

THE RELATIONSHIP OF RANGE CONDITION TO RANCH
INCOME IN SOUTHERN ARIZONA

by
Ben Nelson

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Approved:

E. B. Stanley
Director of Thesis

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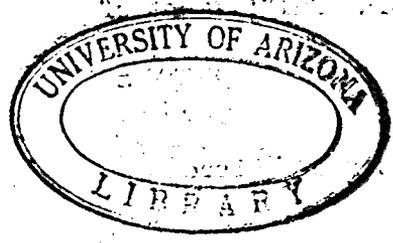
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INTRODUCTION

Problems in range management are many and important. They are as important as the millions of livestock grazing on western ranges and as important as the whole livestock industry itself. These problems are not new, (8)¹ but their importance is comparatively recent. In the early development of the western range country there were many livestock and there was much range. When drought occurred in a piece of range or when it was too heavily grazed and the forage became deteriorated, a new piece was ready for use. Consequently, there was little, if any, value placed on land.

Now cattle ranching is an efficient, orderly business. The ranchers as well as research men are working for the solution to any problem which limits efficiency. One of these problems is to what degree can a range be stocked and produce beef most efficiently over a long period of time. As yet very little work has been done on this weight of relationship between grazing use and income. It has, therefore, been undertaken to set up, in a small way, an experiment of this type.

¹Numbers in parentheses refer to literature cited in the Bibliography, page 30.

REVIEW OF LITERATURE

A review of range management literature (6) reveals little definite information as to the effect which grazing at different levels of intensity has upon ranch income. On the basis of general principles of ranch management, the general opinion of workers in the field is that the relationship between intensity of grazing and income is not a direct one in which the income is proportional to the number of head of stock kept on the range. A larger percentage calf crop, heavier weights, better quality, lower death loss, and less supplemental feeding are believed to accompany reduction in stock numbers, thereby increasing the gross income per head of stock kept on the range and making up partially or wholly for the loss resulting from a reduction in stock numbers. Quantitative data expressing these relationships are extremely meager.

Culley (3) in his bulletin, a report made by the Southwestern Forest and Range Experiment Station on the Santa Rita Range Reserve in southern Arizona, shows the results which can be secured from good management and from stocking at carrying capacity. But it presents no experimental data as to the physical production or economic returns from over-use as compared with stocking at capacity.

Neale (5) deals with a hypothetical set-up based upon nutritional requirements. It is very enlightening as to the principles involved and is probably the best analysis of the situation in the Southwest. Further investigations and actual records would be of definite benefit.

Sarvis, (7) in his bulletin, presents experimental results showing the effect which grazing at various intensities has upon vegetation,

cattle weights, and total weight of cattle produced. It is shown that light stocking of the range produces a high gain per head but does not produce the largest gain per acre. Overstocking, which produces the lowest gain per head, is correlated with the highest individual gain per acre, provided the cattle are not forced to remain on the short pasture for too long a period. This experiment, which was made at the Northern Great Plains Station, was on a seasonal range, and the results would probably be somewhat different on a yearlong basis.

Hein, (4) in a bulletin which reports an experiment conducted at Beltsville, Maryland, to determine the relative gains in weights of yearling steers on pasture grazed at different levels of intensity, states on page 4:

The gain per acre was greatest for cattle on heavily grazed pastures....while for those on the lightly grazed it was much less.

The conclusions are in agreement with those of Sarvis (supra).

Many other bulletins, books, and articles dealt with various phases of the subject and references will be made to some of these in the main body of the report. A list of some of the more important of those not quoted is appended.

METHOD OF PROCEDURE

Ranches in the vicinity of Tucson were chosen for this study to make it possible to contact the ranchers individually at needed occasions. It was decided that six ranches would make a fair small sample, although it is fully realized that a larger number would have been more satisfactory.

Ownership and other means of identification were excluded and the ranchers were given unit letters by which they are known throughout the study. All six ranches are in the semidesert grass zone; two ranches also have a large amount of land in what can be termed semidesert brush. All of the ranches have some land in this zone. Five of the ranches adjoin each other in a relatively compact fashion and one is a few miles south and separated from the others by other ranch units. All the unit operators are efficient businessmen and manage their units in the best up-to-date methods of the cow business. None of the ranches have any other activity or source of income than the cattle.

