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DEVELOPING RANCH LINEAR PROGRAMMING MODELS USING GRAZING RECORDS[1]

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Linear programming (LP) is a mathematical decision-making aid that can help ranchers and range managers choose between various management alternatives and to allocate the resources available to them optimally (Hewlet and Lockman 1975, D'Aquino 1979, Leistritz and Qualey 1975, Torell et al. 1982). However, LP has not been extensively used in this way because organizing the data into the proper format is a formidable task for a person unfamiliar with the technique. COPLAN (Child and Evans 1976), a user-friendly program designed specifically for developing ranch management LP models, has been proven useful on some California ranches (Weitkamp et al. 1981), but it is not widely available and can be run only on larger computers. The purpose of this paper is to outline a procedure for using ranch grazing records to develop simple but useful LP models that can be run using widely available generalized LP programs.

The procedure for deriving the coefficients needed to construct a simple LP ranch planning model can be broken down into the 3 steps outlined below. Each step will be briefly described and illustrated using the University of California's Sierra Foothill Range Field Station (SFRFS) as a case study.

I. Define data needs

II. Define data base

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1. Identify manager's objective.
2. Describe ranch and seasonal forage cycle.
3. Identify and describe range improvement practices to be considered.
4. Identify and describe livestock products to be considered.
5. Define limits on fixed resources
6. Identify and determine area of distinct management pastures.
7. Determine management seasons.
8. Develop calendar of livestock operations.
9. Develop monthly livestock inventory.
10. List historical livestock use of each management pasture.

III. Estimate LP coefficients

1. Estimate seasonal forage requirements of livestock.
2. Estimate current livestock carrying capacity of each management pasture.
3. Determine potential change in carrying capacity of each management pasture due to range improvements.
4. Estimate costs of range improvements.
5. Estimate costs and returns of livestock products.

DEFINE DATA NEEDS

The information needed to develop a LP model for a ranch is much the same as that needed for any good ranch plan whether LP is used or not. The data needed include: 1) detailed physical inventory of the ranch, 2) detailed inventory of the resource base including land, forage, labor, livestock, water, and capital resources, 3) identification of possible management activities including the improvements possible on each pasture and possible grazing systems or other livestock management changes, and 4) identification of possible livestock and crop enterprises.

DEFINE DATA BASE

1. Identify the manager's objective.

LP is a single objective optimization procedure so it is important to define clearly the manager's objective. Profit maximization is the most common objective in ranch planning, but other objectives such as maximizing meat production or minimizing the use of fossil fuels or hired labor while achieving some minimum level of profit may also be considered. The objective used in the SFRFS case study was profit maximization.

2. Describe ranch including seasonal forage cycle

A complete description of the ranch including important aspects of topography, soils, vegetation, climate, and the seasonal forage cycle is necessary to define the resources available for livestock production. This description is also used to divide the

ranch into management pastures and the year into management seasons.

The SFRFS is located approximately 18 miles east-northeast Marysville in Yuba County, California and comprises 5,970 acres. Elevations range from 500 to 2000 ft., and slopes are generally less than 40%, though occasionally slopes as steep as 75% occur. The vegetation is typical of much of the annual rangeland of the Sierra-Nevada foothills. At the lower elevations open oak woodland and grassland are found with the herbaceous component composed mainly of annual grasses, forbs, and legumes. As elevation increases tree cover becomes denser, and shrubby vegetation makes up a larger proportion of the total cover. The most abundant shrubs are Toxicodendron diversilobum (poison oak) and various species of Ceanothus (wild lilac), Arctostaphylos (manzanita), and Rhamnus (buckthorn).

The soils developed from metamorphosed volcanic rocks or greenstone and are mapped mostly as Argonaut-Auburn-Sobrante-Los Posas associations.

A cool, wet winter (Nov.-Jan.) is followed by a moist, warm period in the spring favoring rapid plant growth (Feb.-April), and a dry season (late May to late September). Fall brings the first significant rains, usually in mid-October. Peak rainfall occurs between November and February with rainfall tapering off to infrequent showers by mid-May. Mean yearly precipitation is 30-35 in, and great year-to-year variation in both rainfall amount and seasonal distribution is typical.

