEERS	0	0	0	$0				0
15	HEIFERS	0	0	0	$0				0
16	**COWS, Breeding Stock**			**156**	**$14,824**				**0**
17	Yearlings -- exposed w/out Calf	12	90	21	$2,001		0	0	0
18	Bred Heifers/2 Year Olds	0	0	0	$0		2	0	0
19	3 YEAR OLDS	0	0	0	$0		2	0	0
20	4 YEAR OLDS	0	0	0	$0		2	0	0
21	5 YEAR OLDS	0	0	0	$0		2	0	0
22	6 YEAR OLDS	0	0	0	$0		2	0	0
23	7 YEAR OLDS	0	0	0	$0		2	0	0
24	8 YEAR OLDS	0	0	0	$0		2	0	0
25	9 YEAR OLDS	0	0	0	$0		2	0	0
26	10 YEAR OLDS	0	0	0	$0		2	0	0
27	UNKNOWN >4 — Changes	17	90	135	$12,823		2	0	0
28	**BULLS**			**0**	**$0**				**0**

FEED EXPENSE PLANNING SHEET / GRAZING EXPENSE PLANNI

Figure 9. Range Fire (Drylot Option): Health Expense Planning Sheet Changes

Before

ranch analysis 98

	A	K	L	M	N	O	P
1	HEALTH EXPENSES	DECISION CONTROL=1				TRUE	
2	©1999 University of Arizona	$71		$0		$0	
3							
4	Disclaimer: Neither the issuing in	COST	MED.	COST	MED.	COST	MED.
5		$0.20		$0			
6		EACH	3 WAY	EACH		EACH	
7	CALVES – Spr. Born	$66.40	# Head	$0.00	# Head	$0.00	# Head
8	STEER	$33.20	1	$0.00	0	$0.00	0
9	HEIFER	$33.20	1	$0.00	0	$0.00	0
10	CALVES – Fall Born	$4.20		$0.00		$0.00	
11	STEER	$2.00	1	$0.00	0	$0.00	0
12	HEIFER	$2.20	1	$0.00	0	$0.00	0
13	YEARLINGS on Ranch for Sal	$0.00		$0.00		$0.00	
14	STEERS	$0.00	0	$0.00	0	$0.00	0
15	HEIFERS	$0.00	0	$0.00	0	$0.00	0
16	COWS, Breeding Stock	$0.00		$0.00		$0.00	
17	Replacement Calves	$0.00	0	$0.00	0	$0.00	0
18	Yearlings -- exposed w/out Calf	$0.00	0	$0.00	0	$0.00	0
19	Bred Heifers/2 Year Olds	$0.00	0	$0.00	0	$0.00	0
20	3 YEAR OLDS	$0.00	0	$0.00	0	$0.00	0
21	4 YEAR OLDS	$0.00	0	$0.00	0	$0.00	0
22	5 YEAR OLDS	$0.00	0	$0.00	0	$0.00	0
23	6 YEAR OLDS	$0.00	0	$0.00	0	$0.00	0
24	7 YEAR OLDS	$0.00	0	$0.00	0	$0.00	0
25	8 YEAR OLDS	$0.00	0	$0.00	0	$0.00	0
26	9 YEAR OLDS	$0.00	0	$0.00	0	$0.00	0
27	10 YEAR OLDS	$0.00	0	$0.00	0	$0.00	0
28	UNKNOWN >4	$0.00	0	$0.00	0	$0.00	0

HEALTH EXPENSE PLANNING SHEET / FEED EXPENSE PLANNIN

After

ranch analysis 98

	A	L	M	N	O	P	Q
1	HEALTH EXPENSES	DECISION CONTROL=1			TRUE		
2	©1999 University of Arizona		$0		$96		$0
3							
4	Disclaimer: Neither the issuing in	MED.	COST	MED.	COST	MED.	COST
5			$0	LA 2000	$1		
6		3 WAY	EACH		EACH		EACH
7	CALVES – Spr. Born	# Head	$0.00	# Head	$96.00	# Head	$0.00
8	STEER	1	$0.00	60	$48.00	0	$0.00
9	HEIFER	1	$0.00	60	$48.00	0	$0.00
10	CALVES – Fall Born		$0.00		$0.00		$0.00
11	STEER	1	$0.00	0	$0.00	0	$0.00
12	HEIFER	1	$0.00	0	$0.00	0	$0.00
13	YEARLINGS on Ranch for Sal		$0.00		$0.00		$0.00
14	STEERS	0	$0.00	0	$0.00	0	$0.00
15	HEIFERS	0	$0.00	0	$0.00	0	$0.00
16	COWS, Breeding Stock		$0.00		$0.00		$0.00
17	Replacement Calves	0	$0.00	0	$0.00	0	$0.00
18	Yearlings -- exposed w/out Calf	0	$0.00	0	$0.00	0	$0.00
19	Bred Heifers/2 Year Olds	0	$0.00	0	$0.00	0	$0.00
20	3 YEAR OLDS	0	$0.00	0	$0.00	0	$0.00
21	4 YEAR OLDS	0	$0.00	0	$0.00	0	$0.00
22	5 YEAR OLDS	0	$0.00	0	$0.00	0	$0.00
23	6 YEAR OLDS	0	$0.00	0	$0.00	0	$0.00
24	7 YEAR OLDS	0	$0.00	0	$0.00	0	$0.00
25	8 YEAR OLDS	0	$0.00	0	$0.00	0	$0.00
26	9 YEAR OLDS	0	$0.00	0	$0.00	0	$0.00
27	10 YEAR OLDS	0	$0.00	0	$0.00	0	$0.00
28	UNKNOWN >4	0	$0.00	0	$0.00	0	$0.00

Changes

HEALTH EXPENSE PLANNING SHEET / FEED EXPENSE PLANNIN

Figure 10. Range Fire (Drylot Option): Herd Production Planning Sheet Changes

Before

ranch analysis 98

	A	J	K	L	M	N
1	**LIVESTOCK PRODUCTION**					
2						
3	**DECSION CONTROL=1**	ACTUAL HEAD				
4	TRUE	SOLD OR CULLED				GROSS
5		FROM ACF	31-Dec-98	SALE	PRICE	SELLING VAL
6		DEFICIENCIES	INVENTORY	WEIGHT	($/CWT)	PER HEAD
7	**CALVES - Spr. Born**	**302**	**0**	**(LBS.)**		
8	STEER	169	0	445	$75	$3
9	HEIFER	134	0	420	$70	$2
10	**CALVES - Fall Born**	**11**	**18**			
11	STEER	10	9	435	$80	$3
12	HEIFER	1	9	400	$75	$3
13	**YEARLINGS on Ranch for Sale**	**0**	**0**			
14	STEERS	0	0	700	$65	$4
15	HEIFERS	0	0	650	$60	$3
16	**COWS, Breeding Stock**	**24**	**454**			**$45**
17	Replacement Calves		45			
18	Yearlings -- exposed w/out Calf	1	38			$4
19	Bred Heifers/2 Year Olds	1	84			$4
20	3 YEAR OLDS	1	32			$4
21	4 YEAR OLDS	1	30			$4
22	5 YEAR OLDS	1	28			$4
23	6 YEAR OLDS	1	26			$4
24	7 YEAR OLDS	1	23			$4
25	8 YEAR OLDS	1	18			$4

HERD PRODUCTION PLANNING SHEET | FIXED COSTS PLANNING SHEE

After

ranch analysis 98

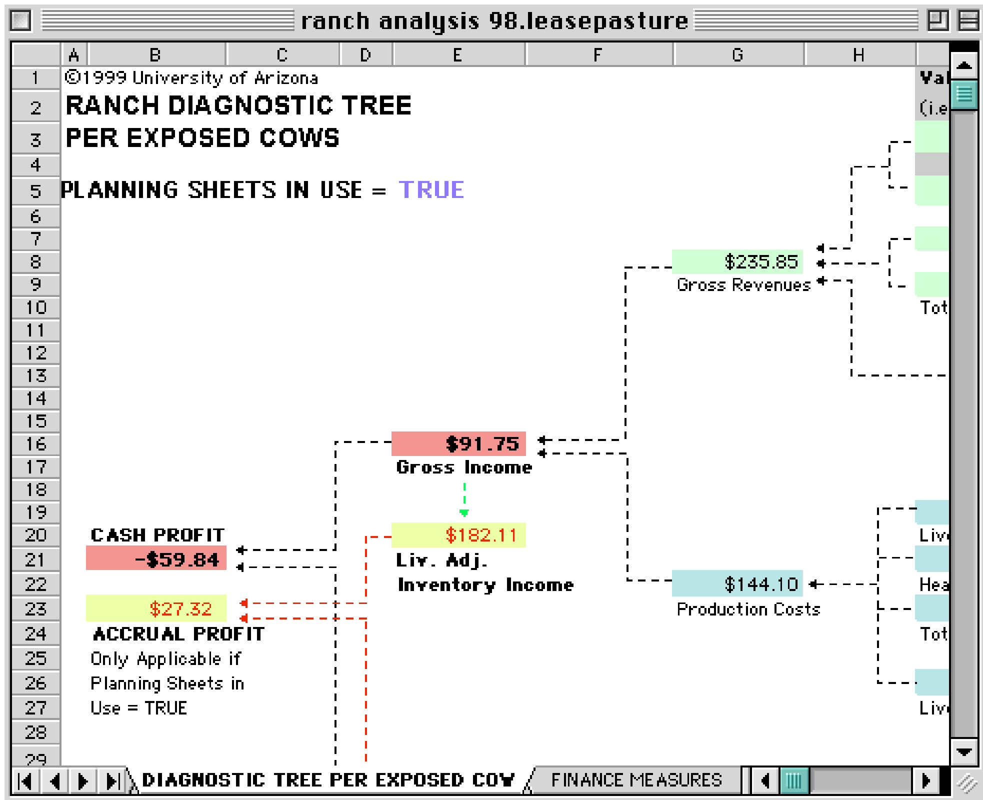
	A	J	K	L	M	N
1	**LIVESTOCK PRODUCTION**					
2						
3	**DECSION CONTROL=1**	ACTUAL HEAD				
4	TRUE	SOLD OR CULLED				GROSS
5		FROM ACF	31-Dec-98	SALE	PRICE	SELLING VAL
6		DEFICIENCIES	INVENTORY	WEIGHT	($/CWT)	PER HEAD
7	**CALVES - Spr. Born**	**302**	**0**	**(LBS.)**		
8	STEER	169	0	452	$75	$3
9	HEIFER	134	0	427	$70	$2
10	**CALVES - Fall Born**	**11**	**18**			
11	STEER	10	9	435	$80	$3
12	HEIFER	1	9	400	$75	$3
13	**YEARLINGS on Ranch for Sale**	**0**	**0**			
14	STEERS	0	0	700	$65	$4
15	HEIFERS	0	0	650	$60	$3
16	**COWS, Breeding Stock**	**24**	**454**			**$45**
17	Replacement Calves		45			
18	Yearlings -- exposed w/out Calf	1	38			$4
19	Bred Heifers/2 Year Olds	1	84			$4
20	3 YEAR OLDS	1	32			$4
21	4 YEAR OLDS	1	30			$4
22	5 YEAR OLDS	1	28			$4
23	6 YEAR OLDS	1	26			$4
24	7 YEAR OLDS	1	23			$4
25	8 YEAR OLDS	1	18			$4