These ranches were not chosen at random but were selected to give as much spread as possible in range condition, and as much similarity as possible in type of operation and management. The units are all old, well-established outfits with the exception of the smallest unit which was begun on a part of one of the larger units used in this study. All types of land ownership are involved: privately owned land, State leases, and Federal grazing allotments.

Unit C has been used as basic data in a number of previous experiments different in nature from this one. The data from this unit has been checked and rechecked, so it was possible to use it as a check on any

large errors that might appear in data from the other units. Also the forage on this unit has been under close observation for a number of years, and it was possible to establish a guide, within certain limits, from it.

Tables 1 and 2 give a summary of the description of the ranch units. It will be noted that there is considerable variance in size and value, but there is close similarity in the other points of description.

During October 1941, a survey of range conditions on the six units was made. The survey crew was composed of two members of the animal husbandry department, one student in the range ecology department, and the author. A form for collecting, compiling, and calculating range condition data was evolved from material used by the Indian Service, Soil Conservation Service, and U. S. Forest Service in making similar surveys. A sample of this form with a sample of the collected data are shown in table 3.

The range condition study was made by the entire crew in three or four varied localities on each ranch unit. And the author, at a later date in October, made an extensive ocular survey of the total area comprising each of the units (9). All the data gathered by the survey, including density, were used in calculating the final range condition factor. The important individual species were then listed, and the percentage composition of each was shown. The palatability or desired use for each species was taken from the Region 3, U. S. Forest Service, Palatability Tables and listed. The percentage composition multiplied by the palatability gave the palatability factor for each of the important species. The total of these palatability factors gives a weighted average

Table 1.- The location, vegetation types, and carrying capacities of the six ranch units studied in southern Arizona in 1941-1942.

Ranch Units	A	B	C	D	E	F
Location	:Adjoins unit B :on east boundary	:Immediately :east of A	:Adjoins A on :west and :north	:10 miles :west of A	:Between A and :D	:Immediately :south of D
Vegetation Types	:2/3 semidesert :grassland; :1/3 semidesert :shrub, chaparral :pinon-juniper	:4/5 semi-desert :grassland; :1/5 semi-desert :shrub	:semi-desert :grassland	:4/5 semi-desert :shrub; :1/5 semi-desert :grassland	:semi-desert :shrub; :semi-desert :grassland; :chaparral :pinon-juniper	:1/2 semi-desert :grass
Carrying Capacity*	:high	:low :to :medium	:high	:low	:low	:low

*High - 10 to 15 acres per C. Y. L.

Medium - 15 to 30 acres per C. Y. L.

Low - 30 to 60 acres per C. Y. L.

Table 2.- The size, valuation, number of animal units, type of operation, and land ownership of the six ranch units studied in southern Arizona in 1941-1942.

Ranch Units	A	B	C	D	E	F
Size	13,000 acres	138,000 acres	1,500 acres	22,900 acres	7,000 acres	25,275 acres
Value	\$125,000.00	\$215,000.00	\$14,500.00	\$60,000.00	\$35,000.00	\$80,000.00
Number of Animal Units	1,050	4,350	84	371	200	463
Type of Operation	Mostly cow and calf	Cow and calf: also yearlings	Cow and calf	Cow and calf	Cow and calf	Cow and calf
Land Ownership	Private State Federal	Private State Federal	Private	Federal Private	Federal Private	Federal Private

Table 3.- A sample form and data collected in making the range utilization survey of the six ranches studied in southern Arizona in 1941-1942.