The weather cycle results in three herbaceous plant growth phases (Bentley and Talbot 1951). The first phase, the "inadequate green forage period" begins with the first germinating rain (0.5 to 1 inch, usually in late October). However, early plant growth is often restricted by low soil moisture and/or low temperature. Occasionally a "false break" occurs when a period of drought or freezing follows germination, resulting in the death of the seedlings. During this first period availability of new green forage is uncertain and forage amounts and quality may not be adequate to achieve desired livestock performance. The second phase, "adequate green forage period" usually begins in early to mid-February. Mean daily temperatures and radiant energy amounts are higher and herbage levels and quality become adequate to maintain optimum livestock performance. Plants start to grow faster than they are being grazed at typical stocking rates. As soil moisture is depleted and temperature continues to increase plants mature, set seed, and then senesce, usually by mid to late May. The third phase is the "dry forage period" which usually lasts from June until the first germinating rains in the fall. The only green herbaceous plants are less palatable summer-growing annuals and occasional perennial grasses. The forage is of very low quality during this phase.

Approximately 4,200 acres of the 5,970 are annual grassland, oak woodland, or brush. There are about 260 acres of irrigated pasture of various ages, and 800 acres have been cleared and seeded to mixtures of annual clovers and perennial grasses without irrigation. Approximately 410 acres have been cleared of much of the tree and brush cover and allowed to reseed to resident annual range species.

3. Identify and describe range improvement practices to be considered.

Only range improvements that are ecologically feasible and for which adequate economic and physical resources are available should be included in the model. Each improvement considered should be described in detail. The description should be complete enough to calculate a per-acre cost for the improvement. Table 1 lists the improvements considered in the SFRFS model.

Table 1. Management alternatives.

Alternatives	Expected life
	Years
1) As is	-
2) Clear brush and trees	20*
3) Seed improved species	10*
4) Fertilize N	1
5) Fertilize N+P+S	2
6) Establish irrigated pasture	7*
7) Clear and seed	10*

*Expected lifespan will vary. These estimates are very conservative and probably underestimate life-span for some situations.

A sample description of one improvement, establishing irrigated pasture on cleared land follows:

Establishment

a. Install water delivery system for flood irrigation. Cut ditches with grader and install gates and valves.

b. Provide necessary access roads, livestock feeding and watering facilities, and boundary fencing.

c. Disk and harrow field, incorporating 250 lb/a 0-36-0-19.

d. Apply any needed weed control practices, including use of interim annual crops such as cereals or Sundangrass.

e. Seed field with a mixture (e.g., 5 lb/a Ladino clover, 5 lb/ac strawberry clover, 3 lb/a orchard grass, and 3 lb/a perennial ryegrass) with range or grain drill. A moderate application of starter fertilizer (e.g., 16-20-0 up to 30-40 lb/a N equivalent) can be included in the drill seeding.

f. Build fences.

Maintenance

a. Yearly maintenance of fences, ditches, and other facilities.

b. Yearly maintenance of pasture stand (e.g., clipping, weed control, and proper grazing management).

c. Refertilize with 400 lb/a 0-25-0 every 3 years.
Expected life of stand with maintenance is 7-10 years.
Expected life of fences is 20 years.

4. Identify possible livestock production alternatives.

Livestock enterprises to be considered in the model should be identified and important production parameters defined. The livestock enterprises considered will depend on the topography and vegetation of the ranch and the experience and preference of the manager.

Livestock enterprises included in the SFRFS model were 1) cow-calf operation, with fall calving and the selling of calves as weaners in July, 2) stocker operation, purchasing steers at 450 lbs in late November and selling at approximately 675 lb at the end of May (assumed 1.15 lb ADG overall), and 3) any combination of the above.

Livestock production parameters should include estimates of purchase and sale dates and weights of stocker animals, mean weight of mature breeding stock, mean weight of replacement stock, number of cows per bull and/or ewes per ram, number of mature breeding animals per replacement, percent calf and/or lamb crop, and percent death loss and culling rate of mature breeding animals (Table 2).