Changes

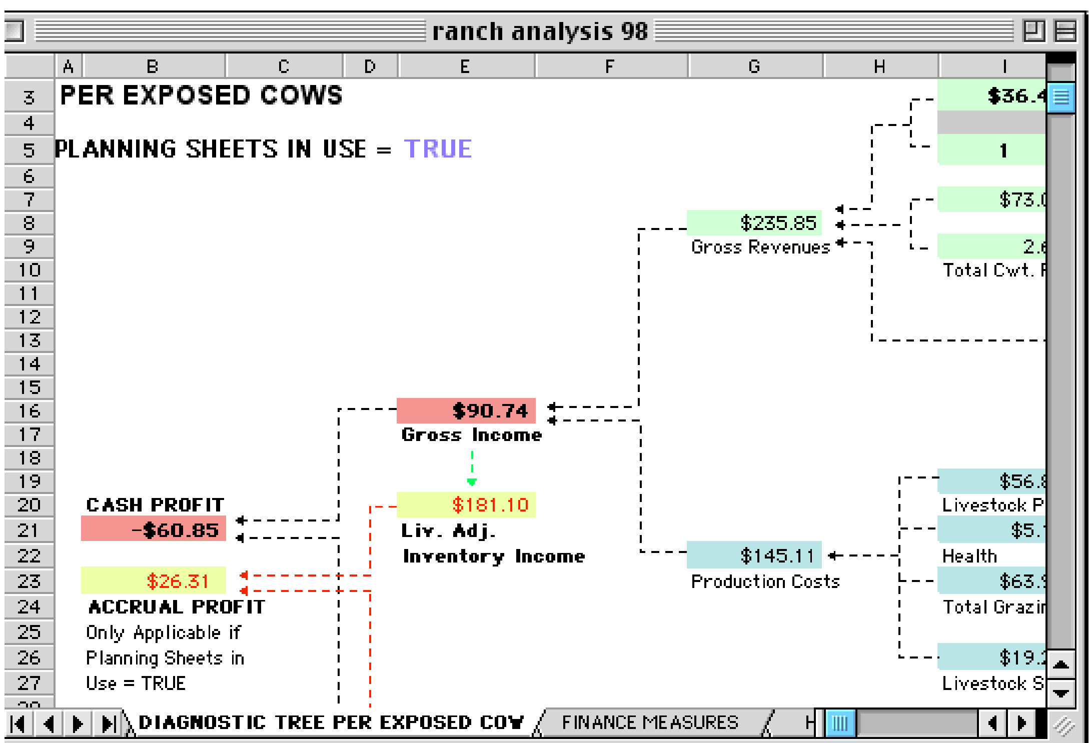
HERD PRODUCTION PLANNING SHEET | FIXED COSTS PLANNING SHEE

Figure 11. Range Fire: Leasing Pasture vs. Drylot Comparison

Leasing Pasture



Drylot



FROM:

Arizona Ranchers' Management Guide
Russell Tronstad, George Ruyle, and Jim Sprinkle, Editors.
Arizona Cooperative Extension

Disclaimer

DROUGHT ASSISTANCE PROGRAMS AND TAX IMPLICATIONS OF DROUGHT INDUCED LIVESTOCK SALES

Russell Tronstad[1]

Government payment assistance during or after a drought is a very real possibility. Drought assistance has been more likely ever since the Disaster Assistance Act of 1988 was legislated. Through this act the Secretary of Agriculture can authorize feed assistance payments for a county or reservation due to a natural disaster or livestock emergency. Programs of relevance for Arizona include the Livestock Assistance Program (LAP), Livestock Indemnity Program, and the American Indian Livestock Feed Program (AILFP).

DROUGHT ASSISTANCE PROGRAMS

Livestock Assistance Program: LAP provides direct payments to eligible livestock producers who have suffered grazing losses due to a natural disaster. A county must have suffered a 40 percent or greater loss of available grazing for at least three consecutive months as a result of damage due to drought, hot weather, insects, etc. Producers must meet certain criteria which include having a financial risk in eligible livestock that they have owned for at least three months before the payment period. LAP assistance is based on the value of feed calculated on a corn equivalent basis. Information needed to apply for LAP benefits includes: 1) number and share of livestock owned, 2) acres, location and type of grass or forage used to support livestock, 3) estimated percentage of grazing loss, and 4) dates of any significant livestock inventory changes.

Livestock Indemnity Program: Another program administered by the Farm Service Agency is the Livestock Indemnity Program. LIP assistance is possible for areas that have received a Presidential Disaster Declaration or requested a Secretarial Disaster Designation and received this status. This program provides partial reimbursement of livestock losses to eligible producers. If a producer's livestock losses exceed the normal mortality rate for the animal category under consideration, a producer may be eligible for payments. Producers must provide documentation to support their claims, and animals used for purposes other than human food or the production of food are not eligible. To not discourage private means of insuring livestock losses, Livestock Indemnity Program payments are not reduced to account for any insurance indemnity payments received from other sources.

American Indian Livestock Feed Program: The purpose of AILFP is to provide emergency financial feed assistance to livestock owners on tribal-governed land affected by a natural disaster. Under AILFP, the Commodity Credit Corporation contracts with governments of affected tribes to administer the program. When a tribal government determines that a livestock feed emergency exists, the tribal government may submit a request to implement the program. Damaging weather conditions, such as drought, which cause more than a 35 percent reduction of feed produced in a region for a defined period may qualify for payments. Livestock owners need not be American Indian nor a member of a tribe in order to receive payments under this program. Eligible owners must own or lease tribal governed land in the approved region and have had livestock on this land during the time of the qualifying disaster. Payments of this program are based on the smaller of either a) 30 percent of Animal Unit Day feed minus any feed sales, or b) actual livestock feed purchases minus sales of livestock feed.

All of the above programs are generally subject to a fixed sum of dollars that is allocated to a program, region, and/or nation. Thus, even if your county or tribe has been declared eligible to receive disaster assistance, judging how much reimbursement or assistance you will actually receive can be difficult. You may have to decide to sell livestock, buy hay, or lease pasture from another region before drought assistance programs are known. Uncertainties surrounding payment assistance, the weather, future market prices, and potential income tax liabilities make decisions regarding livestock sales during a drought difficult. Both drought assistance benefits and added revenues from drought-induced livestock sales need to be considered.

DROUGHT-INDUCED SALES

Managing tax liabilities during a drought can be a challenge due to more livestock sales than "normal" and the tax consequences of drought assistance payments. Special tax treatment is generally available to producers that are forced to sell animals because of a shortage of water, feed, or other drought-induced consequences. There are two basic tax treatments to defer income from drought sales. Both require that drought sales exceed the normal level of sales. Eligibility for the two different treatments depends on the class of livestock sold and whether the federal government has designated your area as eligible for assistance.

TAX TREATMENT #1— POTENTIALLY ALL LIVESTOCK

The deferred sales receipt method has the broadest class of animals which qualify. That is, only breeding livestock are eligible for the involuntary conversion tax method which follows. Yearlings and even"sporting livestock" are potentially eligible for the deferred sales method described here. Income from livestock sold in excess of normal sales, whether raised or purchased, may be deferred for up to one year if the following are satisfied:

1. Your (the taxpayer's) principal business is farming or ranching.
2. You utilize the cash method of accounting.
3. You state you are making an election under I.R.C. section 451 (e) and attach it to your drought-year return. You also attach a statement explaining the reasons that forced sales were necessary (lack of water, feed, etc.).
4. You provide evidence that "excess livestock" sales are due to drought and not a sell-off that is beyond drought-induced conditions. A three-year average is used to compute normal sales levels when making the calculation for "excess livestock" sold.
5. Your county or a neighboring county is designated as eligible for federal disaster assistance. The designation may be made by the president, an agency of the federal government (e.g., the Federal Emergency Management Agency or the Small Business Administration), or a Department of Agriculture agency (e.g., Farm Service Agency). The sale of livestock can occur before or after an area is designated a disaster area.
6. You total the number of animals sold this year and the number sold because of the drought. Any gain realized from weather-related sales must be provided. Income from normal sales is reported on this year's Schedule F while excess sales are reported on next year's Schedule F.

Livestock held for sale (e.g., steers, feeder heifers) can only qualify for tax treatment #1 or a one-year postponement in drought-induced income. Not all income needs to be deferred to the following year though. An advantage to this treatment is that some drought sale income can be taken as income for that year and some can be deferred to the following year. How much income is to be reported in the year of the sale or the following year must be decided by the due date of the return for the tax year in which the drought sale occurred. Another advantage to this treatment is that the tax basis for purchased replacements is not reduced by the amount of the postponed gain. Thus, if a raised cow is sold for $500 and a replacement is later purchased for $500, the entire $500 paid for the replacement is depreciable.

If prices are low and you expect to be in a zero or low marginal tax bracket, counting some if not all drought-induced sales as income for the drought year may likely be your best alternative. Keep in mind that any drought-assisted aid will need to be declared as income for the tax year that monies are received regardless of the method used for reporting livestock sales. See the box below for an example of the deferred tax treatment method. A disadvantage to this method is that you must rely on your area being declared eligible for federal disaster assistance. Also, the "involuntary conversion" tax treatment below for breeding animals may be preferred since it allows for drought-induced gains to be deferred for two years or one year beyond the one-year postponement described above.

Example of Tax Treatment #1 [election under I.R.C. 451 (e)]

Every year in the fall, Rancher Joe normally sells 100 yearlings, 13 cows, and 2 bulls (most recent 3-year average). Due to the drought this year, Joe sold 100 yearlings in May along with 15 pairs (30 head). In June, Joe sold 30 cows, 5 bulls, and 50 lightweight calves that were born earlier in the year. Normally, Joe doesn't sell any pairs or calves that are less than a year old.

Sale prices were $275/head for the yearlings, $400 average for the 15 pairs sold, $325/head for the 30 cows sold, $600/head for each bull, and $150/head for the calves that were less than a year old.

An election is made for each generic class of animals (e.g. cattle, sheep), not specific to an animal's age, sex, or breed. Thus, the average sale price for cattle is determined by dividing the total income received by the number of all cattle sold ($53,750 / 215 hd. = $250/hd.).This average is multiplied by the excess number sold (i.e., 215-115=100) due to drought to give the "excess sales." In this example, 115 hd. x $250/hd., or $28,750 in sales may be deferred for up to one year.

The election of how much income to postpone must be made in the tax year of the drought sale. After accounting for drought assistance benefits and other income and expenses, a plan should be devised for minimizing tax liabilities. The decision to buy breeding stock or retain more heifers in the following year needs to be considered in determining the amount of income to postpone for one year.

TAX TREATMENT #2— BREEDING CATTLE

Tax treatment #2 fits under the terminology of "involuntary conversion" in the tax guides. Gains from livestock sold as the result of a drought do not have to be recognized if the proceeds are used to purchase replacement livestock within two years from the end of the tax year in which the sale takes place. An advantage to this treatment is that your area need not be declared a disaster area by the federal government. Basic rules of this treatment, many similar to Tax Treatment #1, include the following:

1. Your drought-induced sales must exceed a normal three-year average.
2. You must purchase an equal or greater number of replacement livestock within two years of the end of the tax year of sale.
3. There is no minimum holding period. That is, bred heifers that you may have just purchased last year qualify as breeding livestock.
4. You must use replacement livestock for the same purpose.
5. An area need not be declared a federal disaster area, but there must be evidence that a drought occurred. For example, newspaper clippings or rainfall reports are generally sufficient proof.
6. You must provide a computation of the number and kind of livestock sold by category and the accompanying gain realized from drought sales.

When you buy replacements, attach to the tax return the date replacements

Example of Tax Treatment #2 [election under I.R.C. 1033 (e)]

Rancher Bob normally sells 20 cows and bulls from his beef herd every year but this year he sells 50, 30 more than normal due to the drought. The average selling price for all 50 head is $300/head. Thus, Bob defers the income of 30 head or $9,000 for this year if the cows were raised and have a zero basis.

If in the following two years Bob buys only 25 cows to replace the 30 sold, a gain of $300/head for five head must be reported regardless of what was paid for the 25 replacements purchased. Bob would need to report an additional $1,500 ($300 x 5) of income to an amended return for the year in which the drought sales occurred and any additional taxes must be paid.