Unit A Examiner Ben Nelson Date 10/12/41
 Location 2 miles north of headquarters

Important Forage Species	:% Comp.	: Pal.	:Pal. Fac.	:Deg. Ut.	:Ut. Fac.	:% For.Ut.
Hbe	:50	:.85	:.43	:.70	:.35	:81
Bhi	:20	:.85	:.17	:.10	:.02	:12
ARI	:10	:.15	:.01	:.10	:.01	:100
Mwr	:10	:.60	:.06	:.00	:.00	:00
SPO	:5	:.40	:.02	:.20	:.01	:50
Bcu	:5	:.75	:.04	:.60	:.03	:75
Others	:T	:	:	:	:	:
	:	:	:	:	:	:
	:	:	:	:	:	:
	:	:	:	:	:	:
	:	:	:	:	:	:
	:	:Average	:.75	:	:.42	:58

Forage Density .45

Soil Condition (Poor to Good)

Erosion-Activity (High to Low)

Amount (Great to Little)

Transient Species & Abundance -

Plant Vigor (Good to Poor)

Former Use - Satisfactory

Other - Present use slightly over - some active gullies

General Comments

1 _____ 2 _____ 3 _____ 4 X 5 _____

1 _____ 2 X 3 _____

1 _____ 2 X 3 _____

Afr (slight) ann. weeds (med.)

1 X 2 _____ 3 _____ 4 _____ 5 _____

palatability factor for the area, or the percent of the forage that should be used under proper range management. This weighted average palatability factor is not an exact figure in any case, but represents a condition as compared with an average set of conditions in a similar area and is set up so that one error may be counteracted by an opposite error and so that in no one locality, or under an average set of conditions, will the end result be very much out of line.

The next step in gathering range condition data was the calculating and listing of the degrees of utilization for the various species of vegetation represented. This was accomplished by finding an unused plant of the same species and then in comparing it with a used plant, list the percentage used on an estimated surface area basis.² Several of these comparisons were made for each species on the sampled area and an average taken. Each species was recorded separately (table 3). There are several weaknesses in this method in that it is often difficult for the observer to keep in mind that the figure wanted is the percent of the estimated usable surface area of the plant that is used at the time the observation is made. Percentage weight taken by stock or percentage height could probably be substituted and the results be very similar. However, the three percentages should not be substituted for one another in the same study. It is believed without substantiation that the estimated surface area percentage has more advantages in that water content, weight of a fibrous stem or tall leafless plants do not confuse the accuracy. Another factor to keep in mind in calculating the percent-

²This means the area in a silhouette or profile view.

age utilized is how much of the plant is it possible for stock to take. There has been some discussion on this subject, and it seems that the distance up from the crown that a plant can be taken varies greatly with the species involved and also with the species in association. Rocky terrain may also be a factor. The percentage that could be utilized in relation to that which is utilized has to be judged by the observer at each point of sampling and must be judged on the evidence on the ground at that particular point or its immediate locality.

The next step in getting the range condition is to multiply the degree of utilization of each species by the percentage composition of that species (table 3). This will give the utilization factor which is then compared with the palatability factor or proper-use factor (2). The utilization factors for the different species are totalled and this gives the average utilization factor. The average utilization factor means that of the 100 percent of the forage that could, under extreme circumstances, be eaten by stock a determined percent was used to date.

It is understood from the palatability factor that only that percentage, as indicated by the palatability factor, should be utilized. The average utilization factor is divided by the average palatability factor and the result will be the percent of usable forage which has been utilized.

Since the survey was made in October, it became necessary for the percentage utilized at that date to be converted into what would normally be utilized at the end of the grazing season. The end of the grazing season was assumed to be just before the summer rains begin in July. But there is generally a dry period of non-growth before the winter rains

begin and it was calculated that about one-half of this first grazing season had elapsed at the time the survey was made. On this basis each percentage utilization was multiplied by two and in that way the approximate utilization for the grazing season was established.³

In some instances it was found that the records of the intensive survey did not agree (table 4) with the extensive one and adjustments were made in these cases so that the final figure on percentage forage utilization was the figure that seemed most adaptable to that particular range. All estimates were substantiated by figures from the card calculations. It may be said at this point that these utilization figures are similar to every other utilization figure made in that they are not wholly accurate but are, to the best judgment of the observer, the best possible average that can be calculated without further research in this field.