Table 2. Livestock production parameters.

Calf crop	90%
Death loss	5%
Mean mature cow weight	1,000 lb
Mean bull weight	1,500
Replacement heifer weight	600
Stocker purchase weight	450
Stocker sale weight	675
Cow purchase weight (not used here)	850
Replacement purchase weight (not used here)	500
Mean calf birth weight	70
Mean calf weaning weight - heifer	450
steer	500
20 cows/bull	
5 cows/heifer replacement	
"100-cow herd" composed of 80 cows	
20 first-calf heifers	
20 replacements	
5 bulls	
Replacement rate for bulls 20% per year	

5. Define limits on fixed resources.

Determine the limits on the amounts of resources needed to produce the livestock products considered in the model. Such resources include but are not limited to land, water for irrigation, labor, and capital.

For the SFRFS study it was assumed the manager does not wish to rent or purchase additional land. Capital limitation was arbitrarily set at $75,000. The manager in this study was assumed to have family labor available consisting of his or her spouse, and two children and was assumed not to use hired labor. Water for irrigation comes from a local irrigation district, and a total of 80 miner's inches is available in an average year. This amount may be reduced in drought years.

6. Identify and determine area of distinct management pastures.

Unless the ranch is quite uniform in terms of vegetation, topography and past management it will be necessary to divide it into management units or pastures and to determine the area of each. Individual management pastures represent a unique combination of vegetation, soils, topography, past management, ecological potential for range improvement, and management cost. The number of management pastures included depends on the complexity desired in the model. For simple models this number should be kept to the minimum number that will adequately describe uniquely different areas of the ranch.

Eleven management pastures were defined for the SFRFS. Boundaries were determined using slope, vegetation, past management, existing fence lines, potential for improvement, and availability of water for irrigation as primary criteria. The area of each pasture was determined by drawing the management pasture boundaries on a map of the station and using a planimeter. The location and improvement potential of the 11 management pastures are shown in Figure 1 and Table 3.

7. Define management seasons.

Since forage production and livestock requirements vary through the year it is necessary to divide the year into seasons in order to represent better the relationship between the two in the model. As with management pastures, the number of seasons included in the model depends on the complexity needed or desired.

For ranches that depend mostly on rangeland for forage the seasons should be determined by the range forage production cycle, since this is the cycle over which the rancher has the least control. The length of each season should be chosen to represent an "average" year i.e., one in which no single season is extremely long or short compared to the long-term average.

For the SFRFS the length of three distinct seasons was determined using the long term average for each season at the San Joaquin Experimental Range as a guideline.

Table 3. Carrying capacity and cost of management and improvement of each pasture.

Management activity	Carrying Capacity by Season 1	2	3	Cost
	AUM/ acre	AUM/ acre	AUM/ acre	$/acre
Pasture 1				
As is	.08	.18	0	.50
Pasture 2				
As is	.36	.24	.19	6.03
Clear	.24	.31	.30	26.63
Clear and seed	.35	.44	.44	
Pasture 3				
As is	.45	.26	.39	6.03
Seed	.45	.37	.36	26.63
Fertilizer	.43	.54	.60	44.03
Pasture 4				
As is	.5	4.0	4.28	46.65
Pasture 5				
As is	.24	.31	.30	6.03
Seed	.35	.44	.44	26.63
Fertilizer	.43	.54	.55	41.03
Pasture 6				
As is	.17	.54	.27	2.23
Clear	.24	.31	.30	6.03
Irrigate	.5	4.0	4.28	95.61
Pasture 7				
As is	.35	.44	.44	9.50
Pasture 8				
As is	.23	.25	0	.50
Clear	.24	.31	.30	6.03
Clear and seed	.35	.44	.44	28.22
Pasture 9				
As is	.5	4.0	4.28	46.65
Pasture 10				
As is	.423	.45	0	.50
Clear	.45	.26	.34	6.03
Clear and seed	.64	.38	.30	26.63
Irrigate	.5	4.0	4.28	75.46
Pasture 11				
As is	.64	.38	.30	26.63

The seasons of use were:

Season 1	Inadequate green forage	Oct. 25-Feb. 15	114 days
Season 2	Adequate green forage	Feb. 16-June 15	120 days
Season 3	Dry forage	June 16-Oct. 24	131 days

8. Develop calendar of livestock operations.

In order to develop a monthly animal inventory and calculate seasonal forage requirements for all livestock enterprise alternatives, a calendar of all events (such as breeding, calving, lambing, etc.) important to the production sequence is developed. This calendar also aids in planning seasonal labor needs.

