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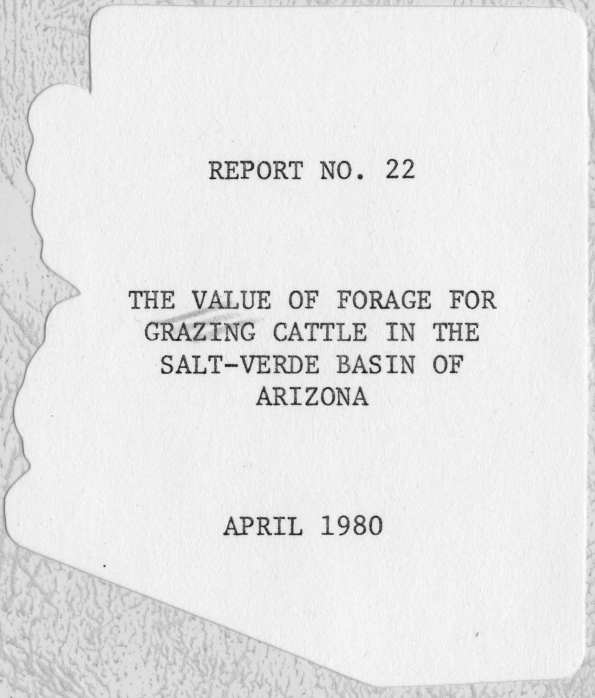

REPORT NO. 22

THE VALUE OF FORAGE FOR GRAZING CATTLE IN THE SALT-VERDE BASIN OF ARIZONA

APRIL 1980

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ACKNOWLEDGEMENTS

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OBJECTIVES

The Salt-Verde Basin of Central Arizona, consisting mainly of National Forest land, is an eight million acre forest watershed (see Figure 1). The basin is administered as a multiple use area. Products include timber, recreation, the water supply for much of the Salt River Valley around Phoenix, and forage for almost 45,000 animal units of cattle on 186 ranches. The area is generally contiguous with the Central Mountain Ranching Area as defined by Dickerman and Martin (1967).

The National Forest Management Act of 1976 states that land management plans for all national forests will be completed by 1985. Such plans should recognize the relative values of the alternative products from the forests. Values for water have been estimated by Kelso, Martin, and Mack (1973) and by Martin and Snider (1979). Recreational values were estimated by Sublette and Martin (1975).

This report concentrates on the value of forage for grazing cattle. Estimates are developed for the annual average value of an animal unit of forage, in both the short run and for the long run, for 4 different sizes of ranches under alternative beef price conditions. Since the value of a cattle ranch ultimately rests on the value of the forage in producing beef, the annual forage value estimates provide the basis for estimates of the capitalized value (sale price) of an animal unit of a Forest Service grazing permit.

Estimates of the long run marginal values of developing additional carrying capacity are also presented. These are the values to be compared with the costs of range forage improvement.

FIGURE 1. Map of Arizona with an Outline of the Study Area.

CONCEPTS

Short Run vs. Long Run

The short run is defined in this report as that period of time in which production takes place, but all the costs of the fixed factors of production may be delayed. For example, the cost of gasoline (a variable cost) must be paid, but a return to depreciation on capital equipment already in place (a fixed cost) may be delayed. The long run is defined as that longer period of time in which all costs must be covered if production is to continue indefinitely. For practical purposes in this report, we consider any given year as a short run.

In the long run, a producer cannot afford to pay as much for a variable input as he can afford in the short run. Therefore annual long run average input values are lower than for the short run. We estimate the annual short run average value of an animal unit of forage by subtracting all annual ranch variable costs except for the costs of forage from annual ranch gross revenues, and dividing the remainder by the number of animal units for the ranch. Thus the short run average value of forage is the residual value after all other variable costs have been paid. In the long run, depreciation of capital investment and interest on that investment must also be considered. Therefore, the annual long run average value of forage is the residual value after both variable and fixed costs except for forage have been counted.

Empirically, estimates of short run values are much more accurate than long run values. Variable costs are more easily estimated than fixed costs since variable costs are observed prices times observed quantities.

Fixed costs are "accounting costs" based on general estimates of capital values. Thus, while both short run and long run values are presented in this report, we have less faith in the accuracy of the long run values.

Adding Carrying Capacity

The base average annual values of forage are estimated for the current average carrying capacity of about 8 AU's per section. We also estimate the annual average values of forage after carrying capacity has been increased or decreased by one unit.

For either case, the annual short run average value of an additional (or one less) unit will remain constant at the base level. However, as the carrying capacity of the range is increased--say from 8 AU's per section to 9 AU's per section--the annual long run average forage value will increase to the extent that additional fixed inputs are not required in direct association with the increased forage. Additional forage implies a proportional increase in output with a less than proportional increase in fixed cost. Therefore, additional forage is more valuable than the original quantity. Conversely, the annual long run average value of an AU of forage declines as carrying capacity is reduced.

These relationships are illustrated in Figure 2. Figure 2A shows linear total cost and revenue functions. Total output is limited to that number of animal units (od) which can be produced on a fixed acreage with a given carrying capacity per section. Fixed costs are shown as constant, regardless of the level of output, over the range of output under consideration.