In gathering the economic and factual data on the ranch units, the complete confidence of each rancher was gained. Each item was checked by the unit operator and the records were substantiated by the knowledge of the rancher. Or if the records seemed to be in error an adjustment was made by the rancher. Most records were found to be satisfactory although in some cases in rather brief form. Data on weights of both cows and calves were checked with actual sales records

³The yearly grazing season can be divided into two parts, one ending in July, one in December. (The divisions are made according to the approximate beginning of the year's two rainy seasons.) The survey was made at the middle of the first season. Therefore, the condition at this time, multiplied by two, gives the range condition for the end of the first grazing period. This condition is usually the same as at the end of the yearly grazing period.

Table 4.- A summary of range condition data collected on the six ranches studied in southern Arizona in 1941-1942.

Ranch Unit	A	B	C	D	E	F
Intensive Survey Range Condition Index Number	102	115	100	121	175	112
Extensive Survey Range Condition Index Number	115	113	114	120	135	112
Adjusted Range Condition Index Number	108	114	105	121	158	112

as were the ages of calves sold and the price per pound. The values of the ranch units were assumed to be the sale prices in all except the instance of unit B in which a sale price could not be calculated and tax valuation substantiated by the owner was taken.

The number of animal units on each ranch unit was taken directly from ranch records but in calculating the number of cows the fact that some of the units also ran steers has to be taken into consideration. To accomplish this the number of bulls and the number of replacement heifers were subtracted from the total number of animal units and the remainder were listed as cows. The result of this calculation is, of course, only a relative figure; but it was found to check very closely with the rancher's estimate of what his cow population would be if his entire ranch were operated on a cow and calf basis.

The percentage calf crop was taken from actual records and used in calculating the total number of calves from the adjusted cow numbers.

The running expenses were taken directly from each ranch's financial records. The 5 percent rate of interest on the ranch valuation has no basis but is assumed to be a fair rate of interest for ranch property, and though it may be too high or too low it was estimated to be the same for each ranch studied and would not greatly affect the relative net incomes of the various units involved.

DISCUSSION OF RESULTS

A complete compilation of all the data collected is shown in table 5.

The results of the range utilization survey varied greatly within each unit. The final results indicate that all of the units studied were utilized slightly over the proper-use standards, which are proper forage utilization estimates made after all the land services have been given due consideration. The interrelated values of soil, grazing, watershed, timber, recreation, wildlife, and other land services all enter into the determination of proper use. Proper use implies more than resistance to grazing, which is the degree of use a plant can stand year in and year out and still maintain its vigor and forage productivity. The ranches varied quite widely in their individual ranges. It was found that unit C was in the best condition and also the most uniform throughout in degree of use. A forage utilization of 105 was given unit C in comparison with 100 which is assumed to be standard. Unit C was closely followed by unit A which had an index of 108; the next unit in order of range condition was F with 112, followed by B with 114. Unit B varied more within itself than did any other unit. However, some of this was due to the large size of the ranch and also the varied forage type. Next came unit D with 121. Unit E was found to be very heavily utilized. All calculations showed it to be about 58 percent more heavily utilized than was proper. It was therefore given a forage utilization index of 158.

Table 5.- A complete summary of all the utilization, management, and economic data collected on the six ranches studied in southern Arizona in 1941-1942.