The calendar developed for the SFRFS followed guidelines of Bell (1978) for a fall calving cow-calf operation and a stocker operation with steers purchased on November 20 and sold on May 31. For the purposes of the LP model, dates were set at the midpoint of the time interval for each event.

9. Develop an animal inventory for each livestock enterprise alternative.

The livestock production parameters and calendar of livestock operations is used to develop a month-by-month inventory of each class of livestock (Table 4).

A table of mean monthly weights for each livestock class (Table 5) can be easily derived from the calendar of livestock operations and the livestock production parameters by assuming linear weight gains between important dates (i.e. birth to weaning for lambs and calves and purchase to sale for stocker animals) (Fig. 2).

10. Grazing records

An account of the historical use of each management pasture on the ranch is required to derive current carrying capacity coefficients for the LP model. These estimates are obtained from grazing records of the ranch, which may be available from ranch records or obtained from the memory of the ranch operator (Table 6). These records may require re-interpretation since they may reflect estimates of pasture carrying capacity either higher or lower than optimal for a given pasture.

III. Calculate LP coefficients

1. Calculate seasonal livestock forage requirements

For ease of calculation, livestock requirements and carrying capacities of management pastures will be expressed as Animal Unit Months (AUM). For the purposes of this model, an AUM is defined as the forage required to support 1000 lb of animal liveweight at a specified level of production for 30 days. Mean monthly weights can be converted to AUMs by dividing by 1000 (Table 5). Monthly forage requirements can be calculated using the information in Tables 4 and 5 and Figure 2 (Table 7). Seasonal requirements can be obtained by summing over the appropriate months in each season (Table 8).