If Bob purchased replacements for $400/head, then the tax basis for the 25 replacements would be $100 (replacement price minus the gain on the drought-induced sale that wasn't taxed). But if Bob purchased 25 replacements for only $250/head then an additional $1,250 gain ($50/head x 25 head) would have to be filed to an amended tax return for the drought year.

Keep in mind that any gains associated with feed assistance or indemnity payments have to be claimed for the tax year that they are received. It is conceivable that feed assistance combined with having to file an amended return of additional income could push a rancher into a higher marginal tax bracket for a drought year than planned.

were purchased, the cost of replacement animals, and the number and kind of replacements. Carefully consider your future intentions for rebuilding your herd when opting for the involuntary conversion treatment. Raised replacements are not eligible for "replacement livestock." Also, attention needs to be given to the selling price and expected purchase price. Consider the example of involuntary conversion on page 178.

Since every tax situation and ranch plan is different, no standard recommendation can be given as to whether the one-year postponement is preferred to the two-year involuntary conversion. Close consultation and planning with a tax advisor or accountant is likely to pay a heavy dividend if you have or plan to make substantial drought sales this year. Please refer to the Farmer's Tax Guide (Publication 225) or contact the IRS (1-800-829-1040) for more current and complete tax information. The Farmer's Tax Guide along with other tax forms and publications are available on the Internet at

http://www.irs.gov

Current information related to drought-assisted aid programs can be found at

http://www.fsa.usda.gov

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FROM:

Arizona Ranchers' Management Guide
Russell Tronstad, George Ruyle, and Jim Sprinkle, Editors.
Arizona Cooperative Extension

TRADE-OFF BETWEEN COW NUMBERS, CALF SIZE, AND SALE DATE INCORPORATING SEASONAL FACTORS AND SUPPLEMENTAL FEEDING

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Rigid sale dates are sometimes adopted to take advantage of seasonal forage availability or aggregate numbers for a given sale to attract more buyers. Arizona ranchers that primarily depend on winter rains for forage typically sell their calves in the spring while regions that most heavily depend upon monsoon rains for forage (e.g., southeast Arizona) sell in the fall. Both regions sell mainly according to the time of year, irrespective of the weight of their calves and very few supplement calves to increase their calf weights. Because ranchers often question the economic trade-offs between sale calf weights, herd size, rates of gain, and feeding supplement with a spring versus fall sale date, our primary objective is to analyze these issues.

The tradeoff between sale weight and timing of sales is complicated by seasonal forage and price conditions along with dramatic variation in the price spread between light and heavy calves. Generally, lighter calves sell for a higher per pound price than heavier calves and calf prices in the spring are greater than in the fall, but exceptions to these generalities occur. Selling calves at a heavier weight generally comes with an opportunity cost of reducing the number of cows that can be maintained on the ranch or calves that can be sold. In addition, variability in seasonal rainfall and the ability to feed supplement complicates analyzing the trade-offs between rates of gain, sale weight, herd size, and the timing of calf sales.

BIOLOGICAL CONSIDERATIONS

Quantifying the future rate of gain for a calf kept on the ranch is a critical element for evaluating the profitability of selling the animal now or at a later date. This analysis defines the calf growth cycle from birth to 20 months of age and evaluates the profitability of sale weight and season (i.e., mid-May or mid-November) under non-supplement and supplement range feeding scenarios. Weight gain was estimated as a function of age, sex, rainfall, compensatory gain, and prior weight levels. Weight data was collected from the Registered Hereford herd of the San Carlos Apache Tribal Ranch, Arsenic Tubs, Arizona for the eight years of 1980, 1981, 1983 to 1986, 1988, and 1989. A birth date and calf weight at birth was recorded for each calf. In addition, weights were taken when the entire calf crop was at an average age of roughly 3, 8, 12, and 20 months of age. Weight and animal combinations are such that we have 1,368 calves and 5,862 unique calf weights. Different calving dates provide age variation around each weighing date so that we can estimate daily weight gains as a function of age.

The solid line in figure 1 shows our calf weight estimates as a function of age for a steer calf with normal rainfall and no compensatory gain effects. The dots in figure 1 represent the weight of a given animal at a specified age and year. On average, calf weights at the 12 month weighing were 8.47 lbs. less than at their 8 month weight due to weaning and poor seasonal forage conditions that typically followed weaning. At any given age, heifer calves were estimated to weigh 4.97%

Figure 1. Calf weight data and estimated growth function

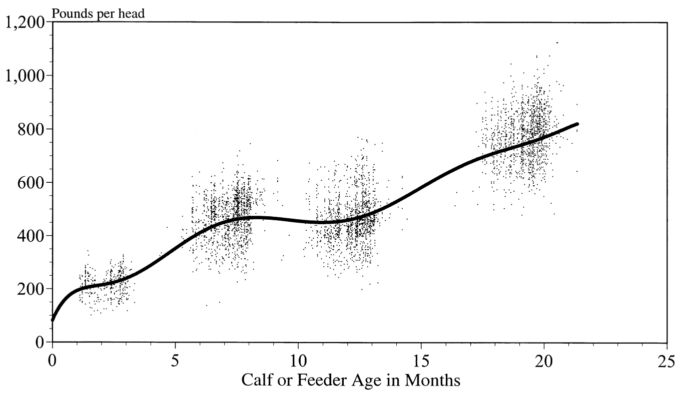
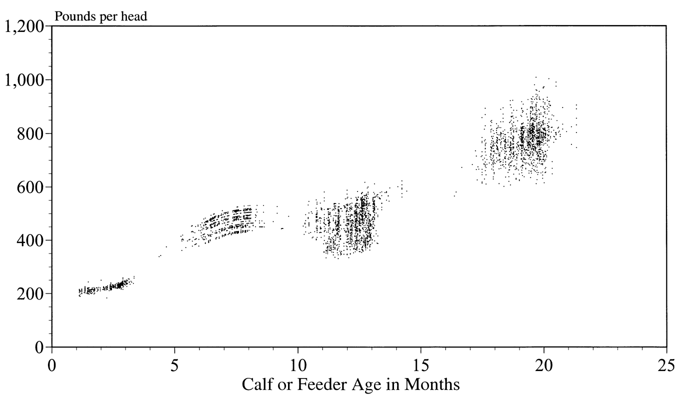


Figure 2. Calf weight estimates based on growth function, rainfall, compensatory gain, prior calf weights, and sex



less than a steer calf. Figure 2 provides weight predictions for each animal weighing. Variations from the solid line in figure 2 are due to differences in sex, cumulative rainfall from a prior weighing, prior weight from the estimated growth function, and compensatory gains.

To gain insights into the trade-off between different sale weights and dates, average real profits for two different ranching regions were simulated from 1980 through 1998 using either mid-May or mid-November sale dates for steer calves that weighed either 350, 450, 550, 650, or 750 lbs. A 350 lb. sale weight was matched with Cattle-Fax sale weight categories of 300 to 400 lb. sales and similarly for the heavier sale weights. The two regions examined have distinct seasonal forage differences. Regions that mainly depend on winter rain for forage rely on cooler season grasses and legumes like jojoba while “monsoon dependent regions” count mainly on warm season grasses for their primary forage production.

Table 1 shows the expected daily gains estimated for different sale weights and dates by region plus the equivalent cow numbers than can be maintained for each scenario. Rates of gain for the two regions were set up to mirror each other with the most favorable gains occurring prior to November and May sales for the “monsoon” and “winter” rain dependent regions, respectively. The most favorable forage conditions under supplementation assume a growth rate of 1.77 lbs./day for weights from birth to 350 lbs. and 1.75 lbs./day for weights from 450 to 750 lbs. These rates of gain were reduced by 10% for when forage is less abundant in each region prior to the animal’s sale date. To calculate the cows that could be supported on an Animal Unit Year (AUY) of forage, reductions of .5, .6, and .7 AUYs were charged for the number of days it took calves to go from 450 to 550, 550 to 650, and 650 to 750 pounds, respectively. The AUY reduction for producing calves heavier than the 450 lb. weight has the effect of reducing total cow numbers and thereby reducing the number of calves available for sale.

Birth dates and supplement requirements to meet the daily rates of gain in table 1 are described in table 2. Birth dates were calculated working backwards from the sale date and the corresponding rate of gain for each protocol. The amount of supplement required is dependent upon sale weight, sale date, and region. Respectable gains of 1.77 and 1.65 lbs. per day are viewed as attainable without feeding any supplement for 350 and 450 lb. sales in November and May for the monsoon and winter rain dependent regions, respectively. Supplemental feeding ranged from 100 to 400 lbs. per Animal Unit (AU), varying in average annual cost from $10.31 to $41.23 per

AU. The retail cost of a 50:50 corn meal and cottonseed meal mixture was charged for supplement. Because some ranchers may be able to obtain more of a wholesale than retail price for supplement, we did not charge additional labor or fuel expenses for distributing supplement to the cow herd. However, the distribution costs for supplement may be very noticeable, depending on the terrain of the ranch.

Cull cows were assumed to weigh 1,000 lbs. when they were culled, irrespective of the herd's mix or supplementation regime. In addition, a calf crop percentage of 85% per exposed cow, calf death loss after birth of 2.5%, and a culling percentage of 16% with a 4% annual death loss for cows was applied to all scenarios. The calf crop is assumed to be a 50:50 mix of steers and heifer. Thus, 40% of all heifers or 20% of all calves are retained each year to replenish the cull cows that either die or are sold. For example, a 100 AUY ranch selling 350 lb. or 450 lb. calves would expect to sell 16.0 cows, 41.4 (i.e., 100•0.85•0.975•0.5) steer calves, and 24.9 (i.e., 100•0.85•0.975•0.3) heifer calves annually.

Another expense item that varied with different sale date and weight options was the opportunity cost of money. That is, calves sold at 450 lbs. could have been sold at 350 lbs. and so forth. The opportunity cost of funds was charged at a real annual interest rate of 4%. Except for grazing expenses, cash costs for each scenario were obtained from Economic Research Service's cow-calf production costs for the west. Cash grazing costs were calculated using the grazing fees and accompanying percentages of grazing land in Arizona owned by the State (33%), Bureau of Land Management (17%), Forest Service (40%), or Private entity (9%) as reported in Mayes and Archer. Common variable and fixed cash expenses for all sale weight and date combinations are given in tables 3a. and 3b. Gao provides more detail to the cost items incorporated.

Table 1. Average daily gain (ADG, lbs./day) and equivalent cow numbers[a] (ECN)

	"Monsoon Dependent Regions"		**"Winter Rain Dependent Regions"**	
	No Supplemental Feeding			
Calf Weight (lbs./head)	May Sales ADG ECN	Nov. Sales ADG ECN	May Sales ADG ECN	Nov. Sales ADG ECN
Birth to 350	1.593 (1.000)	1.770 (1.000)	1.770 (1.000)	1.593 (1.000)
350 to 450	1.485 (1.000)	1.650 (1.000)	1.650 (1.000)	1.485 (1.000)
450 to 550	0.396 (0.743)	0.440 (0.763)	0.440 (0.763)	0.396 (0.743)
550 to 650	1.530 (0.688)	1.700 (0.710)	1.700 (0.710)	1.530 (0.688)
650 to 750	0.981 (0.606)	1.090 (0.631)	1.090 (0.631)	0.981 (0.606)
	Supplemental Feeding			
450 to 550	1.575 (0.920)	1.750 (0.927)	1.750 (0.927)	1.575 (0.920)
550 to 650	1.575 (0.839)	1.750 (0.853)	1.750 (0.853)	1.575 (0.839)
650 to 750	1.575 (0.762)	1.750 (0.780)	1.750 (0.780)	1.575 (0.762)

[a] Equivalent cow numbers were obtained by reducing available Animal Unit Years for cows by 0.5, 0.6, and 0.7 for the number of days it took calves to go from 450 lbs. to 550 lbs., 550 lbs. to 650 lbs., and 650 lbs. to 750 lbs., respectively. No distinction was made for weights less than 450 lbs. since these calves always reached their weight before 8 months of age, within the normal bounds of a one-year breeding and calving cycle.