Ranch Unit	: A	: B	: C	: D	: E	: F
Forage Utilization Index	:108	:114	:105	:121	:158	:112
Surface acres	:13,000	:138,000	:1,500	:22,900	:7,000	:25,300
Number of Animal Units	:1,050	:4,350	:84	:371	:200	:463
Acres per Animal Unit	:12	:32	:18	:62	:35	:55
Number of Cows	:909	:3,759	:73	:321	:173	:400
Weight of Cows	:835 lbs.	:825 lbs.	:850 lbs.	:845 lbs.	:800 lbs.	:874 lbs.
Number of Bulls	:36	:156	:3	:13	:7	:17
Number of Calves	:782	:3,120	:63	:260	:135	:340
Percent Calf Crop	:86	:83	:86	:81	:78	:85
Calves for Replacements	:105	:435	:7	:37	:20	:46
Calves Sold	:677	:2,685	:56	:223	:115	:294
Weight of Calves Sold	:390 lbs.	:370 lbs.	:400 lbs.	:360 lbs.	:310 lbs.	:380 lbs.
Value of Ranch	:\$125,000	:\$215,000	:\$14,500	:\$60,000	:\$35,000	:\$80,000
Interest on Value at 5%	:\$6,250	:\$10,750	:\$725	:\$3,000	:\$1,750	:\$4,000
Running Expenses	:\$7,200	:\$25,000	:\$600	:\$2,260	:\$1,800	:\$3,120
Total Cost of Production	:\$13,450	:\$35,750	:\$1,325	:\$5,260	:\$3,550	:\$7,120
Cost of Production per Cow	:\$15	:\$10	:\$18	:\$16	:\$21	:\$18
Cost of Production per Calf Sold	:\$20	:\$13	:\$24	:\$24	:\$31	:\$24
Price per Pound of Calves Sold	:8 $\frac{1}{2}$:8 $\frac{1}{2}$:8 $\frac{1}{2}$:8	:8	:8 $\frac{1}{2}$
Total Income	:\$22,341	:\$83,235	:\$1,904	:\$6,467	:\$2,875	:\$9,408
Income per Cow	:\$25	:\$22	:\$26	:\$20	:\$17	:\$24
Income per Calf Sold	:\$33	:\$31	:\$34	:\$29	:\$25	:\$32
Total Net Income	:\$8,891	:\$47,485	:\$579	:\$1,207	:\$-675	:\$2,288
Net Income per Cow	:\$10	:\$12	:\$8	:\$4	:\$-4	:\$6
Net Income per Calf Sold	:\$13	:\$18	:\$10	:\$5	:\$-6	:\$8

The results on the forage utilization, therefore, varied within the study from an index number of 105, or just slightly over proper use, to 158, which is considered to be heavy utilization. The wide variation in degree of use presented a sound basis for a comparison of this factor with the net income or final result. The spread between each unit is not uniform but it would not be considered an advantage even if it were because the numerous other variables such as ranch size, ranch valuation, and differences in carrying capacity would of necessity oblivate all the uniformity in differences in range condition.

To substantiate the forage utilization index numbers it was noted that there was considerable difference in the condition of the range cows in unit E and unit C at the end of the grazing period. The cows on unit E, while thrifty and healthy, were quite poor and those on units A and C were in very good condition.

The number of animal units and cow units were, of course, in direct relationship with the area of the ranches. The largest ranch, unit B, ran 4,350 animal units, of which it was calculated there would be 3,759 cow units. The other ranches in order were unit A with 1,050 animal units of which 909 were cows; unit F with 463 animal units containing 400 cows; unit D had 371 animal units with 321 cows; unit E had 200 animal units, 173 cows; and, finally, unit C with 84 animal units of which 73 were cows. Numbers of heifer calves for replacement purposes may be found in table 4 and are in direct relation to the number of cows.

The number of surface acres required or used to graze an animal unit yearlong varied from 62 on unit D to 12 on unit A. This figure

has some significance because on the higher producing ranges an even distribution is easier to attain and the cost of management is somewhat reduced. But as a general rule the higher carrying capacity ranges also have a much higher investment in land which somewhat equalizes the situation. It was assumed in this study that the number of acres required per animal unit were entirely due to the forage producing capacity of the ranges and did not have any direct bearing on the condition of the range, but that this forage capacity had some effect on net income due to the increase in amount of interest on investment.

The cow weights of the units varied from 800 pounds on unit E, which showed the heaviest use, to 874 pounds on unit F which had an index number of 112. However, with possibly unit E as an exception, the units all showed large cows in good condition. The significant point in connection with cow weights seems to be that after a certain point in over-utilization is reached if the ranges are stocked heavier, cow weights go down; although if above that point, or if the ranges are stocked lighter the cow weights do not fluctuate as directly with range conditions. This statement may not be true on ranges with an index number below 100. But down to that point it seems the cows vary in weight within the average of a healthy range cow in good condition.