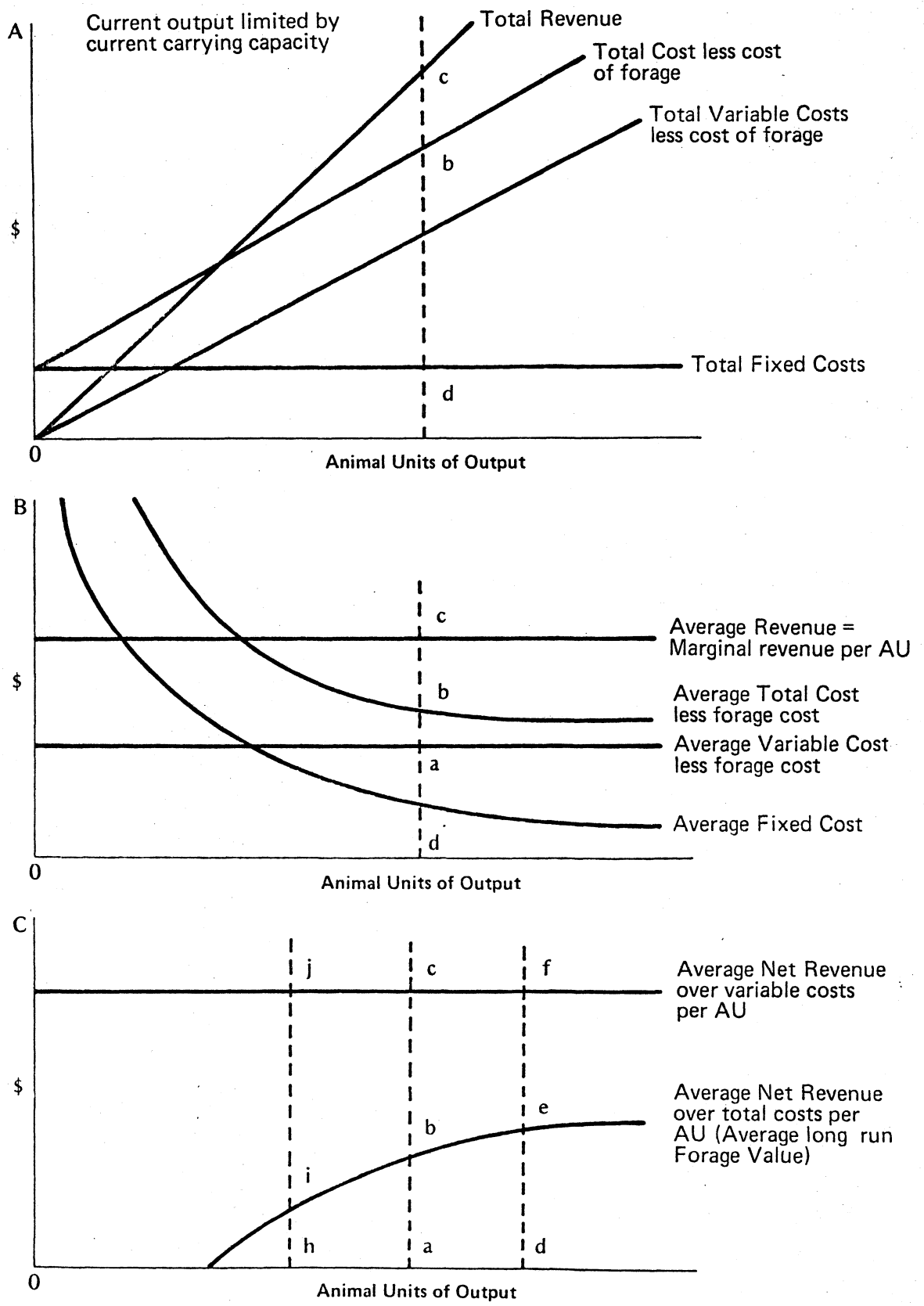

FIGURE 2. The Forage Model

Figure 2B illustrates the associated annual average cost and revenues per animal unit of forage. The distance ac is both the average and marginal (additional) short run value of one AU more or less of forage. The distance ab is the return to the fixed capital. Therefore bc is the annual long run average value of an AU of forage.

The net revenue curves are plotted in Figure 2C. Base output is oa assuming an 8 AU carrying capacity. Output may be increased to od if additional forage is developed or reduced to oh if carrying capacity falls. The distance ac is the annual short run average (and marginal) value of an AU of forage. The annual long run average value of forage is ab at the base level. The long run average value increases to ed with an increase in carrying capacity and decreases to ih as capacity is reduced.

Figure 2 is for general exposition of concepts. It would hold exactly if no inputs that are "fixed" in the short run need be increased in order to increase the animal units of output. But because additional animal units of cows, replacement heifers, and bulls (all treated as fixed assets in the short run budgets) will be associated with increased carrying capacity, total fixed costs as computed herein will rise slightly as animal units rise. Only the other fixed costs such as machinery and equipment remain constant. Therefore, the empirical estimates of the long run average value of additional forage will both rise (b to e) and fall (b to i) at a slightly slower rate than shown in Figure 2C. The long run <u>marginal</u> value of an additional animal unit of carrying capacity would be a horizontal line lower than and parallel to the short run average value curve (jcf), by the amount of the increased total fixed costs. One could afford to invest in <u>additional</u> carrying capacity up to the long run marginal value in order to achieve the higher long run

average value for all units of forage.

Capitalized Values

It has been argued that the sale prices of Arizona cattle ranches have been higher than they should have been if the ranches were purchased only for the single purpose of raising cattle and selling beef for profit (Martin and Jefferies, 1966). Smith and Martin (1972) interviewed a sample of Arizona ranchers and found most to be willing to accept low returns on their investment because of the psychological benefits of owning and living on a ranch.

However, if one assumes the value of a ranch to be strictly related to its income producing potential, and the investor requires a return on his investment equal to the market rate of interest, the present capitalized value (sale price) of a ranch may be directly related to the annual long run average value of the forage. The forage has value because of the net value of selling beef. The ranch has value for raising beef only because of the available forage.

The formula for computing the present capitalized value is as follows:

$$PV = \frac{FV - F}{r}$$

where

PV = present capitalized value per permitted animal unit,

FV = annual long run average forage value per permitted animal unit,

F = annual land use fee per permitted animal unit, and

r = the market rate of interest.

Obviously, if the annual use fee were equal to the annual long run average value of the forage, all value would be paid for on an annual basis and the ranch would have a zero sale price. Since even ranches with negligible deeded land have positive sales prices, the forage value is necessarily larger than the public agency land use fee (Martin and Jefferies, 1966).

THE SUPPLY OF FORAGE

The U.S. Forest Service reported a total of 44,606 animal units of grazing available for cattle permits in the Salt-Verde Basin in 1977. The 1978 animal land use fee was $18.96 per animal unit (Table 1).

The data in Table 1 are organized to correspond with the four sizes of representative ranches for which budgets are prepared in the following section. Note that 53 percent of the allotments average only 87 animal units and use only 18 percent of the animal units in the basin. Only 10 percent of the ranches have 586 animal units or more but they use 32 percent of the forage in the basin.

While carrying capacity per section varies from area to area, the average carrying capacity in the basin is approximately 8 animal units per section.

THE VALUE OF FORAGE

Annual Total Values

Four representative ranch models are developed in order to examine economies of size. Both short run and long run forage values are larger for the larger sized operations.

Table 1. Allotments and Permitted Animal Units on National Forest Land in the Salt-Verde Basin, 1977.

Forest	Allotment Size in Animal Units								
	0 to 190		191 to 349		350 to 585		586 and larger		
	Number	Mean AUs	Number	Mean AUs	Number	Mean AUs	Number	Mean AUs	Total AUs
Kaibab	13	96	2	303	2	533	0	0	2,920
Coconino	35	76	8	268	5	432	3	666	8,962
Tonto	30	77	23	245	20	457	15	905	30,660
Prescott	8	111	6	273	0	0	0	0	2,310
Apache Sitgreaves	14	104	3	273	1	439	0	0	2,714
Total	98	87	42	253	28	457	18	865	-
Total AUs	8,562		10,626		12,805		15,573		47,566
AUs out of Basin	360		447		730		1,423		2,960
Total AUs in Basin	8,202		10,179		12,075		14,150		44,606

Source: Developed by Thomas C. Brown, USFS, Flagstaff, Arizona, from Forest Service records.

Details of the ranch budgets are given in Tables 2 through 5 for the small 151 AU ranch, Tables 6 through 9 for the 229 AU ranch, Tables 10 through 13 for the 468 AU ranch, and Tables 14 through 17 for the large 701 AU ranch.[1/] All tables are grouped together at the end of this report.