Table 2. Supplement requirements and birth dates by sale date, sale weight, and location

Calving Date			**Supplement Required[a]**	
Monsoon Dependent	**Winter Rainfall**			
May Sales	Nov. Sales	Sale Weight (lbs.)	Calf (lbs.)	Calf/Cow (lbs.)
Nov. 27	May 30	350	—	—
Sept. 21	Mar. 24	450	—	—
July 19	Jan. 19	550	200	0
May 17	Nov. 17	650	250	50
Mar. 14	Sept. 14	750	300	100
Nov. Sales	May Sales			
June 16	Dec. 14	350	—	—
April 16	Oct. 14	450	—	—
Feb. 18	Aug. 18	550	0	100
Dec. 23	June 22	650	0	200
Oct. 27	April 26	750	0	300

[a] 50:50 Corn & Cottonseed Meal Ration

ECONOMIC RESULTS

Calf weights were estimated as a function of age, sex, climate, 20 month compensatory gain, and prior weights, as described in equation (1). Table 4 provides the parameter estimates and corresponding statistics for this model.

Table 3a. Common real ($1999 dollars) variable and fixed cash expenses for each Animal Unit Year, 1980–1989

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Variable Cash Expenses										
Grazing Fees	62.15	56.66	46.12	36.29	35.34	34.03	30.58	28.81	32.96	35.97
Protein Supplement	23.80	20.55	19.84	17.36	18.12	15.54	15.80	15.37	17.27	17.53
Salt & Minerals	2.93	2.98	2.99	2.93	2.78	2.81	2.82	2.76	2.66	2.67
Vet & Medicine	9.91	10.02	10.42	10.31	10.39	10.14	10.14	10.03	9.95	10.29
Livestock Hauling	4.04	4.15	4.34	4.22	4.16	4.17	3.94	3.84	3.78	3.87
Custom Rates/Operation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marketing	5.49	5.54	5.81	5.75	5.77	5.80	5.76	5.71	5.86	5.94
Hired Labor	36.62	35.83	35.00	34.43	33.56	33.08	33.70	31.73	32.21	32.29
Fuel, Lube, Electricity	29.77	30.83	28.06	25.67	20.78	19.81	15.90	15.66	15.67	17.20
Machinery & Bld. Repairs	28.42	28.90	30.29	30.78	28.86	29.15	28.86	28.16	28.46	28.35
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Variable Cash Exp.	203.13	195.45	182.87	167.74	159.75	154.54	147.51	142.06	148.83	154.12
Fixed Cash Expenses										
General Farm Overhead	43.67	37.76	34.53	31.18	38.48	33.55	42.96	55.42	34.90	35.29
Taxes & Insurance	32.05	25.16	24.66	23.91	20.54	19.26	25.13	33.93	35.19	35.62
Interest	94.55	81.93	80.57	72.78	74.19	66.25	58.58	60.04	69.58	64.30
Total Fixed Cash Exp.	170.26	144.85	139.76	127.87	133.20	119.06	126.66	149.40	139.67	135.22
Total Cash Expenses	**373.39**	**340.30**	**322.63**	**295.61**	**292.95**	**273.60**	**274.17**	**291.46**	**288.50**	**289.33**

Table 3b. Common real ($1999 dollars) variable and fixed cash expenses for each Animal Unit Year, 1990–1998 [a]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	AVG.
Variable Cash Expenses										
Grazing Fees	34.04	35.31	34.16	33.04	33.82	30.47	31.36	30.08	30.47	36.40
Protein Supplement	22.93	21.93	22.47	22.01	23.46	21.83	10.04	9.78	0.00	17.66
Salt & Minerals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.49
Vet & Medicine	14.30	12.51	14.98	18.44	18.90	18.39	26.56	27.28	35.33	15.17
Livestock Hauling	4.21	5.27	5.08	6.02	0.00	0.00	0.00	0.00	0.00	3.22
Custom Rates/Operation	0.00	0.00	0.00	0.00	0.00	0.00	43.94	45.13	55.17	7.59
Marketing	6.75	6.39	3.36	3.78	3.87	3.77	6.14	6.31	4.59	5.39
Hired Labor	43.95	43.58	44.65	42.16	40.64	41.65	62.17	64.63	15.39	38.80
Fuel, Lube, Electricity	19.27	19.70	17.53	17.88	0.00	0.00	0.00	0.00	22.44	16.64
Machinery & Bld. Repairs	22.98	23.14	23.05	23.02	23.35	24.39	22.94	23.44	18.74	26.07
Other	4.56	4.49	4.50	4.28	0.00	0.00	0.00	0.00	0.00	0.94
Total Variable Cash Exp.	173.00	172.32	169.77	170.63	144.03	140.51	203.16	206.65	182.12	169.38
Fixed Cash Expenses										
General Farm Overhead	47.28	36.70	36.14	47.40	45.06	46.40	39.09	45.09	50.57	41.13
Taxes & Insurance	21.35	18.07	17.86	22.36	21.89	21.93	17.34	17.07	30.49	24.41
Interest	75.25	60.40	51.33	59.38	52.71	59.09	58.58	35.17	12.62	62.49
Total Fixed Cash Exp.	143.88	115.17	105.33	129.14	119.66	127.42	115.01	97.33	93.69	128.03
Total Cash Expenses	**316.88**	**287.49**	**275.10**	**299.76**	**263.70**	**267.93**	**318.16**	**303.99**	**275.81**	**297.41**

[a] Changes in USDA reporting classifications occurred from 1994 to 1998 and account for the large dollar changes in several categories from one year to the next. See the 1982–1998 Cow-Calf Production Cash Costs and Returns report for more detail on these changes.

Note that the model to estimate calf weights is constructed so that if climate, compensatory gain, and prior weight deviations are "normal," weight gain is an 8^{th} order polynomial function of calf age in months with a constant weight percentage differential between steers and heifers.

If rainfall was above (below) the 30 year average for the months prior to their last weighing, calves would weigh more (less) than otherwise. For example, if the accumulated rainfall between the 3 and 8 month weighing was above (below) the 30 year average by 1 inch, calves would weight 11.196 lbs. more (less) than otherwise. The magnitude and statistical significance of the rainfall variable decreased as the animal increased in age. We believe that this result is because of the 20 month compensatory gain effect and the greater importance of lagged weight components as the animal increased in age. That is, these factors were able to better capture both genetic and environmental components as the calves increased in age compared to the rainfall variable.

Table 4. Average real return (APR) and standard deviation (SD) of returns ($ / Animal Unit Year), 1980–1998

Sale Weight (lbs./steer)	**"Monsoon Dependent Regions"**		**"Winter Rain Dependent Regions"**	
	No Supplemental Feeding			
	May Sales	Nov. Sales	May Sales	Nov. Sales
350	36.15 (61.78)	23.66 (57.58)	36.49 (61.85)	23.32 (57.52)
450	86.87 (67.70)	70.60 (63.90)	87.52 (67.82)	69.97 (63.79)
550	4.72 (50.84)	2.30 (50.34)	15.19 (52.67)	-7.79 (48.54)
650	1.00 (49.18)	6.91 (51.40)	13.75 (51.38)	-5.55 (49.11)
750	-20.71 (46.01)	-17.77 (63.14)	-5.08 (48.68)	-32.83 (60.20)
	Supplemental Feeding			
550	70.53 (66.10)	69.29 (64.57)	85.18 (66.97)	54.91 (63.78)
650	50.57 (63.10)	60.51 (65.41)	68.81 (64.62)	42.52 (63.97)
750	28.55 (61.55)	52.70 (84.79)	50.23 (63.70)	13.35 (79.38)

The average and standard deviation of real returns for different sale dates and weights are given in table 4. These figures are determined using the rate of gains estimated, Cattle-Fax prices for calf and cow sales, and the opportunity cost of forage described in table 1 (i.e., reduced cow numbers for heavier calf weights). With no supplemental feeding, a sale weight of 450 lbs. for May is the most profitable alternative for both regions. Under this management plan, an average real return of $86.87/AUY for the monsoon dependent and $87.52/AUY for the winter rainfall dependent region was realized for the 19 years from 1980 to 1998. November sales of 450 lbs. are the next most profitable strategy for both regions, and this strategy has a somewhat lower standard deviation of return than the May sales of 450 lbs. It is interesting to note that cull cow sales in May rather than November account for the largest share of the $17.05 per AUY favorable revenue differential between these two seasons. Cull cow sales account for $9.39 or 55 percent of the revenue differential, while 450 lb. steer and heifer calf sales account for $5.22 and $2.44, respectively, of the favorable revenue for May sales.

Without feeding supplement, the growth function estimated is essentially flat after reaching 7 months of age or 450 lbs. for the next 5.5 months. Thus, the opportunity cost of lower cow numbers and lower calf prices outweigh the gains from heavier sale weights for weights beyond 450 lbs. without supplement. However, heavier weights offset lower calf prices when going from 350 to 450 lb. weights carrying the same cow numbers. No opportunity cost of fewer cows is added when going from 350 to 450 lb. weights since 450 lb. calves are weaned at about 7 months of age, which allows ample time for cows to breed back in a year-round calving system.

Supplemental feeding is able to remove the long flat period for range calves from 7 to 12.5 months of age. Given the supplement requirements and weight gains described in table 2, supplementation has a considerable impact on returns when selling heavier calves. For example, supplementation for May

Table 5. Average real return (ARR) and standard deviation (SD) of returns ($ / Animal Unit Year) for extra grass year scenarios, 1980–1998

Sale Weight (lbs./steer)	"Monsoon Dependent Regions"				"Winter Rain Dependent Regions"			
	May Sales		Nov. Sales		May Sales		Nov. Sales	
	ARR	SD	ARR	SD	ARR	SD	ARR	SD
Supplemental Gains at No Supplement Cost								
550	91.42	(66.31)	79.63	(64.63)	95.63	(67.08)	75.59	(63.87)
650	81.96	(63.46)	81.22	(65.44)	89.75	(64.87)	73.62	(63.99)
750	70.47	(62.07)	83.82	(84.03)	81.69	(64.10)	54.90	(78.34)
Non-Supplemental Gains with No AUY Reduction								
550	116.09	(70.86)	101.04	(68.81)	118.08	(71.23)	99.10	(68.46)
650	147.05	(75.36)	139.61	(77.01)	149.42	(75.80)	137.29	(76.59)
750	178.59	(82.20)	161.28	(103.80)	181.64	(82.75)	158.28	(103.42)

sales and 550 lb. calves increased the average revenues per AUY by $65.81 and $69.99 for the monsoon and winter rainfall dependent regions, respectively. The $85.18 return associated with supplemental feeding and 550 lb. May sales for the Winter rainfall dependent regions almost attains the $87.52 return for 450 lb. May sales and no supplemental feeding for this region.

Table 5 illustrates what the return to different sale weights and dates would be if a rancher had "extra grass" so that supplemental gains were obtainable without feeding supplement or no reduction in AUYs was charged for selling calves at heavier weights. Even when supplemental gains are available at no extra feed cost, 550 lb. sales are the most profitable except for November sales in the monsoon dependent region. However, the difference between 550 and 750 lb. sales for this scenario is rather modest at $4.19 per AUY. In general, the opportunity cost associated with foregone calf numbers and lower prices does not outweigh the benefit of heavier calf weights, even when supplemental gains are imposed with no added feed cost. But if no AUY reduction is charged for producing heavier calves, the heaviest calf weight of 750 lbs. yields the highest return with May sales still somewhat preferred over November sales for both regions.