In calf weights there seemed to be more of a definite trend than in certain of the other factors which followed the trend of range conditions. Unit E, whose utilization index was 158, produced calves weighing 310 pounds while unit C with an index number of 105 sold

calves with an average weight of 400 pounds. The other units corresponded similarly as indices 108, 112, 114, 117, and 121 showed average calf weights of 390, 380, 370, 370, and 360 pounds. This trend in calf weights indicates that on the more heavily grazed ranges the calves did not have as much range feed to supplement the milk from their mothers as on the more lightly grazed ranges. Hence the higher the index number the lower the calf weight. Another factor which probably entered in was that the cows with less condition and getting less forage supplied less milk to their calves, thus cutting down calf weights. Milk supply of the mother cows and green feed on the ranges are both very important in producing heavy weight calves and these two factors are undoubtedly knit closely together in that lack of feed for the mother means lack of both feeds for the calf. The calf weights shown for the various units were all calculated for a 7-month-old calf and thus are comparable in every respect. It will also be noted that the calf weights do not correspond exactly with the range utilization index. While it is believed that these two figures would never correlate perfectly under any circumstances, in this experiment certain factors such as slight differences in the quality of the breed and differences in methods of working the cattle may have tended to influence the relationship somewhat.

The percentage calf crop, also one of the most important factors in range income, varied in a fairly direct line with range condition. Slight changes in the forage use factors did not seem to affect calf crop. As shown in table 5, the low unit with a range index of 158 had a 78 percent calf crop while the high unit with a 105 index produced

an 86 percent calf crop. All of the calf crop percentages shown are higher than the average for the State and are probably higher than on some of the best ranches in certain sections of the State. The quality of the cattle represented, the smoothness of terrain, and the quality of the range all make for this high level of percentages. While it is shown by this experiment that range condition affects the calf crop, yet it would hardly be fair to isolate this one factor. Other practices in livestock management are probably just as important as the degree of range use. The condition of the bulls is undoubtedly very important, (1) and the topography of the range also has a direct influence on calf crop. The health of the cows and the bulls, the climate, the treatment or handling of the bulls, and the care or management of the cows during calving season are other factors that bear directly on calf crops. But it cannot be overlooked that the condition of the range or the degree of stocking has an important part in the condition of the bulls and of the cows both during the breeding season and during calving. This condition carries on into calf crop percentages and as shown by the data collected there is a marked difference in the units which represent various degrees of stocking. The units with the intermediate forage condition indices are not as marked as the extremes when taken individually but the general trend is the same. It also is shown that below a certain point in range use the calf crop drops a greater amount than in the upper classes. In other words the poorer a range becomes the more definite is its effect on calf crop, and on nearly properly used ranges a degree or two change in use probably has very little effect. The unit with a forage utilization index of 108

had the same calf crop as the unit with 105, the 114 and 117 were alike, both 83 percent. When the index number dropped to 121, as it did on unit D, the calf crop dropped to 81 percent.

Table 6 shows the utilization index numbers as compared to the pounds of beef produced per cow. The straight line relationship will be noted. A correlation was run on this set of data and a high degree of correlation existed. The test of significance indicated a true correlation. This is a very important comparison as the forage use is the clue to the available nutrients and the beef produced involves the factors of production such as calf crop and calf weights.

The cost of production figures are made up of two items. First, the interest on the value of the ranch unit, and, second, the running expenses or cost of operation. In the first item it seemed essential that something be charged for the investment in the ranch. In some cases it may be the operator's own money which is invested; while in others outside capital may be interested. In either case the capital has an earning power and its wages must be shown. Also lands of better quality upon which are more efficient and more or less expensive improvements must be taken into consideration when income is the subject. Theoretically in any business if the investment is high enough so as to provide the greatest degree of efficiency a profit exclusive of interest on investment is very probable. When due wages are given to capital, however, the law of diminishing returns applies to investment as well as other factors. The 5 percent charged as interest on investment, as stated previously, is an arbitrary figure. Unit C has the largest investment per acre of land closely followed by unit A.