For example, for the 151 AU ranch, summary Table 2 shows total cattle sales of $23,725. Crucial assumptions affecting this estimate are an 80 percent calf drop, a 3 to 4 percent death loss on calves after drop, a 3 percent death loss on animals 2 years and older and a culling rate of 10 percent per year. These assumptions are held constant throughout the analysis. Even more crucial to the sales estimate are cattle prices. The prices shown in these basic tables are representative for Arizona for 1978. Prices were lower in recent years previous to 1978; they have been higher since. In a later analysis the price of yearling steers is raised to 80 cents and then to $1.00 per pound with the prices of heifers and cows rising by the same percentage. The effect on the value of forage is dramatic.

Variable costs, detailed in Table 3, are also summarized in Table 2. Variable costs exclude land use fees since the value of the forage is to be computed as the residual return. Variable costs include a $12,000 charge for the opportunity value of the operator's labor. One might assume that charge was adequate to also include the value of management.

The difference between total sales and variable costs is labeled net return to management, depreciation, interest on investment and USFS

[1/] Ranch sizes were selected arbitrarily as ranging from relatively small to relatively large. The sizes are in odd numbers (i.e., 151 rather than 150) because of the method of computing animal units. For example, a number of cows was selected so that when the associated animal units for bulls, horses, calves and yearlings were counted, the total animal units would be as close as possible to 150.

forage. This value is the annual short run value (both average and marginal) of the forage resource. When depreciation and interest on investment is subtracted, the final residual is the net return to management and USFS forage. If one assumes the charge for labor is adequate to cover the opportunity cost for management, the residual may be considered the annual long run total value of the forage.

Capital investment does not include deeded land nor the capitalized sale value of forest service permits, since the value of the forage is estimated as the residual and the land value is assumed to be related only to the forage value. Fixed costs do not include taxes on deeded land since taxes are simply a transfer payment of a portion of the forage value from the ranches to the government; in that way taxes are analogous to a land use fee.

As shown in Tables 2, 6, 10, and 14, with 1978 prices the annual short run total value of forage is positive on all ranch sizes while the annual long run total value of the forage is negative for all except the largest ranch.

Forage Values per Animal Unit Under Current Carrying Capacities

One further explanation is needed for interpretation of Tables 18 through 21, where values per animal unit of forage are presented. The classifications of ranch size, i.e., 151, 299, 468 and 701 animal units are in terms of Forest Service charges rather than actual forage consumed. Grazing fees on the particular Forests involved are based on the number of animals on hand on January 1. Under this system all animals (cows, yearlings, bulls,

horses and even calves) are each one AU. However, calves are assumed to be dropped after January 1, yearlings are only charged for 5 months until they are sold, and horses are assumed to be grazed only 7 months of the year. We take these estimates of permitted AUs to be equivalent to the reported estimates of forage supply.

However, in actuality calves use forage, and bulls and horses are normally considered to use 1.25 AU per year. Thus, our computed actual forage use assumes that a cow equals 1 AU, a replacement heifer is .75 AU, a bull is 1.25 AU, a yearling is .65 AU, a horse is 1.25 AU and a calf is .32 AU. Given the mix of animals in this area, actual AUs of forage required to support the operation are 108 percent of Forest Service permitted AUs.

Given this assumption, the 151 AU ranch really requires 164 AUs of forage, the 299 AU unit requires 322 AUs, the 468 unit uses 508 AUs and the 701 unit uses 755 AUs of forage. Since we are interested in the value of forage itself, all per animal unit values in Tables 18 through 21 are based on these larger numbers.

For an example, examine Table 18 for the 151 AU ranch. The first column is based on the 1978 price of $0.58 per pound for yearling steers with associated prices for cows and heifers as shown in Tables 2, 6, 10 and 14.

On this small ranch with a carrying capacity of 8 animal units per section, total return from cattle sales is $23,725. Total net return above variable costs is $1,246, creating a short run average value per animal unit of $7.60 for each of the 164 animal units of forage. Total net return to forage in the long run (after fixed costs are deducted) is (-)$14,217. Thus the long run average value per animal unit of forage is (-)$86.69.

If beef prices rise to near the 1979 level of $.80 per pound for yearling steers, the short run average value increases to $62.57 and the long run average value increases to (-)$31.72. Finally, if yearling steer prices were at $1.00 per pound, the short run average value would be $111.76 per AU and the long run average value becomes a positive $17.47.

The Average Values After Increasing or Decreasing Carrying Capacity

A major policy question is the effect of improving the range or of letting it deteriorate. We may assume that for a one animal unit per section increase or decrease, most depreciable assets as listed in Tables 5, 9, 13, and 17 would remain constant. An exception would be the number of bulls to be associated with the increase or decrease of cows and replacement heifers. Cows and heifers are not depreciable assets, but they are assets on which interest on investment must be charged. Thus, fixed costs as shown in the costs and return summaries, would remain constant except for an increase or decrease in depreciation because of more or fewer bulls, and an increase or decrease in interest on investment related to the increase or decrease in bulls, cows and replacement yearlings associated with the change in forage availability.

Let us use the 151 animal unit ranch as the example. Assume an increase in carrying capacity from the current 8 AUs per section to 9 AUs per section. The long run average value of an animal unit of forage may be computed as follows.

(1) 151 stated AUs adjusted for actual forage use = 164 actual AUs of forage.

(2) 164 actual AUs at 8 AUs per section = 21 sections, or 21 additional animal units of carrying capacity. Total carrying capacity is now 185 animal units.

(3) 21 additional AUs times the short run average value per animal unit of $7.60 (see Table 18), plus the base net returns above variable costs of $1,246 (Table 18) = total net returns above variable costs of $1,406.

(4) New total depreciation is $5,549 (Table 2) minus $580 (Table 5) plus 185/164 times $580 = $5,623.

(5) New interest on depreciable investment of $4,742 (Table 2) minus $\frac{(5,800 + 2,900)}{2}$ 10% plus 185/164 $\frac{(5,800 + 2,900)}{2}$ 10% = $4,798.

(6) New interest on investment in cows and replacement yearlings is 185/164 times $5,172 (Table 2) = $5,834.

(7) New total fixed costs are $5,623 plus $4,798 plus $5,834 = $16,255.

(8) The long run average value of forage per animal unit with 9 AU/section is total net returns above variable costs ($1,406) minus total fixed costs ($16,255) divided by 185 animal units = (-)$80.26.

If carrying capacity were to decrease to 7 animal units per section, the long run average value per animal unit may be computed by following the same general procedure. However, the relevant adjustment ratio is now 143/164 and the change in the short run average value would be subtracted rather than added to the base net income.