CONCLUSIONS

We found that the benefit of higher sale weights was not enough to overcome lower calf prices and fewer calf and cull cow sales for calf weights above 450 lbs. While feeding supplement was never the optimal strategy, supplemental feeding increased average returns by $45 to $70 per AUY for sale weights above 550 lbs. May sales were found to be more profitable than November sales, even with discounted rates of gain. More favorable market conditions for May than November sales are the main reason why May sales were often more profitable than November sales. It is also interesting to note that cull cow sales account for the largest share of the favorable revenue differential between these two months. Cull cow sales accounted for 55 percent of the favorable revenue differential, while 450 lb. steer and heifer calf sales accounted for 31 and 14 percent, respectively, of the favorable revenue for May sales in the mainly monsoon dependent rainfall region.

It is important to note that a more flexible sale date, weight combination, and supplemental feeding strategy could have generated more net return than the "fixed strategies" above. In addition, fertility was assumed to be high enough so that no increase in fertility was associated with feeding supplement. An increase in fertility from feeding supplement would most likely make a supplemental feeding regime as one of the most profitable strategies. But high labor and distribution costs to remote and difficult to access range sites would also make supplemental feeding less attractive than what we have expensed in our analysis. In addition, a strategy that could take advantage of market opportunities for buying replacements when they are cheap or feeding calves to a heavier weight when corn prices are high and forage is available would probably outperform the best "fixed strategy" of always producing and selling 450 lb. calves in May.

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Arizona Ranchers' Management Guide
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DEALING WITH MEDIA

Lorraine B. Kingdon[1]

Why deal with media? Quite simply, because people pay attention to newspapers, magazines, radio and television — and because agriculture is in the news. According to a recent study, 84 percent of Americans watch TV every day; 75 percent take at least 45 minutes every day to read a newspaper; 75 percent listen to the radio (but most of them aren't paying full attention); 94 percent read at least one magazine every month; and 50 percent read a book a month. People say they're extremely interested in stories about the environment, and as ranchers, you're often part of the environmental news coverage (Yarbrough, 1991).

Take a good look at today's news. Almost every day the press, television and radio report on the many kinds of trouble faced by individuals, small businesses, farmers — and unfortunately much too often, ranchers. You've seen them.

- Grazing fees are too low, an unfair subsidy to ranchers who, the article says, shouldn't be on our public land anyway.
- Cows are degrading our desert lands, tearing them down beyond repair.
- Ranchers want to shoot elk because they're eating forage that belongs to the cattle.
- Ranchers are shooting, poisoning, destroying our wildlife heritage, and their cows are endangering tortoises.

Sometimes the words are inflammatory; sometimes the stories are more or less accurate; sometimes just the quotes are misleading. What's going on? Unfortunately, it's all too easy to automatically blame the reporters, the editors, the TV anchors. If blame is to be allotted, some of it belongs to you, as well as the media. To get your side of the story told, you need to be able to deal knowledgeably with media.

You need to know the rules when you play with the pros. Understanding how reporters operate — and why — can help ensure that both sides of an issue are presented accurately and fairly. Taking the time to understand how reporters work pays off.

You also may need to change your attitudes about reporters. Colleen Patrick put it this way in her book, ***Mind Over Media***:

> "It is always surprising for me to discover how intimidated people often are of the media. Seeing it as devil or angel, most non-media people tend to attribute a monstrous amount of power to the industry and the people who work in it. More often than not, this much adulation is undeserved.
>
> Occasionally, the full impact of the communications industry devastates or inspires to a magnificent degree, but generally you (yes, you!) can also find a way to influence the coverage about which you are concerned. It means getting your message through to the right people and presenting it in a manner to which they will be receptive.
>
> Remember, in the world of media you are dealing with human beings who work with a communications product—a communication product which deals with stories about people or that affect people in one way or another. You have as much a right to approach them as anyone else."
>
> (Patrick, 1987)

Most reporters are generalists, trained to be journalists, not ranchers. They know how to write news so it can be understood. In small papers, reporters may cover the general call-in news, schools, the local business community and even the city hall and police. On larger papers, reporters may rotate from one type of news to another. And, they're always on a deadline that allows little time for serious consideration of subtleties or details. Unfortunately, most reporters rarely are given the luxury of true investigative reporting, spending months learning about one topic in great depth.

The journalistic theory of "balanced reporting" causes more misunderstanding than practically any other practice. In the media, "balance" means that all sides of a controversy are given a chance to state their position. As a rancher, you and an environmental activist may fight it out in the same article, and the readers are supposed to make up their own minds.

Problems enter when one side states a position more clearly than the other. Or, one side may make arguments not backed by facts. Reporters are supposed to be totally objective, but they're human and bias can enter.

Environment-related stories sell here in the Southwest because we have what is recognized as a sensitive, delicate desert. Also, Tucson and Phoenix are largely populated by recent urban immigrants from vastly different climates in the Midwest and East. These migrants are unfamiliar with the West's wide open spaces and often have preconceived negative ideas about ranching. Reporters are often urbanites, too.

Your first step should be approaching reporters with the right attitude. If you start out by assuming the reporter and the editor and everyone else associated with media are biased, deliberately misinterpreting the facts—that they are liars and scoundrels—don't be surprised if you continue getting a negative press. You're entitled to your feelings about the news coverage ranchers have received, but you harm your credibility if you lose your temper. **No matter what the provocation, keep your cool.**

No matter whether you approach the media or they come to you, you need to know what "news" means. And there are definitions — hundreds of them. Basically, "news" equals information that people **want** to find out about or **need** to find out about. A more cynical definition says that "news" is whatever an editor decides to print or put on radio or TV that day. If you believe you have a story that should be told, ask yourself:

- Is it local?
- Is it unusual? Unique?
- How timely — if the story isn't told this week, is it gone?
- How are people touched, involved, entertained?
- Which people? How many? Where are they?
- Does it solve a problem — or cause one?
- Why do people need to know? (That's the most basic question of all, and the one most often forgotten.)

All right, you have a story idea that will benefit ranchers; now what do you do with it? Abandon the idea that you must write a news release; that job is for the pros who work in the media. Let's assume you want publicity for an event —your local cattle growers organization is holding a meeting to talk about mountain lion predation that has suddenly increased dramatically. First question: Is the public invited? If not, don't bother calling the media because they only give publicity to events their readers can attend. Second question: Are the media invited?

Is the meeting going to present worthwhile information? Nothing will hurt your credibility more with your audience and the media than a highly publicized event that just doesn't amount to much.

Plan ahead to publicize your meeting. If you want to use magazines, get the information to them at least three months in advance. Simply write a letter or call the editor; be sure to provide the famous "**5 W's and the H**:" **Who, What, When, Where, Why** and **How**. Whatever you do, **DON'T** call or write anyone until you have all your facts, figures and ideas well thought out.

You'll need the same information for daily and weekly newspapers, but don't send it to them until two weeks in advance. Direct your letters to the proper editor, by name not merely by title. If you don't know who that is, call the paper and find out.

If you want to involve television in meeting coverage, use a slightly different approach to the assignment editor. The TV news very rarely will give advance notice of an event unless it has widespread importance. They may send a reporter and a camera to be at the meeting if:

- your topic is controversial (The suggested meeting fits that criterion.); or
- your speakers are well-known; or
- your topic is greatly important to the area; and
- you have something visual going on (so-called "talking heads" are usually considered boring).

Persistence is another key to coverage. Keep trying to interest the media in your story. After you've sent the letter with your news tip, call the editor. Be business-like but friendly. And remember deadlines. Deadlines are part of the everyday world reporters face, and the deadlines are always tight. Only the outbreak of a worldwide catastrophe "stops the presses," despite what you may have seen in the movies. TV Evening News goes on exactly on schedule, not a moment later.

In general, the following deadlines are appropriate (but always check with your media ahead of time, and never, ever call within an hour of the deadline):

- weekly newspapers often go to press on Wednesday, with deadlines for copy on the previous day;
- copy deadlines for morning daily papers are usually about midnight for the last edition;
- for afternoon daily papers, the deadlines range from 8 a.m. to noon, depending on the number of editions printed;
- television can go live, using their remote facilities. Otherwise, for a 5 p.m. newscast, reporters want to be back at the studio to edit their video by 2 p.m. The deadline for the late evening newscast is usually 7 p.m.
- If the radio station has regular newscasts, call the station just about any time; ask when the news director has time to talk.

News releases and newscasts are not the only way to get your story told. For example, if the newspaper has an editorial policy favorable to ranching, perhaps you can persuade the editorial board to express an opinion. This is a long shot except in smaller papers. If you're a good writer, try getting a column on the op-ed page; this is, logically enough, the page opposite the editorial page.

The “Letters to the Editor” section is one of the most heavily read parts of every paper, so it’s a good place to reply to news articles or editorials. Use such letters to correct mistakes rather than trying for a retraction; more people will read your letter. Here are some guidelines:

- Limit your letter to one specific subject.
- Use a news “hook.” Continue the debate on an issue currently in front of the public.
- Write in a calm, logical manner. Don’t rant or rave. Use unbiased expert sources and quote relevant statistics.
- Be careful about using humor or sarcasm. People either will not take you seriously or they will misinterpret. In either case, your point will be lost.
- Write to your local paper or specialized publications as well as the metropolitan papers. But don’t write identical letters or ones that look like form letters.
- If you write about the same subject too frequently, you run the risk of diluting your credibility. Ask a friend to write.
- Always sign your letters. Include your name, title, address and daytime phone number so the paper can contact you to verify that you actually sent the letter. At that point, you can ask that your name be withheld.

Radio and television have alternatives to the news, also. They both have talk shows, and talk shows need guests. Think it through before you decide on this type of publicity. You’ll be on the air much longer than you are during a 90-second news spot. How do you look on-camera? How do you sound on the mike? Listen to the show. How good is the interviewer? How sympathetic to the guests? Even more important, does the show reach the people you want to convince?

Up to this point, I’ve assumed **YOU** want to talk to the media. It’s just as likely that the **MEDIA** will want to talk to you. Suddenly, you’re the pursued, not the pursuer. And, you’re in a new ball game.

WORKING WITH THE MEDIA — PRINT

If reporters call on the telephone, first get their names and where they work; then find out what information they’re interested in. At that point, decide whether you’re willing to cooperate. Is this an issue you know enough about? Is this a reputable newspaper? There’s a big difference between the Arizona Daily Star and the National Inquirer.

Encourage a face-to-face interview. You’ll communicate more clearly because you’ll be able to detect when the reporter doesn’t understand, and you can clear up confusion immediately. However, sometimes deadlines don’t allow a meeting in person.

When you’re talking on the phone, identify yourself clearly. Spell your name and have the reporter spell it back. If the reporter has only one or two questions — and you know the answers — give the information promptly. If you need to look something up, say so. If you’re not the authority they ought to be talking to, say so and suggest another name. Ranching is a complex business that varies from one part of Arizona to another. If it’s necessary to call back later, tell the reporter when you can have the information; ask if that will be convenient, and always follow through. If you have a FAX available, ask about sending information this way.

Never forget, an interview with a reporter is not a conversation, no matter how friendly. It's a highly structured situation, and your role is to communicate as much information as possible about a particular topic, probably as quickly as possible.

Reporters are always on tight deadline. Don't let this fact keep you from controlling the interview. Rarely will the information be valuable only today. Let the reporters know that you understand deadlines and respect them. But also let them know that you will not be pressured to rush into an answer until you get your facts straight. Many issues are complex, and there may be times when a written, not a verbal, answer is more appropriate. Don't try to explain a highly complicated issue over the phone to a reporter who doesn't know much about ranching. You're inviting a story with errors and misquotes.

"No comment" is a reply that will invariably get you into trouble. It will only make reporters suspicious and lead to innuendos or negative references in the story. People who read the articles will have their doubts about you, also. If reporters ask you for information you can't give out — or don't want to — say so and say why.

Sometimes reporters will ask you to comment on a controversial issue, promising that your name won't be used without your permission. "Off the record" is fine if you're a national politician; if you're not, stay away from it. Newspaper editors occasionally insist on using names — no matter what promises the reporter has given during an interview. Comment on controversy if you want, but only if you're willing to see your name in print. Also, anything you say at a public meeting is fair game for reporters. "Off the record" is legally impossible to uphold; don't even try.