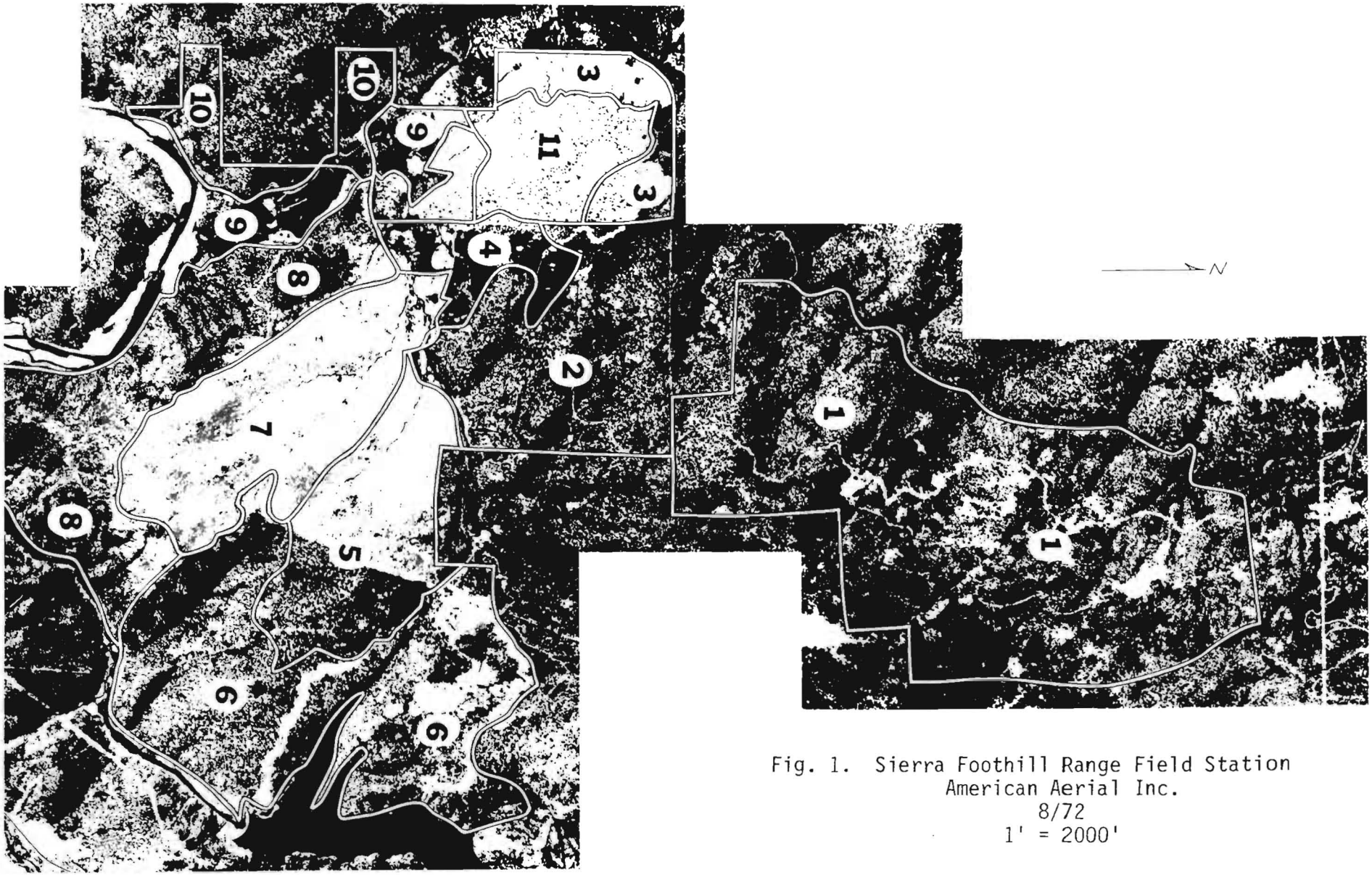

Fig. 1. Sierra Foothill Range Field Station
American Aerial Inc.
8/72
1' = 2000'