The results of similar computations are presented in Tables 18 through 21 for the four ranch sizes at the three levels of beef prices. The short run average forage values remain constant, changing only with the price of beef. However, the average long run average values rise for improved

carrying capacity and fall for decreased forage availability since most depreciation and interest on investment has remained constant. The exceptions are approximately $38 of interest and depreciation associated with each new or sacrificed animal unit; that is, the change in depreciation and interest on investment associated with the change in number of bulls, and the change in interest on investment associated with the change in the number of cows and replacement heifers.

For example, for a 151 AU ranch with $.80 per pound yearling steer prices, improvement of the range to 9 AU per section implies an increase in production of 21 AUs to 185 total AUs and an annual long run increase in average value to (-)$25.30 per AU. Similarly, a drop in forage availability to 7 AUs per section would decrease production by 21 AUs and decrease the annual long run average value per AU to (-)$39.99.

Examination of Tables 18 through 21 shows that the annual long run average value of forage is positive for ranches only if yearly steer prices are $.80 per pound or above and if ranches are equal to or larger than approximately 300 animal units. For the 701 AU ranch (Table 21) the annual long run average value is $55.52 if evaluated using $.80 yearlings--near recent (1979) prices. Recognizing that this value is for actual animal units of forage rather than for permitted AUs, one may adjust the value by 108 percent to obtain an annual long run average value of $59.96 per permitted animal unit.

The Long Run Marginal Values of Increased or Decreased Carrying Capacity

Both of short run and long run values discussed thus far are average values. That is, given an operating ranch with a fixed carrying capacity, the average animal unit of forage is generating the given short run and long run values. However, the relevant value when one is considering an investment or disinvestment decision is the long run marginal value of the new or sacrificed forage. The long run marginal value is the change in net income generated as carrying capacity is changed.

What values change with changed carrying capacity? Most fixed costs remain constant and therefore are not relevant. The two values that change are the total net returns and the depreciation and interest associated with the increase or decrease in the breeding herd. Thus the long run marginal forage value per animal unit of changed carrying capacity is the short run average value per animal unit less the increase or decrease in depreciation and interest associated with that increased or decreased animal unit.

The change in depreciation and interest per changed animal unit of carrying capacity is estimated at $38 in this report. Thus, the long run marginal values shown in Tables 18 through 21 are the short run average values per animal unit less $38. If carrying capacity could be increased by an investment of less than the long run marginal value it would pay to do so. Likewise, if one could avoid a decrease in carrying capacity by an investment of less than the marginal value it would also be profitable. For example (see Table 21), if the price of yearling steers was 80 cents per pound, a rancher running about 700 animal units on 8 animal unit per section land could afford to pay up to about $93 per year per animal unit of additional

carrying capacity in order to achieve a $131 increase in total net returns above variable costs.

Capitalized Values

If one is considering an investment in a whole ranch, rather than simply adding on to an already operating ranch, the present capitalized value of the expected long run average forage value per animal unit is the relevant quantity.

Obviously the capitalized value of a long run investment in forage is negative on the smaller ranches. Yet, ranch sales prices are positive. One must conclude that the ranch sales market is basically related to the possibilities for a positive annual long run average net forage value; that is, the larger, more profitable ranches create the pressures that rule the market. Therefore, we use the annual long run average forage values on the 701 animal unit ranch to compute reasonable ranch sale prices. Assume 80 cent per pound yearling steers and 8 AUs per section. Subtracting the annual Forest Service land use fee of $18.96 from the estimated annual long run permit value of $59.96 (forage value of $55.52 times 108 percent), and capitalizing the remainder at 10 percent, one obtains a sale price of the right to a Forest Service permit of $410 per animal unit. Few ranches sell for so little. Ranchers and ranch buyers obviously often are willing to accept a lower rate of return than 10 percent on their investment.

However, if prices rise higher or if available AUs are higher, the annual long run average value per AU also rises. For example, the annual long run average value of an AU of forage at $1.00 per pound for yearling steers (8 AUs per section--701 AU ranch) is $105.88 per forage animal unit

or $114.35 per permitted animal unit. After payment of the $18.96 per AU fee, the capitalized value of the permit is about $954--a high but sometimes observed sale price. If yearling prices are at 80 cents per pound, but the ranch has a 9 AU per section carrying capacity, the capitalized value of an animal unit permit is $455.[2/]

But as we have seen, the value of a long run marginal animal unit of carrying capacity is higher than that of a long run average animal unit. From the point of view of an already operating rancher (701 AU ranch; 80 cent yearling steers; 8 AUs per section), an additional unit of carrying capacity would be worth $814 as a one-time payment, given he would have yearly grazing fees of $18.96 per AU.[3/] From the viewpoint of society the total one time investment (before adjusting for grazing fees or taxes) would be $1,004. Given that yearling prices have fluctuated in the last year or two between 60 to 80 cents, one could conclude that the current present value to society of an additional unit of carrying capacity in the Salt-Verde Basin, without regard to who pays the costs or who receives the benefits, is somewhere between $400 and $800.[4/] The estimated range is large--but so is the variance in cattle prices. The critical relationship of cattle prices to forage value is clearly illustrated.

[2/] From the ranch investor's point of view, these values should also be reduced by the amount of real estate taxes per animal unit.

[3/] As above, a downward adjustment for real estate taxes would be necessary.

[4/] Since this estimate is from society's point of view, no adjustments for grazing fees or taxes is necessary.

Table 2. Cost and Return Summary, 151 Animal Unit Central Mountain Cattle Ranch.

Item	Explanation		Costs and Returns ($)
Cattle Sales			23,725
	Cull Cows	10 x 850 lbs. x $.39/lb.	3,315
	Yearling Heifers	25 x 580 lbs. x $.49/lb.	7,105
	Yearling Steers	37 x 620 lbs. x $.58/lb.	13,305
Variable Costs			
From Table 3; includes $12,000 operator labor			22,479
Net Return to Management,[a]			
Depreciation, Interest on Investment, and USFS Forage[b]			1,246
Depreciation			
From Table 5			5,549
Interest on Investment[c]			
From Tables 4 and 5			
	Depreciable Investment $\frac{(82,660 + 12,180)}{2}$ 10%		4,742
	Cows and Yearlings (51,720) 10%		5,172
			9,914
Net Return to Management[a] and USFS Forage[b]			(-)14,217

a. Since operator labor is already included at $12,000 per year, one might assume that the charge includes a charge for management.

b. Actual land use fees are $18.96 x 151 A.U. = $2,863.

c. No charge is included for interest on investment in deeded land or USFS permits, since the value of the forage is to be estimated as the residual, and the land value is assumed to be related only to the forage value.

Table 3. Variable Costs for a 151 Animal Unit Central Mountain Cattle Ranch, 1977.