Table 6.- Utilization indices and pounds of beef produced per cow on the six ranch units studied in southern Arizona in 1941-1942.

Ranch Unit	A	B	C	D	E	F
Utilization Index	108	114	105	121	158	112
Pounds of Beef Produced per Cow	336	307	345	292	242	323

And the smallest investment per acre is on the largest ranch, unit B. Because cost of production is not calculated on a per acre basis but on the cost per cow or calf, the effect of size of the investment is somewhat tempered and it fits more closely into the other calculations.

The second item under cost of production, running expenses, is the cash outlay by the operator during the year. These expenses are the amount of money it costs to produce and market a crop of calves, not including interest. Running expenses include such items as depreciation, supplemental feed, salt, labor, medicine, and replacement bulls. In this study the running expenses varied from slightly over \$7 to about \$10.70 per cow. The total running expenses varied from \$25,000 on unit B to \$600 on unit C.

In adding these two expense items the total cost of production was calculated and is shown in table 5 on a per cow and per calf sold basis. The total cost of production per cow shows differences in the various units more or less in relation to the forage condition. On unit F, the heaviest stocked range, it costs \$21 per cow to produce 78/100 of a calf; while on unit C, whose index is 105, it costs \$18 per cow which in turn produces 86/100 of a calf. However, the trend is by no means a straight line. On unit B there is a forage utilization index of 114 and yet it costs only \$10 per cow and this cow returns 83/100 of a calf. Unit D with a higher index figure than unit C also has a lower production cost per cow. The value of the unit has an important part in making this cost of production figure what it is. It is well to remember also that the cost of production

alone means little and not until it is combined with income is its full significance made clear.

The income was affected by the price per pound, the calf crop, and the calf weights. The selling price per pound of the calves produced on the ranges in this study were quite similar. The 5-year average, however, revealed that on the two units having the heaviest utilization and the lightest calf weights the price received per pound of calf was $\frac{1}{2}$ cent lower than on the other units.

The income on a per cow basis indicates a direct relationship to the range utilization index. The high index number on unit E effected an income of only \$17 per cow while the income per cow was \$26 on unit C with its index of 105. The other units kept the same trend with the exception of units B and F which had index numbers of 114 and 112 and incomes per cow of \$22 and \$24 respectively. This exception may tend to show that when range utilization is nearly equal there is little effect on income and where there is a wide spread in the degree of utilization the income is definitely affected.

The net income, which is the total income minus the total cost of production, is the combination outcome of the factors of production. This net income is made up of managerial wages and profit. This figure is the most important to the ranch operator because it represents the fruits of his labors and determines whether or not his management is efficient. It will be noted from table 5 that unit E shows a net loss. This loss should not be taken as a direct loss because it probably does not exist in that form but rather it merely represents a lower interest on the capital investment. Unit E is probably showing an over-all profit, including interest on investment,

or it would not exist long as a practical ranch unit.

In relation to the degree of forage utilization, the net income is not direct. It does show that when the range use becomes heavy to the point of deterioration the net income falls appreciably. And also that other factors of production have more weight when the utilizations are within a degree or so of each other and in the brackets nearest proper use. Unit E with the highest index on range use has a net income per cow of minus \$4 and is the lowest figure in the study. On the other hand, unit B has the highest net income with \$12 per cow and its range is used heavier than unit C or A which have net incomes of \$8 and \$10. Then when the degree of utilization rises to 121, the net income goes down to \$4 per cow as shown by unit D. It may be observed that the size of the first three units correspond with the net incomes. This may or may not be significant but probably the larger unit is more efficient because it has more of the advantages of division of labor and large-quantity buying power, and can be operated on a much lower running expense than the smaller units. In the case of unit F there is also a high investment cost and the running expenses are the same as for the units A and C. In this connection it may have been more fair to have called the wages of capital profit also. But as stated previously this would have complicated matters because of the efficiency of expensive equipment and it was therefore regarded best to calculate net income as shown. The net incomes shown in table 5 are probably higher than they should be but this study was not set up to calculate these exactly but to show their relationship to each

other and to the utilization index numbers. It may also be noted that low investment cost has made for a higher net income on unit B than on unit C in spite of the lower utilization factor on unit C. Table 7 shows the resulting net incomes per cow when interest on investment is not calculated. From this table it will be seen that the utilization indices and net incomes, exclusive of interest, are in direct relationship. This shows the importance of interest costs but the net income shown in this table must not be confused with the true net income shown in table 5. As nearly as could be calculated from the ranch records the net incomes in table 4 are all on exactly the same basis. However, the human element of estimating the value of the ranch unit is present and normal errors are to be expected.