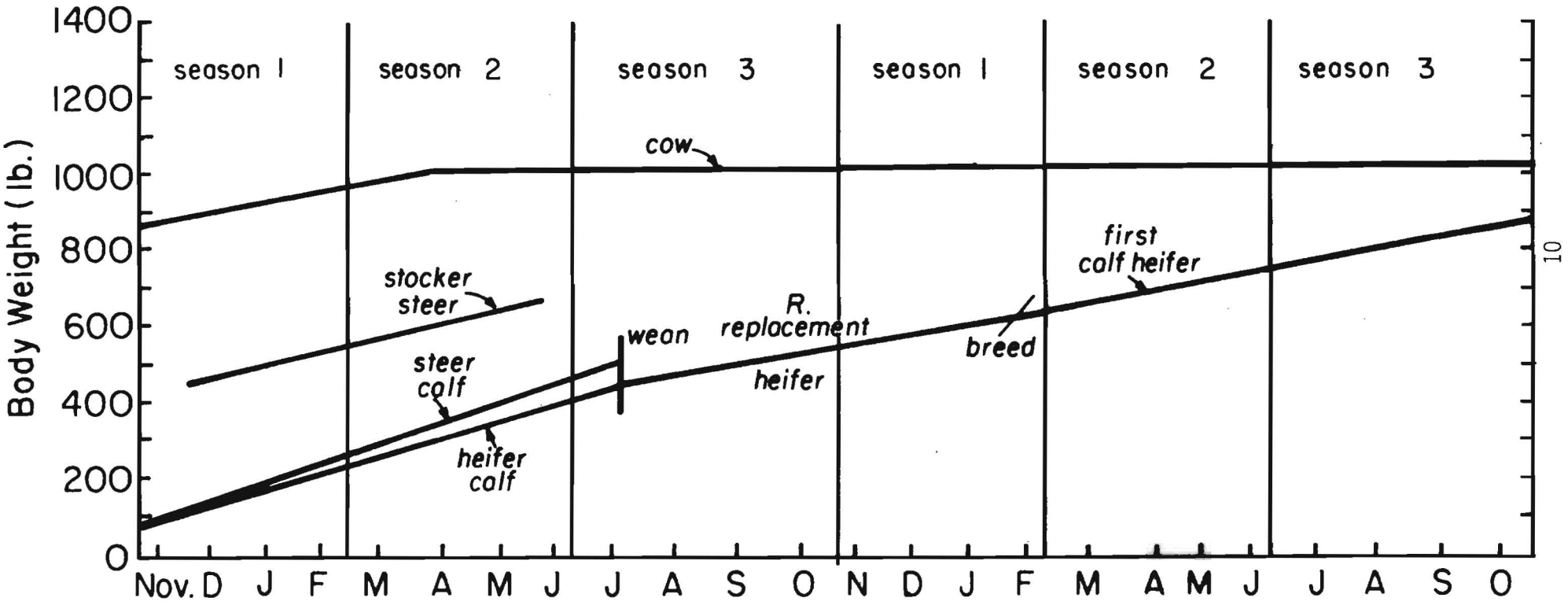

Fig. 2. Growth curves for the livestock classes.

Table 4. Animal inventory.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Died	Sold	Trans-ferred	Bought/ replaced
Cows	100	100	100	100	99	80	80	80	80	80	80	100	1	19	0	20
					-1	-19						+20				
1st calf heifer	26	26	26	26	25	20	20	20	20	20	20	20	1	5	20	20
					-1	-5										
Replacement							26	26	26	26	26	26	0	0	26	26
Heifer calf	45	45	45	45	44	44					45	45	1	18	26	45
					-1		-18									
Steer calf	45	45	45	45	44	44					45	45	1	44	0	45
					-1		-44									
Bull	5	5	5	5	4	4	4	5	5	5	5	5	0	1	0	1
					-1			+1								
Stocker	1	1	1	1							.3	1	0	1	0	1

Table 5. Mean weight and AUM equivalent for each livestock class by month.

	Cow		Heifer calf		Steer calf		1st calf heifer		Replacement		Stocker		Bull	
Month	Mean wt.	AUM	Mean wt.	AUM	Mean wt.	AUM	Mean wt.	AUM	Mean wt.	AUM	Mean wt.	AUM	Mean wt.	AUM
Oct	1000	1.0	74	.074	78	.079	813	.813	525	.525			1500	1.5
Nov	1000	1.0	101	.101	107	.107	838	.838	550	.550			1500	1.5
Dec	1000	1.0	148	.148	157	.157	863	.863	575	.575	478	.478	1500	1.5
Jan	1000	1.0	191	.191	207	.207	608	.608	594	.594	514	.514	1500	1.5
Feb	1000	1.0	236	.236	257	.257	623	.623			550	.550	1500	1.5
Mar	1000	1.0	280	.280	307	.307	640	.640			585	.585	1500	1.5
Apr	1000	1.0	321	.321	357	.357	663	.663			621	.621	1500	1.5
May	1000	1.0	366	.366	407	.407	689	.689			657	.657	1500	1.5
June	1000	1.0	410	.410	457	.457	713	.713					1500	1.5
July	1000	1.0	440	.440	491	.491	738	.738					1500	1.5
Aug	1000	1.0					763	.763	475	.475			1500	1.5
Sept	1000	1.0					788	.788	500	.500			1500	1.5

Table 6. Current use of management pastures.

Pasture	Animal Use
1	100 stockers Jan-May plus 31 cows + calves Jan-May
2	30 pair year round plus 25 pair 6 months
3	20 cows Aug-Feb plus 12 cows year round
4	1 cow/acre
5	25 pair year round
6	35 pair year round plus 25 pair May-July
7	1 cow per 12 acres year round
8	35 heifers Oct-Mar plus 75 stockers Nov-June
9	1 cow/acre
10	30 heifers Jan-March
11	40 pair 6 months in winter

Table 7. AUMs required for a 100-cow herd by month.