Item	Explanation	Cost ($)	
Feed[a]			2,244
Alfalfa Hay	5 tons @ $65/ton	325	
Grain	1 ton @ $135/ton	135	
Mineralized Salt Blocks	24 cwt. @ $4/cwt.	96	
Range Cubes (Supplements)	225 cwt. @ $7.50/cwt.	1,688	
Labor			12,600
Owner	Full time @ $1,000/month	12,000	
Seasonal	1 man-month @ $600/month	600	
Vehicle (gas, oil, repairs)			3,278
Utilities $100/month			1,200
Livestock Taxes[b]			590
Bulls		78	
Cows		317	
Yearlings		195	
Veterinary			169
Repairs on Capital Investment			1,108
Insurance			585
Miscellaneous Expense			70
Brand Inspection		18	
Bookkeeping, dues, subscriptions, etc.		52	
Interest on Borrowed Operating Capital[c] 10% x 1/2 (12,707)			635
Total Variable Costs			22,479

a. Excluding $2,863 in land use fees.

b. $9 per $100 assessed value. Assessed at 18%.

c. $12,707 excludes operator labor and includes $2,863 in land use fees.

Table 4. Investment in a 151 Animal Unit Central Mountain Cattle Ranch . January 1, 1977.

Item	Explanation	Cost ($)	
Cattle			59,020
	Cows 98 (2 years and over) @ $480/head	47,040	
	Yearlings 13 replacement heifers @ $360/head	4,680	
	Bulls 8 @ $725/head	5,800	
	Horses 3 @ $500/head	1,500	
Buildings and Improvements			55,400
	Barn with tack room and storage 800 sq. ft.	8,000	
	Corrals	2,500	
	Water System		
	Well, windmill, pump, storage tanks, etc.	10,000	
	Dirt tanks @ $1,500 each	4,500	
	Fence		
	Private: full cost .5 miles @ $3,200/mile	1,600	
	Forest Service: half cost 18.0 miles @ $1,600/miles	28,800	
Machinery and Equipment			19,960
	Automobile (ranch share is 1/2)	2,500	
	Pickup 1/2 ton 4WD (used)	5,285	
	Stock truck 2 ton with rack (used)	8,050	
	Livestock Equipment		
	portable chute, branding and vet equipment, etc.	1,500	
	Ranch Equipment		
	tools, full and water tanks, etc.	750	
	Horse trailer single (used)	875	
	Saddles and tack 2 complete	1,000	
Deeded Land 160 acres @ $600/acre			96,000
Total Investment			230,380

Table 5. Depreciation Schedule for a 151 Animal Unit Central Mountain Cattle Ranch, 1977.

Item	Cost	Salvage Value	CB-SV	Life	Depreciation per Year
	($)	($)	($)	(Years)	($)
Barn w/tack room	8,000	400	7,600	25	304
Corrals	2,500	200	2,300	20	115
Well	10,000	800	9,200	16	575
Dirt tanks	4,500	-	4,500	10	450
Fence (.5 miles)	1,600	120	1,480	25	59
(18.0 miles)	28,800	2,160	26,640	25	1,066
Automobile (1/2)	2,500	625	1,875	8	334
1/2 ton 4WD pickup (used)	5,285	2,115	3,170	5	634
2 ton stock truck (used)	8,050	2,100	5,950	7	850
Horse trailer (used)	875	225	650	5	130
Ranch equipment	750	60	690	10	69
Livestock equipment	1,500	100	1,400	10	140
Saddles and tack	1,000	75	925	10	93
Horses	1,500	300	1,200	8	150
Bulls	5,800	2,900	2,900	5	580
Total	82,660	12,180			5,549

Table 6. Cost and Return Summary, 229 Animal Unit Central Mountain Cattle Ranch.

Item	Explanation	Costs and Returns ($)	
Cattle Sales			46,835
Cull Cows	19 x 850 lbs. x $.39/lb.	6,299	
Yearling Heifers	49 x 580 lbs. x $.49/lb.	13,926	
Yearling Steers	74 x 620 lbs. x $.58/lb.	26,610	
Variable Costs From Table 7; includes $12,000 operator labor			30,479
Net Return to Management,[a] Depreciation, Interest on Investment, and USFS Forage[b]			16,356
Depreciation From Table 9			9,459
Interest on Investment[c] From Tables 8 and 9			
Depreciable Investment	$\frac{(131,200 + 18,754)}{2}$ 10%	7,498	
Cows and Yearlings	(102,000) 10%	10,200	
			17,698
Net Return to Management[a] and USFS Forage			(-)10,801

a. Since operator labor is already included at $12,000 per year, one might assume that the charge includes a charge for management.

b. Actual land use fees are $18.96 x 299 A.U. = $5,669.

c. No charge is included for interest on investment in deeded land or USFS permits, since the value of the forage is to be estimated as the residual, and the land value is assumed to be related only to the forage value.

Table 7. Variable Costs for a 299 Animal Unit Central Mountain Cattle Ranch, 1977.

Item	Explanation	Cost ($)	
Feed[a]			4,422
Alfalfa Hay	9 tons @ $65/ton	585	
Grain	2 tons @ $135/ton	270	
Mineralized Salt Blocks	48 cwt. @ $4.00/cwt.	192	
Range Cubes (Supplements)	450 cwt. @ 7.50/cwt.	3,375	
Labor			13,200
Owner	Full time @ $1,000/month	12,000	
Seasonal	2 man-months @ $600/month	1,200	
Vehicle (gas, oil, repairs)			5,835
Utilities $135/month			1,620
Livestock Taxes[b]			1,159
Bulls		146	
Cows		625	
Yearlings		387	
Veterinary			330
Repairs on Capital Investments			1,710
Insurance			943
Miscellaneous Expense			110
Brand Inspection		35	
Bookkeeping, dues, subscriptions, etc.		75	
Interest on Borrowed Operating Capital[c] 10% x 1/2 (22,998)			1,150
Total Variable Costs			30,479

a. Excluding $5,669 in land use fees.

b. $9 per $100 assessed valuation: Assessed at 18%.

c. $22,998 excludes operator labor and includes $5,669 in land use fees.

Table 8. Investment in a 299 Animal Unit Central Mountain Cattle Ranch, January 1, 1977.

Item	Explanation	Cost ($)	
Cattle			115,875
	Cows 193 (2 years and over) @ $480/head	92,640	
	Yearlings 26 replacement heifer @ $360/head	9,360	
	Bulls 15 @ $725/head	10,875	
	Horses 6 @ $500/head	3,000	
Buildup and Improvements			85,500
	House trailer for hired help (used)	3,500	
	Barn with tack room and storage 1200 sq.ft.	12,000 3,000	
	Corrals		
	Water System		
	Well, windmill, pump, storage tank, etc.	10,000	
	Dirt tanks @ $1,500 each	9,000	
	Fence		
	Private: full cost 1.0 miles	3,200	
	Forest Service: 1/2 cost 28.0 miles	44,800	
Machinery and Equipment			31,825
	Pickup 1/2 ton 4WD (used)	5,285	
	Pickup 1/2 ton (new)	5,900	
	Stock truck 2 ton with rack (used)	8,050	
	Wheel tractor 40 HP (used)	5,390	
	Livestock Equipment		
	portable chute branding and vet equipment, etc.	2,000	
	Ranch Equipment		
	tools, fuel and water tanks, etc.	1,200	
	Horsetrailer, double	2,000	
	Saddles and tack, 4 complete	2,000	
Deeded Land 320 acres @ $600			192,000
Total Investment			425,200

Table 9. Depreciation Schedule for a 299 Animal Unit Central Mountain Cattle Ranch, 1977.