When you give a personal opinion on any subject, identify it as such. Make sure the reporter understands that you are speaking for yourself, not other ranchers or your professional organizations.

Answer questions seriously. Watch your sense of humor. Being flippant or funny may appear cold and cynical in print. Being friendly and casual are fine but quite different from making inappropriate jokes.

Don't talk jargon. Reporters are trained journalists and usually know very little about ranching. An "AUM" is incomprehensible. They can't write responsibly and accurately unless they understand exactly what you mean. Good reporters will dig until they're satisfied they know what you're talking about, but don't assume all reporters have the time, the expertise, or the willingness to interpret you. So, start out with uncomplicated language and try to explain what you mean in more than one way. Phrase your answers with a Phoenix reader in mind — someone who probably came from "back East" and couldn't tell a cow from a goat at six feet on a clear day.

If you know the subject ahead of the interview, think through your answers. Have in mind one or two key points that you want the reporter to mention in the finished story. Put them as clearly and as succinctly as you can. Get your points in early, even if you have to redirect the questions.

Think of stories that illustrate your point; use colorful language, but not profanity. Reporters will use a colorful, pithy quote word for word — accurately. This is usually (unless your quote is too colorful) preferable to a paraphrased quote that may or may not be accurately used.

Be positive, not defensive, even though the reporter may phrase the question in a negative way. For example, if the reporter asks, "Why should you be subsidized with cheap grazing fees?" Resist answering, "Grazing fees aren't subsidies!" Instead, talk about the environmentally favorable things you routinely do on public lands.

Don't let reporters put words in your mouth. If you don't like the way a question is worded, either deny it or give a positive response. Don't simply repeat the question while you think of an answer. In other words, don't say, "Some people think grazing fees are a subsidy, but . . ." Tomorrow's story could read, "Rancher admits grazing fees are a subsidy." Don't be misdirected by the reporter's questions. Questions don't get printed; your answers do. Watch out for "So in other words..." Reporters are trying to interpret what you said and get points down clearly. Be certain their rephrasing is accurate.

Control the interview. Constantly remind yourself that you must remain in control. Don't wait for reporters to ask the right question; do it for them. Smile; look at them directly, and say, pleasantly, "That's an interesting question, but it's more important to consider. . ." Take an active role; don't hesitate to offer pertinent information — a different angle — a piece of human interest. You're the expert, but make sure the information you offer backs up the major points you've decided to discuss. On the other hand, don't let reporters side-track you or lead the interview in directions you don't want to go.

Spell all names and double-check on figures. If possible support your interview with written material, if you have time to locate it before the reporters come. If you have a FAX machine, offer to send corroborating material to the reporter's office, before their deadline.

Sometimes the question is obviously biased — or contains what you know to be untrue. The reporter may be playing a game, hoping to get you annoyed, hoping to get an off-guard comment. Or, the reporter may simply be misinformed. Correct the misinformation, but don't repeat it in your answer, particularly on a radio or TV talk show.

> **"The reason:** *The more people hear the lie, the more they believe it. If the question includes the lie and you reiterate it before giving the accurate information, the lie has been heard twice, the truth only once. One response could be, "That's not true," then give the correct information.***"** (Patrick, 1987)

What about "dumb" questions? If reporters had time to do some background research into ranching, they wouldn't embarrass you — and themselves — by asking totally irrelevant, inane questions. It's not a good idea, obviously, to belittle the reporters. They control what appears in the newspaper, after all. Just smile politely to acknowledge the question, and then say what you want to say; your answer need not directly relate to the question.

I can't repeat it too often: know what you want to say and how you can best get your point of view across. You may have days or hours to plan your side of the interview, or you may have to make those decisions in minutes. Very often, you can't afford to extrapolate, to ad lib. To be blunt about it, when you've said what you want to say — shut up.

A friendly, listening attitude is still one of the best tools a reporter can cultivate. Good interviewers ask questions that demand more than a "yes" or a "no"; they ask for the "why" and "how." They invite you to continue explaining. They listen deeply. They try by their questions and even their body language to inspire you to answer clearly and fully. That's all well and good, but don't be "listened" into saying anything you don't want included in the story.

If you've been misquoted in the past —

and you're worrying about it happening again — tell the reporter. Ask for cooperation; reporters want to be accurate. Volunteer to clarify any information, on the phone if necessary. ***Don't*** ask to see the reporter's story before publication. You can't — you won't — and it's journalistically naive to even ask the question. Also, ***don't*** expect to see the magazine before it goes to print.

If you have complaints about the printed article, go to the reporter first. Talk to the editor, who supervises reporters, only if you can't get satisfaction from the reporter. A retraction may not be in order, but letting reporters and editors know about outright errors is important. If you don't, the error may be repeated in subsequent articles by other reporters using the original stories as background material. If the paper has an ombudsman, be sure to include that person in your complaint.

Another word about retractions. They're usually brief and buried somewhere on a back page. They rarely reach the same readers who may have paid attention to the error. On the other hand, realize that most people read quickly and forget fast; the errors may not be remembered. Well, you can hope they aren't.

INTERVIEWS — BROADCAST

Most of the preceding recommendations also apply to broadcast media, but here are a few additions:

Be brief. Summarize your major points in 15-20 second "sound bites". It's not easy, and yes, you leave out a great deal of important material, but whoever said television was fair? The average recorded quote in a broadcast news story runs under 30 seconds; it's more like 15 seconds. The shorter your answers, the less editing they'll get. That doesn't mean you answer all the reporter's questions in 15 seconds. Just make sure that somewhere in your longer answer, you summarize. The average news piece is two minutes or less — unless the station is reporting a large-scale disaster or the latest sex-related, notorious trial. These time constraints mean that only the barest essentials of any story get on the air, no matter how complicated the issue seems to you. Avoid time-consuming details, rambling explanations and complicated answers. However, remember that as long as you're hooked up to the microphone, what you say can be used in the broadcast.

Deadlines for broadcast reporters are even tighter than they are for print reporters. News broadcasts occur within a fraction of a second of the time they're scheduled. Reporters really don't have much time to listen to casual conversation.

Photographers and TV camera crews want the most dramatic pictures possible. Again, you need to be in control. Show them your lushest pasture, and don't go by way of an eroded stream bank.

Of course, it's a different ball game if ranching is the topic of a half-hour or hour-long documentary; these literally take months to prepare and tape. If you're asked to be a guest on such a program, I suggest you get intensive training. You're apt to need it!

Because they broadcast so frequently, radio reporters can be demanding. They want your statement NOW! Again, don't allow yourself to be pressured. There will be another newscast in a half-hour or an hour. Trying to answer a question when you don't have adequate information is a quick way to get into trouble.

When broadcast reporters call you, they do so because they've received a specific assignment from their assignment director. They are under tight deadlines; they're rarely interested in hearing ideas for other possible stories. Ideas go directly to the station's assignment director.

SUMMARY

The job you do (or don't do) when the media call on you can have a great deal of influence on what people think about ranchers and ranching. It's a job worth doing well. Always be honest, factual, friendly. You can only lie once to reporters; after that, they will doubt everything you say. Show that you're proud and enthusiastic about ranching.

If the article or broadcast is well done, tell the reporters. Better yet, tell their editor. Reporters don't get many compliments, and they'll remember you favorably forever.

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SUSTAINABLE RANCHING

George Ruyle [1]

Sustainable agriculture (SA) is a concept that is increasingly being used to describe food production systems that maintain natural resources without large inputs of synthetic chemicals. In practice SA includes social and environmental aspects of resource management in addition to production. Farming and ranching are now accountable to public scrutiny as never before.

The concept of SA is not new to range livestock production. In fact, the use of range forage by livestock on a sustained basis is the topic of some of the earliest range management literature. Methods to detect overgrazing and the application of basic grazing management principles were developed to ensure continued livestock production on rangelands.

Central to the sustainable agriculture theme is the integration of ecological principles into agronomic practices. Range livestock production provided perhaps the earliest practical application of ecology as a natural science. As the science of ecology developed early in this century, so did the application of ecological principles to the management of rangelands. For example, as early as 1917 range managers recognized that various plant species and communities were reliable indicators of overgrazing. Range management continues to use native species and habitats as standards against which to judge the impacts of grazing practices. The current move towards "ecologically-based" agriculture is a continuation of this development.

The sustainability of livestock grazing largely depends upon the inherent carrying capacity of the land and the level of management applied. While not all rangelands should be grazed, sustainable levels of livestock grazing can be accommodated in all but the most extreme environments. To stay in business ranchers must not only conserve this productive potential of the land, they must also plan and manage for environmental enhancement. A major goal of sustainable range livestock production is to harvest range forage without reducing the rangelands' future potential to produce vegetation. But there are other precepts to the concept of sustainability besides maintaining future options for the land.

Obviously the concept of sustainability does not just include environmental considerations. Limits to livestock grazing are imposed biologically, economically, legally and socially. Strict analysis of costs and returns are no longer enough to justify management decisions. Range livestock production requires both short-term and long-term analysis. Long-term economic returns are often emphasized when conservation projects are undertaken while economic measures seem less adequate to measure resource conservation over the shorter-term. A combination of economic and environmental analysis is required to assess proposed conservation measures.

Today, range livestock production operations must strive for sustainable forage utilization without jeopardizing future uses of the rangeland. Society's values may further constrain levels of production not associated with environmental limits, especially where public land grazing is involved. Rangeland resource managers have the added responsibility to document that their management practices indeed meet all of the demands that sustainability implies.

Current approaches to developing indexes of sustainability for a variety of rangeland uses are focusing on soil protection as the characteristic most directly related to maintaining potential site productivity. Accelerated soil erosion is as old as agriculture itself and continues to be a major problem today.

Vegetation will nevertheless continue to be a major indicator of rangeland conditions and therefore part of the index to whether or not current uses are sustainable. Particular plant communities may not be as important to future potentials as they are to current uses. However, plant communities are not static. They change with climate, species availability and other factors. Additionally, management practices will not always control vegetation change. While some simplistically believe that only complete removal of livestock will correct past damage from overgrazing, rangelands will not necessarily return to previous conditions simply by alleviating livestock grazing.

The SA approach to range livestock production involves meeting future objectives which may or may not relate to past vegetation types. The demands placed on rangelands are also changing resulting in changing demands for products and values. Maintaining a particular vegetation may not be feasible or desirable over the long-term, but maintaining the productive potential of the land is.

To ranchers and other land managers who serve as natural resource stewards, sustainability is often an implicit responsibility. But the public needs to become more aware of the processes that lead to sustainable uses of rangelands. Sustainable range livestock production is achieved through the thoughtful application of science and experience and documented through monitoring resource values and production levels.

The idea of sustainable ranching may serve as a rallying point for forward-thinking natural resource planning and management rather than the popular focus on past abuses. As Dr. Neil West of Utah State University recently wrote "the bigger issue is protecting the ability of the land to produce into the future." Ranching practices that consider broad environmental and community issues are basic to the concept of sustainable agriculture.

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COORDINATED RESOURCE MANAGEMENT

William E. Frost[1] *and George B. Ruyle*[2]

Increasing demand for natural resources has resulted in intensified conflicts between interest groups, land users and resource management agencies. Coordinated Resource Management (CRM) has evolved as a means for reducing these conflicts and reaching mutually agreeable management strategies. In recognition of this process the University of Arizona Cooperative Extension System, USDA Forest Service, USDI Bureau of Land Management, USDA Soil Conservation Service, and the Arizona State Land Department have signed a Memorandum of Understanding supporting and encouraging the use of CRM in Arizona. In addition, the Arizona Association of Conservation Districts and the Arizona Game and Fish Department signed the memorandum as witnesses, adding their support to the process.