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cow 1000 lb	100	100	100	100	99	80	80	80	80	80	80	80	
1st calf heifer 600-1000 lb	5.3	16.2	16.6	17.2	17.2	14.3	19.8	15.3	15.8	16.3	16.8	17.3	
Replacement 450-600 lb	10.8	0	0	0	0	0	0	12.4	13.0	13.7	14.3	15.0	
Calves:													
Heifer	8.6	10.6	12.6	14.4	16.5	18.5	6.6			15.6	4.5	6.6	
Steer	9.3	11.6	13.8	16.1	18.3	20.6	7.3			15.9	9.8	7.1	
Bulls	6	6	6	6	4.5	4.5	4.5	4.5	6	6	6	6	
Total	140	144	149	154	156	140	118	112	115	148	131	132	

Table 8. Animal unit months per season for the two livestock enterprises used.

	Season 1	Season 2	Season 3
	AUM	AUM	AUM
Cow-calf	4.9	6.0	5.0
Stocker Steer	1.4	2.1	0

2. Calculate current carrying capacity for each management pasture.

Current seasonal carrying capacities for each management pasture can be calculated using the information in Tables 5 and 6. The following example for pasture one in season one will illustrate the procedure:

Pasture 1, 1680 acres
Season 1, Oct. 25-Feb. 15
Animal use: 100 stockers Jan.-May (from Table 6)
30 cows and calves Jan.-Apr.

AUM equivalents: (from Table 5)
stockers in Jan. = 0.51 AUM/head
stockers in Feb. = 0.55 AUM/head
cows in Jan. = 1.0 AUM/head
cows in Feb. = 1.0 AUM/head
calves in Jan. = 0.09 AUM/head
calves in Feb. = 0.11 AUM/head

Total AUMs provided by pasture one in season one: 100(0.51)+30(1.0)+30(0.09)+ (100(0.55)+30(1.0)+30(0.11))/2 = 127.9 AUM for pasture one in season one/1680 acres = 0.076 AUM/a in pasture one in season one. Table 3 shows the calculated seasonal carrying capacities for all 11 management pastures at SFRFS.

3. Estimate changes in carrying capacity due to possible range improvements.

Whenever possible, carrying capacities of presently improved pastures should be used to estimate changes due to improving currently unimproved pastures. For example, all 181 acres of pasture 10 could potentially be cleared or cleared and seeded. Pasture 10 consists of open rolling terrain with sparse woody vegetation. Pasture 3 represents an area of somewhat similar terrain and soils which has been cleared of woody vegetation, so the existing carrying capacity for pasture 3 was used to estimate the carrying capacity of pasture 10 if it were cleared. Pasture 11 is also somewhat similar to pasture 10 except it has been cleared and seeded, so the carrying capacity of pasture 11 was used to estimate the carrying capacity of pasture 10 if it were cleared and seeded. If an area of similar topography and soils

that has not already received desired improvement does not exist on the ranch, then estimates from other ranches, local farm advisors, public service bulletins, or the research literature must be used. These estimates must be adjusted to inherent differences in productivity by expressing them as a percent increase in carrying capacity due to the improvement.

4. Cost of Range Improvements

The cost of a range improvement includes the total costs of all materials and labor required to establish and maintain an improvement over its expected life time. The costs are amortized over the life span of the improvement at the current interest rate to obtain a yearly cost. Estimates of costs of improvements can be obtained from Cooperative Extension farm advisors, Soil Conservation Service personnel, extension publications, material suppliers, and equipment contractors. The following example will illustrate the procedure for calculating costs of improvements. Prices are 1983 values.

Improvement: Establish and maintain irrigated pasture on cleared land.

Establishment

Materials

Seed 16 lb/a at $3.50/lb	$56.00/a
Fertilizer 250 lb/a 0-36-0-19 at $310.00/ton	$38.75/a

Labor and Equipment

Hourly rate for each operation includes necessary equipment, operator, and one field person.