Item	Cost	Salvage Value	CB-SV	Life	Depreciation per Year
	($)	($)	($)	(Year)	($)
House trailer (used)	3,500	700	2,800	7	400
Barn w/tack room	12,000	600	11,400	25	456
Corrals	3,000	240	2,760	20	138
Well	10,000	800	9,200	16	575
Dirt tanks	9,000	-	9,000	10	900
Fence (1.0 miles)	3,200	240	2,960	25	118
(28.0 miles)	44,800	3,360	41,440	25	1,658
1/2 ton 4WD pickup (used)	5,285	2,115	3,170	5	634
1/2 ton pickup	5,900	900	5,000	4	1,250
2 ton stock truck (used)	8,050	2,100	5,950	7	850
40 HP wheel tractor (used)	5,390	980	4,410	10	441
Double horse trailer	2,000	300	1,700	10	170
Ranch equipment	1,200	96	1,104	10	110
Livestock equipment	2,000	133	1,867	10	187
Saddles and tack	2,000	150	1,850	10	185
Horses	3,000	600	2,400	8	300
Bulls	10,875	5,440	5,435	5	1,087
Total	131,200	18,754			9,459

Table 10. Cost and Return Summary, 468 Animal Unit Central Mountain Cattle Ranch.

Item	Explanation		Costs and Returns ($)
Cattle Sales			73,542
Cull Cows	30 x 850 lbs. x $.39	9,945	
Yearling Heifers	77 x 580 lbs. x $.49	21,883	
Yearling Steers	116 x 620 lbs. x $.58	41,714	
Variable Costs From Table 11; includes $12,000 operator labor			45,372
Net Return to Management,[a] Depreciation, Interest on Investment, and USFS Forage[b]			28,170
Depreciation From Table 13			14,247
Interest on Investment[c] From Tables 12 and 13			
Depreciable Investment $\frac{(201,905 + 27,729)}{2}$	10%	11,482	
Cows and Yearlings (158,400)	10%	15,840	
			27,322
Net Return to Management[a] and USFS Forage[b]			(-)13,399

a. Since operator labor is already included at $12,000 per year, one might assume that the charge includes a charge for management.

b. Actual land use fees are $18.96 x 468 A.U. = $8,873.

c. No charge is included for interest on investment in deeded land or USFS permits, since the value of the forage is to be estimated as the residual, and the land value is assumed to be related only to the forage value.

Table 11. Variable Costs for a 468 Animal Unit Central Mountain Cattle Ranch, 1977

Item	Explanation	Cost ($)	
Feed[a]			6,930
Alfalfa Hay	15 tons @ $65/ton	975	
Grain	3 tons @ $135/ton	405	
Mineralized Salt Blocks	75 cwt. @ $4.00/cwt.	300	
Range Cubes (Supplements)	700 cwt. @ 7.50/cwt.	5,250	
Labor			21,600
Owner	Full time @ $1,000/month	12,000	
Full time	12 man-months @ $650/month	7,800	
Seasonal	3 man-months @ $600/month	1,800	
Vehicle (gas, oil, repairs)			6,170
Utilities $175/month			2,100
Livestock Taxes[b]			1,830
Bulls		252	
Cows		972	
Yearlings		606	
Veterinary			501
Repairs on Capital Investment			2,976
Insurance			1,095
Miscellaneous Expense			155
Brand Inspection		56	
Bookkeeping, dues, subseriptions, etc.		99	
Interest on Borrowed Capital[c] 10% x 1/2 (40,230)			2,015
Total Variable Costs			45,372

a. Excluding $8,873 in land use fee.

b. $9 per $100 assessed value. Assessed at 18%.

c. $40,230 excludes operator labor and includes $8,873 in land use fee.

Table 12. Investment in a 468 Animal Unit Central Mountain Cattle Ranch, January 1, 1977.

Item	Explanation	Cost ($)	
Cattle			182,250
	Cows 300 (2 years and over) @ $480/head	144,000	
	Yearlings 40 replacement heifers @ $360/head	14,400	
	Bulls 26 bulls @ $725/head	18,850	
	Horses 10 @ $500/head	5,000	
Buildings and Improvements			139,820
	House trailer for hired help (used)	3,500	
	Barn with tack room and storage 1,500 sq. ft.	15,000	
	Corrals	4,000	
	Water Systems		
	Wells (2), windmill, pump, storage tanks, etc.	20,000	
	Dirt tanks @ $1,500 each	13,500	
	Pipeline 8 miles @ $1,600/mile	12,800	
	Workshop and Garage	3,500	
	Fence		
	Private: full cost 1.6 miles @ $3,200/mile	5,120	
	Forest Service: half cost 39 miles @ $1,600/mile	62,400	
Machinery and Equipment			38,235
	Pickup 1/2 ton	5,900	
	Pickup 3/4 ton 4WD (used)	5,625	
	Stock truck 2 ton with rack (used)	8,050	
	Wheel tractor 70 HP (used)	8,910	
	Livestock Equipment		
	portable chute, branding and vet equipment etc.	3,000	
	Ranch Equipment		
	tools, water and fuel tanks, etc.	1,750	
	Horse trailer double	2,000	
	Saddles and tack, 6 complete	3,000	
Deeded Land 640 acres @ $600/acre			384,000
Total Investment			744,305

Table 13. Depreciation Schedule for a 468 Animal Unit Central Mountain Cattle Ranch, 1977.

Item	Cost	Salvage Value	CB-SV	Life	Depreciation per Year
	($)	($)	($)	(Year)	($)
House trailer	3,500	700	2,800	7	400
Barn w/tack room	15,000	750	14,250	25	570
Corrals	4,000	320	3,680	20	184
Workshop and garage	3,500	175	3,325	25	133
Wells	20,000	1,600	18,400	16	1,150
Dirt tanks	13,500	-	13,500	10	1,350
Fence (1.6 miles)	5,120	384	4,736	25	189
(39.0 miles)	62,400	4,680	57,720	25	2,309
Pipeline	12,800	960	11,840	10	1,184
1/2 ton pickup	5,900	900	5,000	4	1,250
3/4 ton 4WD pickup (used)	5,625	2,250	3,375	5	675
2 ton stock truck (used)	8,050	2,100	5,950	7	850
70 HP wheel tractor (used)	8,910	1,620	7,290	10	729
Double horse trailer	2,000	300	1,700	10	170
Ranch equipment	1,750	140	1,610	10	161
Livestock equipment	3,000	200	2,800	10	280
Saddles and tack	3,000	225	2,775	10	278
Horses	5,000	1,000	4,000	8	500
Bulls	18,850	9,425	9,425	5	1,885
Total	201,905	27,729			14,247

Table 14. Cost and Return Summary, 701 Animal Unit Central Mountain Cattle Ranch.