WHAT IS CRM?

Coordinated Resource Management is a process by which natural resource owners, managers, users and related interests work together as a team to formulate and implement plans for the management of all major resources and ownerships within a specific area and/or resolve specific conflicts. The purpose of CRM is to resolve conflicts or issues that may hinder or preclude sound resource management decisions. It can also be proactive in planning for improvement of natural resources and is based upon the belief that people with common interests can work together to develop viable management strategies. The goal of CRM is to enhance the quality and productivity of natural resources by achieving compatibility among the multiple uses in a specific area. The objective is to improve and maintain natural resources in ways consistent with the priorities of the landowners, land users, interest groups and land management agencies.

Coordinated Resource Management is a voluntary, non-regulatory process that uses consensus as the strength of the process. Land owners, users, managers and other interested parties work together as a team from beginning to end. The exchange of values and viewpoints on objectives, problems and alternatives is essential to achieving common goals and meeting resource needs. The most effective process is one which involves the local community from the outset and where the regulating agency is comfortable with the local community being involved at the highest level of decision making.

CARDINAL RULES OF CRM

CRM involves the use of four cardinal rules:

1 - Management by consensus.

Participation in CRM is voluntary and consensus promotes involvement. Everyone will agree on conclusions before it is accepted by the group, with abstentions permitted.

2 - Commitment.

All participants must be committed to the success of the program.

3 - Broad involvement.

All interested and/or affected parties should participate. To leave out interests which care is to invite criticism and generate conflict.

4 - Express needs not positions.

Expressing positions creates confrontation while expressing needs generates trust and the group will take care to address legitimate needs.

INITIATING A CRM EFFORT

CRM is usually initiated because of a resource management problem or conflict that those involved and affected want resolved. Good coordinated management can also exist where immediate problems are not present but plans are developed to keep problems from developing.

Preferably, a CRM program is initiated at the local level by a request from a person, group, organization or agency that sees the need for a group action approach to resolving a local resource management problem. For example, a Natural Resource Conservation District (NRCD) might receive a request for a CRM effort as these districts are legal subdivisions of the state government with responsibility for land and water conservation. Processing of this request would include assignment of priorities and creation of timetables and schedules with the other agencies, organization and interests involved.

The CRM process should be reviewed with all interests to assist them in deciding whether or not to proceed. If the decision is made to proceed using the CRM process, a list of everyone to be invited to participate should be drafted and notices sent. A chairman should be selected to guide the organization of the planning group, assemble available inventory data, schedule meetings and otherwise motivate the individuals involved in this planning process.

The general flow of a CRM process is:

- CRM program request from private or public entity
- private and public landowners and managers, resource managers, and other interested parties in the general planning area are invited to initial meeting
- at end of initial meeting, consensus is reached to continue
- specific planning area is defined, issues, problems and concerns listed, goals and objectives developed
- information available and needed is determined
- checklist developed to ensure all resources have been considered
- each objective is addressed and all actions needed to accomplish it are determined, for each action who, what, when and how long is determined
- plan is developed using all information from prior steps and plan is reevaluated
- system set up to maintain and implement plan
- plan implemented
- annual reviews of plan, plan progress, accomplishments, problems, new objective development and years plan of work.

For more details about the actual process and steps of the CRM process consult the **Arizona Coordinated Resource Management: Handbook and Guidelines** distributed by the USDA Forest Service, USDI Bureau of Land Management, USDA Soil Conservation Service, Arizona Land Department and the University of Arizona Cooperative Extension in association with the Arizona Association of Conservation Districts and the Arizona Game and Fish Department or **Coordinated Resource Management: Guidelines for Doing,** published by the Society for Range Management.

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PUBLIC GRAZING IN THE WEST: THE IMPACT OF "RANGELAND REFORM '94"

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INTRODUCTION

The general public seems to believe that public lands ranchers pay substantially less for livestock grazing rights than do ranchers who lease similar privileges from private landowners. This impression contributed to the recent public range policy reform movement aimed at, among other things, a substantial increase in grazing fees on federal lands. But what are the differences in the costs of grazing on public and private lands? How do costs vary across states in the West? How will the fee increases proposed in the Rangeland Reform '94 (RR '94) initiative affect public lands ranchers, the Federal treasury, and the economies of the western states? How are these economic impacts distributed among public lands ranchers and between states? And how much is at stake? I will attempt to address these issues in this paper.

PUBLIC AND PRIVATE GRAZING FEES

Statewide average grazing fees on private lands are available for the years 1965 through 1992 for the eleven western states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Figure 1 compares grazing fees on federal and private lands for this period. The grazing fees in the figure have been adjusted for the effects of inflation so that the amount for each price series in each year is comparable to the respective 1992 value for that series. The unit of measure for grazing fees in the figure, and throughout this paper, is dollars per animal unit month (AUM), where an animal unit month is defined as 26 pounds of dry matter grass per day (equivalently, 780 pounds of dry matter grass per 30-day month). Montana is included in the figure because private grazing fees in Montana historically have been consistently among the highest in the eleven western states. On the other hand, private grazing fees in Arizona historically have been generally among the lowest.

Figure 1. Real Private and Federal Grazing Fees, 1965-92.

(1992 $ per Animal Unit Month)

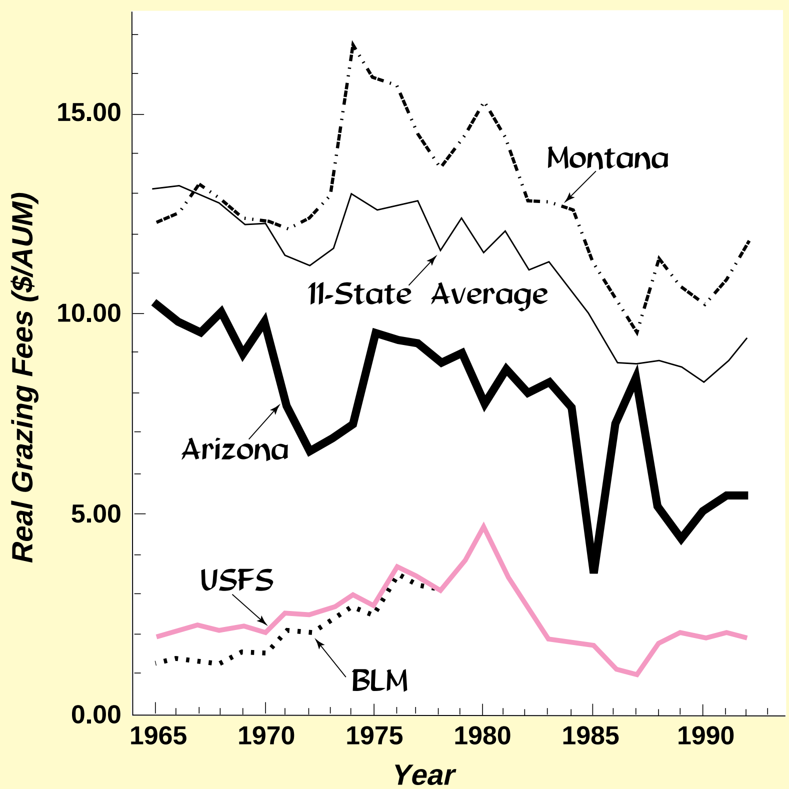


Figure 1 illustrates two aspects of the market for grazing rights in the western states. First, historically there has been, and continues to be, a substantial difference in grazing fees between the private and public sectors. For example, real grazing fees for Forest Service (USFS) and Bureau of Land Management (BLM) lands have averaged only $2.44 and $2.21 per AUM, respectively, over the 28-year period from 1965 through 1992, while the average real private grazing fees for each of the eleven western states over the same period have been as follows: Arizona, $7.80; California, $13.70; Colorado, $13.20; Idaho, $10.90; Montana, $12.80; Nevada, $7.55; New Mexico, $9.45; Oregon, $12.00; Utah, $10.45; Washington, $13.10; and Wyoming, $12.10. The eleven-state average real grazing fee on private lands over this period has been $11.20 per AUM, nearly $9.00 per AUM higher than real grazing fees on federal lands. Perhaps this provides some insight into the general public perception that public lands ranchers are being subsidized.

However, this perspective misses two aspects of the market for public grazing rights relative to the market for private grazing rights. First, private landowners often provide several rights and services to their grazing tenants that are not part of the bargain in public lands grazing leases. Since these services are costly to provide, their value is built into the competitive market price for private grazing rights. Second, because federal grazing permits can be bought and sold, they have a market value that represents an opportunity cost to public lands ranchers. The purchase price of a public grazing permit is as much a real cost to those ranchers as the initial capital investment required for the buildings, corrals, tractors, and other facilities and equipment necessary to operate their ranches.

The second aspect of the livestock grazing market illustrated by Figure 1 is the fact that there are large, consistent, and persistent differences in private grazing fees between states, ranging from a high of $13.70 per AUM in California to a low of $7.55 per AUM in Nevada. This implies that a substantial increase in federal grazing fees will have a much larger percentage impact on the value of a federal grazing permit in the Desert Southwest (Arizona, Nevada, western New Mexico, and southeastern California) than, for example, in the Rocky Mountain region (Montana, Wyoming, and Colorado).

For example, the results that I present below suggest that, should the fee increases of the RR ’94 initiative be fully implemented, two main effects on public lands ranchers in Arizona are likely in the long run. First, the net market value of federal grazing permits will fall considerably, and for some ranchers federal grazing permits eventually may become worthless. If economic conditions do not improve in the market for livestock over the long haul, then we may see an exodus of unprofitable ranchers from this sector of the livestock market in Arizona due to the higher grazing fees proposed in this initiative. Public lands ranchers in the other western states also will experience losses in income and wealth due to higher grazing fees and lower market values for their grazing permits. With the possible exception of Nevada, none of the other western states are as likely as Arizona to experience significant negative incomes for public lands ranchers or the exit of unprofitable ranchers from the industry. Let’s now look at these issues in more detail.

LANDLORD SERVICES AND THE NET VALUE OF FORAGE

Private landowners usually provide many kinds of services and rights to grazing tenants that are not provided on public lands. These services often include, but are not always limited to, the following: (1) fencing, including initial investments and maintenance expenditures; (2) access to water, including the initial investment in water facilities and expenditures for maintenance and upkeep; (3) the exclusion of access to the grazing tract by individuals other than the grazing tenant and landowner; (4) hunting, fishing, and timber-harvesting rights; and (5) several miscellaneous other services such as periodic moving, checking, and supplemental feeding of the tenant's livestock. Frequent efforts to estimate the value of landlord services have been made in New Mexico over the last decade. Recent estimates by Torell and Doll (1991) and Torell and Fowler (1992) place the cost of landlord services to be $1.88 per AUM for New Mexico in 1989, approximately 30 percent of the private grazing rate in New Mexico for that year. In 1992 dollars, this gives us a figure of $2.10 per AUM in New Mexico as an estimate for the average cost to landlords for providing these services and rights to their grazing tenants.

I have estimated the cost of landlord services for the other western states in real 1992 dollars using two methods: (1) by assuming that landlord costs are 30 percent of the private grazing rate in all states; and (2) by assuming that real landlord costs are $2.10 per AUM in all states. The first method implies that the net value of forage on private grazing lands is 70 percent of the private grazing fee. This assumption is supported by the fact that 30 percent of private grazing fees consistently has been the estimated cost of landlord services in New Mexico from a variety of methods and a number of studies over the past decade (Gray, et al. (1983), Fowler, et al. (1985), Torell, Ghosh, and Fowler (1988), Torell and Doll (1991), and Torell and Fowler (1992)). The second method is equivalent to assuming that both the cost of providing landlord services and the average level of services provided per animal unit month are uniform across states. It is useful to point out that, although the assumptions underlying the second method may not be completely valid, this method is useful as a basis for comparison and to evaluate the robustness of any conclusions we might draw from the first method.