Harrow	$6.70/a
Disk	$6.70/a
Seed and fertilizer application	$4.00/a
Ditches	$1.75/a
Establishment costs	$113.90/a
Fencing (materials and labor)	$40.00/a
Yearly establishment cost amort. 7 years at 14 %	$26.56/a/yr
Yearly fence cost amortized for 20 years at 14%	$6.04/a/yr
Total yearly establishment cost	$36.60/a/yr

Maintenance of established irrigated pasture

Materials

Irrigation water 0.5 miners inches/a at $28.00/in	$14.00/a/yr
250 lb/a 0-36-0-19 every 3 years $200.00/ton	$38.75/a/yr

Labor and Equipment

Irrigation labor provided by family at no cost	
Fertilizer application every three years	$ 4.00/a
Fence maintenance	$0.75/a/yr
Yearly fertilization cost = $42.75 every 3 years amortized for 7 years at 14%	$12.43/a/yr
Total yearly maintenance cost	$27.18/a/yr
Total yearly cost of establishment and maintenance	$63.78/a/yr

5. Calculate costs and returns of livestock products

Costs and returns for livestock products are calculated from estimates of the expected price at the time of sale of the products. The beef prices used in the SFRFS model are 1983 prices. Calculation of expected cost and return figures for a cow-calf unit for the SFRFS model is presented as an example.

Cow-calf unit costs

Vet & medicine	$12.00 cow-calf/yr
Salt & minerals	$2.00

Cost of buying cow-calf unit

1 cow 850 lb $400 ea	$400.00 unit
0.2 heifers 500 lb at $400 ea	$ 80.00 unit
0.05 bulls 950 lb at $1200 ea	$ 60.00 unit
Total	$540.00 unit
Expected life of cow-calf unit is 10 years	
Yearly cost for purchase of cow-calf unit at 14%	$103.52 unit/yr
Total yearly cost	$117.52 unit/yr

Returns for cow-calf unit

0.2 cows 1000 lb at $0.50/lb	$100.00 unit
0.48 steer calf 500 lb at $0.65/lb	$156.00 unit
0.22 heifer calf 450 lb at $0.55/lb	$ 54.45 unit
0.0125 bull 1500 lb at $0.50/lb	$ 9.38 unit
Total return	$319.83 unit
Gross income per cow/calf unit = $319.83-117.52	$202.31 unit

Table 9 contains the yearly expected gross income and capital requirements for all livestock products considered in the SFRFS model.

Table 9. Capital requirements and income for livestock enterprises.

Unit	Capital	Income Before Feed Costs
Owned Cow-calf	$ 14.00	$305.83
Purchased cow-calf	103.52	202.31
Stocker steer	290.50	62.50

RUNNING THE MODEL

The model was run using the Burroughs Corporation's TEMPO linear programming package. The following constraints were added to the model: all existing improved land is to be used; the supply of labor is not limiting; the rancher owns 200 cow-calf units, and any additional units must be purchased; the limit on available capital is $75,000.

RESULTS

In the optimal solution for the assumptions used the as-is management activity was selected for all pastures, i.e., no further improvements were selected. All the available acres of each management were used. Livestock products chosen were all 200 owned cow-calf units and 84 purchased cow-calf units. This plan produced a contribution margin (income above fixed costs) of $69,252 and used $39,640 of the available capital.

Sensitivity analysis showed that the model was fairly robust to changes in parameters associated with management activities. The estimated cost for each activity was well within the range of prices for which the solution remained optimal. For most activities the cost would have to be cut by more than one-half to cause any change in the set of activities in the optimal solution.

The model was slightly more sensitive to changes in cattle prices than to changes in the costs of management activities. The computed lower profit for a purchased cow-calf unit, below which the optimal solution will change is $170. This means that if the income per purchased cow-calf unit falls below $170, the 84 purchased cow-calf units in the optimal solution will be replaced by some number of stocker steers. Since the income for purchased cow-calf units may drop below $170 per unit, the model should be run at a range of prices for all sensitive activities in order to help determine where trade off points between the different activities lie.

The sensitivity analysis also showed that forage production in season 1 (Oct. 25-Feb. 15) was the factor limiting the total number of cow-calf units that could be carried on the ranch. A surplus of 1,095

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