Item	Explanation		Costs and Returns ($)
Cattle Sales			110,530
Cull Cows	45 x 850 lbs. x $.39	14,917	
Yearling Heifers	115 x 580 lbs. x $.49	32,683	
Yearling Steers	175 x 620 lbs. x $.58	62,930	
Variable Costs			
From Table 15; includes $12,000 operator labor			53,672
Net Returns to Management,[a] Depreciation, Interest on Investment, and USFS Forage[b]			56,858
Depreciation			
From Table 17			18,272
Interest on Investment[c]			
From Tables 16 and 17			
Depreciable Investment $\frac{(263,560 + 35,299)}{2}$ 10%		14,943	
Cows and Yearlings (237,240) 10%		23,724	
			38,667
Net Return to Management[a] and USFS Forage[b]			(-) 81

a. Since operator labor is already included at $12,000 per year, one might assume that the charge includes a charge for management.

b. Actual land use fees are $18.96 x 701 A.U. = $13,291.

c. No charge is included for interest on investment in deeded land or USFS permits, since the value of the forage is to be estimated as the residual, and the land value is assumed to be related only to the forage value.

Table 15. Variable Costs for a 701 Animal Unit Central Mountain Cattle Ranch, 1977.

Item	Explanation	Cost ($)	
Feed[a]			10,163
Alfalfa Hay	20 tons @ $65/ton	1,300	
Grain	4 tons @ $135/ton	540	
Mineralized Salt Blocks	112 cwt. @ $4.00/cwt.	448	
Range Cubes (Supplements)	1050 cwt. @ $7.50/cwt.	7,875	
Labor			23,400
Owner	Full time @ $1,000/month	12,000	
Full time	12 man-months @ $650/month	7,800	
Seasonal	6 man-months @ $600/month	3,600	
Vehicle (gas, oil, repairs)			6,360
Utilities $200/month			2,400
Livestock Taxes[b]			2,747
Bulls		379	
Cows		1,458	
Yearlings		910	
Veterinary			749
Repairs on Capital Investment			3,771
Insurance			1,260
Miscellaneous Expense			205
Brand Inspection		84	
Bookkeeping, dues, subscriptions, etc.		121	
Interest on Borrowed Operating Capital[c] 10% x 1/2 (52,346)			2,617
Total Variable Costs			53,672

a. Excluding $13,291 in land use fees.

b. $9 per $100 assessed value. Assessed at 18%.

c. $52,346 excludes operator labor and includes $13,291 in land use fees.

Table 16. Investment in a 701 Animal Unit Central Mountain Cattle Ranch, 1977.

Item	Explanation	Cost ($)	
Cattle			272,015
	Cows 450 (2 years and over) @ $480/head	216,000	
	Yearlings 59 replacement heifers @ $360/head	21,240	
	Bulls 39 @ $725/head	28,275	
	Horses 13 @ $500/head	6,500	
Buildings and Improvements			188,540
	House for hired help	7,500	
	Barn with tack room and storage 1750 sq. ft.	17,500	
	Corrals	5,500	
	Workshop and garage 400 sq. ft.	4,000	
	Water System		
	Well (3) windmill, pump, storage tanks, etc.	30,000	
	Dirt tanks @ $1,500 each	21,000	
	Pipeline 11 miles @ $1,600	17,600	
	Fence		
	Private: full cost 2.2 miles @ $3,200/miles	7,040	
	Forest Service: half cost 49 miles @ $1,600/mile	78,400	
Machinery and Equipment			40,245
	Pickup 1/2 ton 4WD (used)	5,285	
	Pickup 3/4 ton (new)	7,000	
	Stock truck 2 ton with rack (used)	8,050	
	Wheel tractor 70 HP (used)	8,910	
	Livestock Equipment		
	portable chute, branding and vet, equipment, etc.	3,500	
	Ranch Equipment		
	tools, full and water tanks, etc.	2,000	
	Horse trailer, double	2,000	
	Saddles and tack, 7 complete	3,500	
Deeded Land 1,280 acres @ $600/acre			768,000
Total Investment			1,268,800

Table 17. Depreciation Schedule for a 701 Animal Unit Central Mountain Cattle Ranch, 1977.

Item	Cost	Salvage Value	CB-SV	Life	Depreciation per Year
	($)	($)	($)	(Years)	($)
Bunkhouse	7,500	375	7,125	25	285
Barn w/tackroom	17,500	875	16,625	25	665
Corrals	5,500	440	5,060	20	253
Workshop and garage	4,000	200	3,800	25	152
Wells	30,000	2,400	27,600	16	1,725
Dirt tanks	21,000	-	21,000	10	2,100
Fence (2.2 miles)	7,040	528	6,512	25	260
(49 miles)	78,400	5,880	75,520	25	3,021
Pipeline	17,600	1,320	16,280	10	1,628
1/2 ton 4WD pickup (used	5,285	2,115	3,170	5	634
3/4 ton pickup	7,000	1,050	5,950	4	1,488
2 ton stock truck	8,050	2,100	5,950	7	850
70 HP wheel tractor	8,910	1,620	7,290	10	729
Horse trailer double	2,000	300	1,700	10	170
Ranch equipment	2,000	160	1,840	10	184
Livestock equipment	3,500	233	3,267	10	327
Saddles and tack	3,500	263	3,237	10	324
Horses	6,500	1,300	5,200	8	650
Bulls	28,275	14,140	14,135	5	2,827
Total	263,560	35,299			18,272

Table 18. The Value of Forage Under Alternative Assumptions as to Cattle Prices and Forage Availability: 151 AU Central Mountain Ranch.[a]

	Price of Yearling Steers ($/lb.)		
	.58	.80	1.00
	----------dollars----------		
Cattle Sales (8 AU/Section)	23,725	32,740	40,807
Net Returns Above Variable Costs (8 AU/Section)	1,246	10,261	18,328
Net Returns To Forage (8 AU/Section)	(-)14,217	(-)5,202	2,865
Short-Run Average Value per Animal Unit	7.60	62.57	111.76
Long-Run Average Value per Animal Unit (8 AU/Section)	(-)86.69	(-)31.72	17.47
(9 AU/Section)	(-)80.26	(-)25.30	23.89
(7 AU/Section)	(-)94.96	(-)39.99	9.20
Long-Run Marginal Value per Animal Unit	-30.40	24.57	73.76

a. The 151 AU herd (8 AU/section) actually consumes 164 AUs of forage. The 9 AU/section improved range is based on 185 AUs. The 7 AU/section deteriorated range is based on 143 AUs.