The two methods produce the following range of estimates for the 1965-92 average real forage value per AUM in each state: Arizona, $5.45-5.70; California, $9.60-11.60; Colorado, $9.25-11.10; Idaho, $7.60-8.80; Montana $8.95-10.70; Nevada, $5.30-5.45; New Mexico, $6.60-7.35; Oregon, $8.40-9.90; Utah, $7.30-8.35; Washington, $9.20-11.00; and Wyoming, $8.50-10.00. The overall average real value of forage in the eleven western states appears to be between $7.85 and $9.10 per AUM for this period. These results suggest that the relative cost differences between public and private grazing are not as large as it may appear at first blush. We probably should be using a figure in the neighborhood of $7.85 to $9.10, rather than $11.20, for the overall average net forage value on private grazing lands when making the comparison with federal grazing fees.

It is useful to compare private net forage values and actual federal grazing fees with the fee structure of the RR '94 proposal to develop a feel for the latter's likely economic impacts. The current method for setting grazing fees on federal lands is mandated by the Public Rangelands Improvement Act (PRIA; 1977). Under this act, and its temporary extensions in each year since 1985, federal grazing fees are determined by the formula

$$Fee_t = 1.23 \times (FVI_{t-1} + BCPI_{t-1} - (PPFI_{t-1}/100)),$$

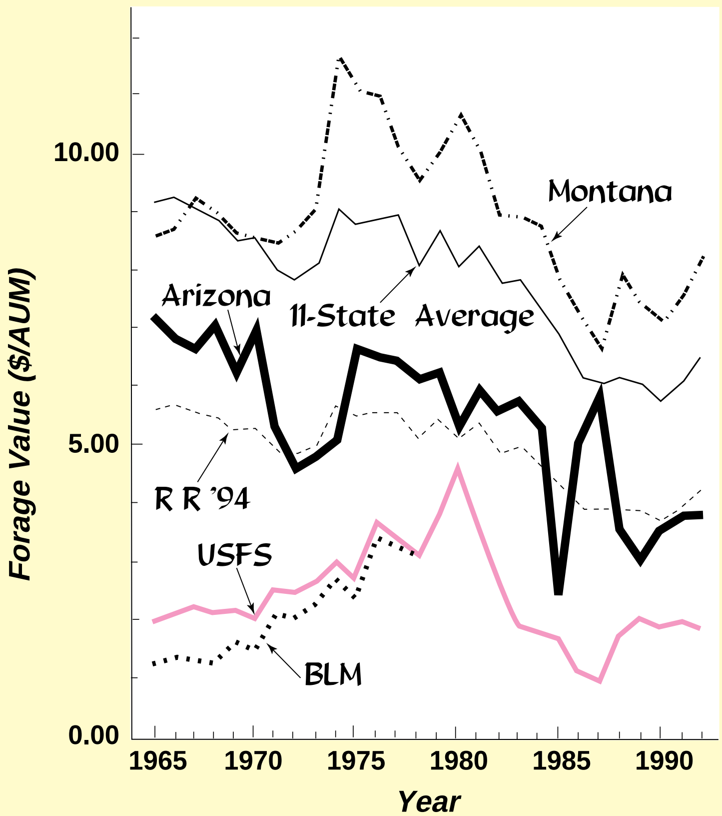
where FVI_{t-1} is a forage value index defined as the eleven western state average private grazing fee in the previous year divided by the 1967 average private grazing fee; $BCPI_{t-1}$ is a beef cattle price index defined as the average price received for all beef in the eleven western states in the previous year divided by the 1967 average price received for all beef cattle; $PPFI_{t-1}$ is the index of prices paid by farmers in the previous year, with a value of 100 in the 1967 base year; and $1.23 per AUM is the 1967 base year Federal lands grazing fee. This formula is applied uniformly across all states, to both USFS and BLM grazing lands, and has been in effect since 1978.

The method for setting grazing fees in the RR '94 initiative is given by the formula

$$Fee_t = 3.96 \times FVI_{t-1},$$

Figure 2. Net Forage Values and Public Grazing Fees, 1965-92.

(1992 $ per Animal Unit Month)



where FVI_{t-1} is the weighted average private grazing fee (weighted by Federal AUMs) divided by $8.67, which is the average private fee for the three-year period 1990-1992. In the new formula, private grazing fees for seventeen western states (the original eleven western states plus the six contiguous states to the east - North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas) are included in the calculations. The base fee of $3.96 per AUM is the average minimum net forage value for grazing rights on federal lands obtained from two estimation methods: (1) a 1991 update of the 1983 appraisal of the value of livestock grazing on Federal lands in sixteen Western states; and (2) a 1991 update of the 1966 Western Livestock Grazing Survey. The appraisal update generated a range of estimated values from $4.68 per AUM in the desert southwest (Arizona, southeastern California, Nevada, and southwestern New Mexico) to $10.26 per AUM in the northern plains (North Dakota, South Dakota, and northern Nebraska). The grazing survey update increased the PRIA base rate to $3.25 per AUM for 1991. The base fee of $3.96 per AUM in the new formula is the simple average of the two minimum forage value estimates of $3.25 and $4.68 per AUM.

Figure 2 illustrates the impacts that the RR '94 fee system would have had on federal grazing fees over the historical period 1965 through 1992. In this figure, net grazing fees for the private sector are calculated as 70 percent of the actual private grazing fees to estimate forage value net of landlord costs. Also in the figure are estimates of what federal grazing fees are likely to have been had the RR '94 formula been used over the past three decades. These estimates use the available eleven-state average private grazing fee rather than the full seventeen-state average because the latter figures are not available for the full historical time period. However, this should not create a significant bias in the results since the lion's share of livestock grazing on federal lands occurs in the eleven westernmost states.

Changing the method for setting federal grazing fees to the RR '94 proposal would have increased grazing fees considerably on federal lands over the past three decades. The average increase in USFS grazing fees is $2.48 per AUM in constant 1992 dollars over the 28-year period, while the average increase is $2.72 per AUM on BLM lands. This represents increases of approximately 100 and 125 percent, respectively, over the actual grazing fees for the two agencies. As should be expected, this figure is quite close to the estimated forage values of $5.45 per AUM in Arizona and $5.30 in Nevada. However, for each of the last five years in the available sample period, the RR '94 grazing fee is consistently higher than the estimated net forage value in Arizona. Perhaps this provides some insight into the furor caused by the proposed increase in federal grazing fees to $4.28 per AUM, as well as some level of understanding of the basis for the compromise proposal of $3.45 per AUM by Senator Reid of Nevada in fall 1993.

If we take these estimates as reasonable, and if current economic conditions persist in the market for livestock, then it appears as though an increase of the magnitude proposed in RR '94 could lead to negative incomes for some (indeed, possibly even a majority of) public lands ranchers in Arizona. Furthermore, because the net forage value is less than the federal grazing fee, we would expect that the average market value of federal grazing permits will fall to zero and that unprofitable public lands ranching operations will eventually exit the industry in the state. However, according to my estimates, although public lands ranchers in the other western states will experience losses in income and wealth due to higher grazing fees and lower market values for their grazing permits, none of the other states are as likely as Arizona to experience significant negative incomes or the exit of unprofitable public lands ranchers from the livestock grazing industry.

HOW MUCH IS AT STAKE?

It is well-established that the relatively low price of grazing on public lands (the 1993 Federal grazing fee is $1.86 per AUM) and the expectation that these low prices will continue into the future has led to a capitalized market value for public land grazing permits (Gardner (1962, 1963, 1989); Hooper (1967); Martin and Jeffries (1966); Roberts (1963); Torell and Doll (1991)). As part of their analysis of this issue, Torell and Doll estimated the real rate of capitalization for the relative cost advantage on public grazing lands to be 3.35 percent per annum, and also estimated that 85 to 90 percent of all current public grazing land permittees have purchased their public land leases from someone else. Thus, most public lands ranchers paid an initial investment cost for their federal grazing permits that absorbs, or at least partially absorbs, any benefits due to a relative cost advantage for grazing livestock on federal lands. Moreover, even those ranchers that have not purchased grazing permits from existing permittees face an opportunity cost associated with the income that is foregone by keeping rather than selling their permits in the open market. Any increase in federal grazing fees will lead to lower net incomes and a fall in the market value of federal grazing permits. The result is a wealth transfer away from public lands ranchers and towards the USFS and BLM coffers.

Table 1 reports estimates of the impacts of the RR '94 proposed fee increase on the value of federal grazing permits for each of the eleven western states. The cost estimates presented in the table were developed as follows. Figures for the total number of animal unit months and number of permittees on USFS and BLM grazing lands in each state for the fiscal year 1991-1992 were obtained from USDA, USFS (1992) and USDI, BLM (1992). The figures for total AUMs per

Table 1. Western States Federal Grazing Permits and Increased Annual Payments to the USFS and BLM under Rangeland Reform '94.

State	Number of AUMs USFS	Number of AUMs BLM	Number of Permits USFS	Number of Permits BLM	Average Annual Cost / Permit USFS	Average Annual Cost / Permit BLM	Average Annual Cost / Permit Weighted Average	Statewide Cost per Year
Arizona	1,057,895	684,664	498	838	$5269	$2222	$3358	$4,500,000
California	400,169	378,516	880	757	1127	1361	1235	2,000,000
Colorado	882,598	693,303	1151	1774	1902	1063	1393	4,100,000
Idaho	765,524	1,372,839	1162	2240	1633	1667	1655	5,600,000
Montana	516,863	1,317,677	1092	3873	1174	925	980	4,900,000
Nevada	258,679	2,487,130	186	723	3452	9357	8149	7,400,000
New Mexico	783,707	1,922,603	1125	2475	1728	2113	1993	7,100,000
Oregon	443,161	1,043,641	562	1431	1956	1984	1976	3,900,000
Utah	578,283	1,317,800	1232	1744	1164	2055	1686	5,000,000
Washington	112,692	26,377	171	331	1634	217	700	350,000
Wyoming	632,757	2,012,250	703	2748	2232	1992	2041	7,000,000
11 States	6,432,328	13,256,800	8762	18,934	$2116	$2269	$2288	$52,000,000

year were multiplied by the average fee increase of $2.48 per AUM for BLM land and $2.72 per AUM for USFS land obtained from the above analysis of differences in federal grazing under the historical and proposed fee systems. The statewide totals are the sum of the separate costs estimates for higher BLM and USFS grazing fees. The average cost per permittee is calculated as a weighted average, with the number of permits of each type (BLM and USFS) used as weights.

If we focus on statewide totals, or the aggregate figure for the entire west, we see that there really is not much money at stake for the overall economy or for any individual state. Indeed, on a per capita basis for the country as a whole, the issue boils down to a little less than 25¢ per person per year. However, due to the relatively small number of permittees - an average of slightly over 2500 per state - the stakes are considerably higher, amounting to a little less than $2300 per permittee per year. For public lands ranchers that continue to graze on federal lands, this translates into an average reduction in the discounted present value of their net incomes of just under $70,000 per grazing permit if we use the 3.35 percent per year discount rate from Torell and Doll. For Arizona, the comparable net loss in wealth is slightly more than $100,000 per permit, while for Montana it is slightly less than $30,000. The state with the public lands ranchers that have the most to lose appears to be Nevada, where the estimated loss in wealth associated with the RR '94 fee system is nearly $250,000 per operator under RR '94.

CONCLUSIONS

The conclusions we can draw from this simple analysis are the following. First, there is a small number of individuals, something less than 30,000 public lands ranchers, that have a significant financial stake in the federal grazing fee issue. For some of these ranchers, the economic impacts of the RR '94 proposal will be substantial enough to eventually lead them to close down their operations and exit the industry. Second, there appears to be a large variance in the economic effects across ranchers and between the western states. On the other hand, the grazing fee issue appears to matter very little financially to the rest of the country, both in terms of the Federal treasury and the overall total level of economic activity.

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