Table 7.- The utilization index, cost of production, income, and net income per cow exclusive of interest charges of the six ranches studied in southern Arizona in 1941-1942.

Ranch Unit	A	B	C	D	E	F
Utilization Index	108	114	105	121	158	112
Cost of Production per Cow Exclusive of Interest	\$8	\$7	\$8	\$7	\$11	\$8
Income per Cow	\$25	\$22	\$26	\$20	\$17	\$24
Net Income per Cow Exclusive of Interest	\$17	\$15	\$18	\$13	\$6	\$16

CONCLUSIONS

Certain facts are pointed out by this study and in discussing them they will be taken up in the order followed in the discussion of the report. Of the six ranch units studied the forage utilization or degree of range use varied from an almost proper use of 105 to a heavily used range of 158. The surface acres of land in each unit were from 1,500 on the smallest to 138,000 on the largest. Animal unit numbers ran from 84 to 4,350. The number of acres per animal unit varied directly with the carrying capacity of the land, not including the rate of overstocking. The latter had no particular significance in this study except to show that this factor did not enter into the final results. The number of cows per bull was the same for all the units studied. The calf crop percentages varied somewhat directly with the degree of forage utilization which indicates that the degree of range use has an effect on calf crop. Because of the variance of calf crop percentages from a direct relationship, it may be implied that other management factors are as important as the degree of range use. The trend in calf weights and the forage utilization index numbers indicate a high degree of correlation. The deviations from this correlation may be attributed to the differences of quality within a breed and differences in general livestock management. One of the most important conclusions can be drawn from the fact that there is a high degree of correlation between forage-use indices and pounds of beef produced per cow.

The degree of utilization apparently does not influence the trend of cow weights until a point of heavy utilization. There is then a marked drop in the weight of cattle. In the other cases, the weights seem to show a difference in various herds of cattle such as size, condition, and ease of keeping. The estimated present value of the different ranch units varied widely. They did not correspond to any one factor or group of factors. But these values did represent asking price which was influenced by factors such as roads, scenic aspects, proximity to town, and power lines. Running expenses did not vary with range use. The total cost of production was influenced somewhat by range condition but not directly. The price per pound of calves sold was the same for the four units with the lowest degree of stocking. But in the two heavier stocked units the weights and condition of the calves, which are directly affected by range condition, caused the price to be lower. The gross income per cow, influenced by factors already mentioned, varied directly with the degree of utilization of the range.

Net incomes, exclusive of interest charges, varied directly with the utilization indices. This brings out the importance of interest charges and also that running expenses are higher on a per cow basis on the more heavily stocked ranges. Total net income figures indicate that it is probably more profitable, in most cases, to operate ranch units on ranges that are properly used than on heavily grazed ranges.

SUMMARY OF CONCLUSIONS

1. Cow weights are apparently not affected by small changes in the degree of forage utilization.
2. When utilization becomes extremely heavy, cow weights are affected.
3. As the degree of stocking becomes heavier, the calf crop percentages lower.
4. Calf weights respond directly to range condition.
5. Pounds of beef produced per cow varies directly with forage use.
6. At the present time ranch unit value is affected by other factors besides the factors of production.
7. The running expenses of a ranch unit do not correspond exactly to range condition.
8. The cost of production per cow is affected more by other factors than by the degree of range utilization.
9. The total income per cow varies directly with range condition.
10. Net income, exclusive of interest charges, corresponds with degrees of use.
11. The final net income per cow is greatly influenced by the degree of forage utilization.

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