Table 19. The Value of Forage Under Alternative Assumptions as to Cattle Prices and Forage Availability: 299 AU Central Mountain Ranch

	Price of Yearling Steers ($/lb.)		
	.58	.80	1.00
	----------dollars----------		
Cattle Sales (8 AU/Section)	46,835	64,632	80,556
Net Returns Above Variable Costs (8 AU/Section)	16,356	34,153	50,077
Net Returns To Forage (8 AU/Section)	(-)10,801	7,005	22,929
Short-Run Average Value per Animal Unit	50.80	106.07	155.52
Long-Run Average Value per Animal Unit			
(8 AU/Section)	(-)33.54	21.75	71.21
(9 AU/Section)	(-)28.38	26.89	76.34
(7 AU/Section)	(-)40.12	15.15	64.60
Long-Run Marginal Value per Animal Unit	12.80	68.07	117.52

a. The 151 AU ranch (8 AU/section) actually consumes 322 AUs of forage. The 9 AU/section improved range is based on 362 AUs. The 7 AU/section deteriorated range is based on 282 AUs.

Table 20. The Value of Forage Under Alternative Assumptions as to Cattle Prices and Forage Availability: 468 AU Central Mountain Ranch.

	Price of Yearling Steers ($/lb.)		
	.58	.80	1.00
	----------dollars----------		
Cattle Sales (8 AU/Section)	73,542	101,488	126,860
Net Returns Above Variable Costs (8 AU/Section)	28,170	56,116	81,488
Net Returns To Forage (8AU/Section)	(-)13,399	14,547	39,919
Short-Run Average Value per Animal Unit	55.45	110.46	160.41
Long-Run Average Value per Animal Unit (8 AU/Section)	(-)26.38	28.64	78.58
(9 AU/Section)	(-)21.41	33.60	83.55
(7 AU/Section)	(-)32.74	22.27	72.22
Long-Run Marginal Value per Animal Unit	17.45	72.46	122.41

a. The 468 AU herd (8 AU/section) actually consumes 508 AUs of forage. The 9 AU/section improved range is based on 572 AUs. The 7 AU/section deteriorated range is based on 444 AUs of forage.

Table 21. The Value of Forage Under Alternative Assumptions as to Cattle Prices and Forage Availability: 701 AU Central Mountain Ranch.

	Price of Yearling Steers ($/lb.)		
	.58	.80	1.00
	----------dollars----------		
Cattle Sales (8 AU/Section)	110,530	152,531	190,553
Net Returns Above Variable Costs (8 AU/Section)	56,858	98,859	136,881
Net Returns To Forage (8 AU/Section)	81	41,920	79,942
Short-Run Average Value per Animal Unit	75.30	130.93	181.29
Long-Run Average Value per Animal Unit (8 AU/Section)	(-)0.11	55.52	105.88
(9 AU/Section)	4.04	59.68	110.04
(7 AU/Section)	5.42	50.21	100.57
Long-Run Marginal Value per Animal Unit	37.30	92.93	143.29

a. The 701 AU herd (8 AU/section) actually consumes 755 AUs of forage. The 9 AU/section improved range is based on 849 AUs. The 7 AU/section deteriorated range is based on 661 AUs.

APPENDIX

Derivation of the Ranch Budgets

The four representative ranch budgets were synthesized from published and unpublished data, and from discussions with knowledgeable persons. Most assumptions as to prices, costs, numbers, weights, etc. are included in Tables 2 through 17. For each item, the relevant published and unpublished estimates were examined, analysed for possible errors or inconsistencies, and discussed with persons with knowledge on that subject, before the final "best judgement" estimate was selected.

The basic published references are Martin and Goss (1963), Dickerman and Martin (1967), Menzie and Archer (1975), USDA (1974) and Hathorn (1977). Unpublished data are from Stubblefield and Robertson (1979), a current study developed with much primary data. Discussions were held with Thomas Archer, Scott Hathorn, Jr., Charles Robertson, Charles Romaniello, Roger Selley, and Thomas Stubblefield, all of the Department of Agricultural Economics; also with Richard Benson, Department of Animal Sciences; and with Gene Wright, Center for Arid Lands. In every case, each individual's judgement was weighed as evidence, but there is no suggestion of a complete concensus of opinion.

REFERENCES

Archer, Thomas F., Research Associate, Department of Agricultural Economics, University of Arizona, personal communications, 1978.

Benson, Richard, Professor of Animal Science, University of Arizona, personal communications, 1978.

Dickerman, Alan R. and William E. Martin, "Organization, Costs and Returns for Arizona Cattle Ranches," Department of Agricultural Economics File Report 67-6, The University of Arizona, September 1967. (dittoed)

Hathorn, Scott, Jr., "Arizona Farm Machinery Costs 1977," Department of Agricultural Economics, University of Arizona, May 1977. (processed)

Kelso, Maurice M., William E. Martin and Lawrence E. Mack, Water Supplies and Economic Growth in an Arid Environment: An Arizona Case Study, The University of Arizona Press, Tucson, 1973.

Martin, William E., and William K. Goss, Cost-Size Relationships for Southwestern Arizona Cattle Ranches, Arizona Agricultural Experiment Station Technical Bulletin 155, 1963.

Martin, William E., and Gene L. Jefferies, "Relating Ranch Prices and Grazing Permit Values to Ranch Productivity," Journal of Farm Economics, Vol. 48, No. 2., May 1966.

Martin, William E., and Gary B. Snider, "Valuation of Water and Forage from the Salt-Verde Basin of Arizona," unpublished report to the U.S. Forest Service, Research Agreement 16-879-CA, Department of Agricultural Economics, University of Arizona, September 1979.

Menzie, Elmer L., and Thomas F. Archer, "Cattle Ranching in Arizona," Progressive Agriculture in Arizona, College of Agriculture, University of Arizona, July/August 1975.

Romaniello, Charles, "Towards an Optimal Culling Strategy for Beef Cow Herds," unpublished M.S. Thesis, Department of Agricultural Economics, University of Arizona, 1979.

Selley, Roger, Professor of Agricultural Economics, University of Arizona, personal communications, 1978.

Smith, Arthur H., and William E. Martin, "Socioeconomic Behavior of Cattle Ranchers, with Implications for Rural Community Development in the West," American Journal of Agricultural Economics, Vol. 54, No. 2, May 1972.

Stubblefield, Thomas, Professor of Agricultural Economics, University of Arizona, personal communications, 1978.

Stubblefield, Thomas, and Charles Robertson,"Gila County Ranch Costs, 1977," Department of Agricultural Economics, University of Arizona, 1978. (unpublished)

Sublette, Werner J., and William E. Martin, Outdoor Recreation in the Salt-Verde Basin of Arizona: Demand and Value, Arizona Agricultural Experiment Station Technical Bulletin 218, 1975.

U.S. Department of Agriculture, Economic Research Service, Southwest Cattle Ranches: Organization, Costs, and Returns 1964-72, Agricultural Economic Report No. 255, 1974.

Wright, Gene, Center for Arid Lands, University of Arizona, personal communications, 1978.