Costs and Returns in a Study of Common Property Range Improvements¹

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Highlight

The clearing and reseeded of mesquite-covered alluvial flood plains on the Papago reservation in the southwestern United States to blue panic-grass was determined to be economically feasible. This improved range must, however, be used at full carrying capacity and livestock numbers restricted so the increased forage will be reflected as an increase in calves sold. A benefit-cost analyses was performed to determine what effect different methods of management would have on returns for a common property resource.

La Ventaja Economica de un Manejo Adecuado—un Estudio Sobre Los Costos e Ingresos en Mejoramiento de Pastizales en Propiedad Comunal.

Resumen³

El estudio fué llevado a cabo en la reservación de los indios Papagos en el Estado de Arizona, E.U.A. En el pastoreo comunal en esta reservación ha habido un sobrepastoreo que ha causado que los pastizales se encuentren en malas condiciones y de que haya baja producción de ganado y carne.

Debido a que es difícil corregir el sobrepastoreo por razones sociales, los técnicos pensaron que sería mejor aumentar el coeficiente de agostadero utilizando ciertas prácticas tales como control de arbustos, siembras, bandas de dispersión de escurrimiento y construcción de facilidades tales como aguajes, corrales y potreros.

Sin embargo, había dudas si este método era económico o no. Se encontró que los métodos de mejorar el coeficiente de agostadero resultaban económicos solo con una carga animal adecuada. El sobrepastoreo aún en los pastizales mejorados no era económico y no cubrió los costos del mejoramiento.

The Papago Indian Reservation consists of arid valleys and plains

with high temperatures and low rainfall characteristic of the Sonoran Desert Region. Drought and overgrazing have resulted in a range where annual plants provide much of the forage.

The Papago cattlemen have traditionally derived their income from a cow-calf operation which is poorly suited to this type of range. This inflexible method of operating has resulted in periodic starvation conditions and a range that yearly becomes more depleted. Private and Federal funds were solicited during the spring and early summer of 1969 to feed starving cattle.

To prevent resentment caused by forced reduction of cattle numbers, Bureau of Indian Affairs (BIA) range personnel have searched for a method to prevent seasonal starvation and weight losses, at the same time assisting conservation and rejuvenation of the denuded range land. Complementary pastures utilizing floodwater from the mountains to provide much needed perennial grasses appears to be a partial answer (Simpson, 1968).

About 2,025 hectares (5000 acres) of mesquite-covered alluvial fans have been cleared and seeded on the reservation over the last five years. Although the improvements provide a striking contrast to the surrounding rangeland, economically they might not be paying for themselves, principally because of lack of proper management. (This is defined here as fullest possible use to maximize profits over a

long term period.) In light of this situation, a feasibility study was initiated prior to developing the remaining 10,125 hectares (25,000 acres) thought to be suitable. The method of benefit-cost was used as an indicator of potential returns under various pasture-management assumptions.

In this study, two systems of management were considered, one which evaluates management training assuming no restrictions on herd numbers (Plan "A"), and one in which herd build up in response to additional available forage is curtailed (Plan "B"). To compare the two plans, the benefits are divided by their respective costs to determine benefit-cost ratios.

Communal Grazing System

Traditionalism, group rather than individual decision making, antiquated methods, little formal education, and a communal grazing system are the social constraints encountered in evaluating the dollar return from pasture improvement. The name "communal grazing system" is employed because the land in and around each village is thought of as belonging to that community and is apportioned by the village or district council.

The majority of the Papago stockmen own only a few animals. Woodbury and Woodbury (1962) cite references which suggest that the largest Papago herd is over 1,000 head, that there are three herds of over 500 head, five of over 100 head, 36 herds of 10 to 99, and about 400 families have herds of 9 head or less. Because it is not generally feasible for each owner to fence a portion of range for his own use (stocking rates are about 5 to 10 head per section) there are definite unwritten "property rights" which serve well, as long as they are followed.

All livestock are owned individually but run together. Were an individual to reduce his cattle numbers, he would not benefit directly, since his neighbor, who, running his cattle on the same general range,

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would then use the extra forage available. Thus, to the individual Papago stockman, overgrazing is rational and may be expected to continue until curtailed by outside pressure. Although the communal grazing system is often criticized as the main contributor to overgrazing, it becomes apparent that what is needed is not a radical change to a new system but a more careful governing of the common property resource, i.e. land. The overuse of this common property resource (known as the commonality problem; other instances are groundwater basins and ocean fisheries) paradoxically has also been aggravated by BIA water development on the reservation.

During the 1930's an active campaign of building dirt water tanks and wells was carried out to "improve livestock distribution." In the 1950's an additional \$1,000,000 was spent. Lack of adequate regulation of stock numbers resulted in additional range which is overgrazed as cattle are better able to utilize the land area.

Methods for Estimating Range Improvement Cost and Production

The actual range development requires clearing the mesquite-covered alluvial bottomland by pushing the trees with the blade of a large crawler type tractor. In the same operation a "root knife" attached to the drawbar dislodges the roots, plowing the land. Because the trees are usually less than 3 m in height, they are left to rot and no further land preparation operations are required. The area is then fenced, and corrals, water spreaders, and "charcos" (dirt tanks) are built. The cleared area is seeded by aircraft just prior to summer rains. Grazing is deferred for one year to allow for stand establishment.

In the analysis of reservation potential, about 9,315 hectares (23,000 acres) were delineated on aerial photos as suitable for pasture development. Clearing cost calculations were determined by plotting mesquite areas designated as heavy

Table 1. Cost assumptions for renovating mesquite-covered alluvial fans, Papago Indian Reservation, Arizona.¹

Fencing	\$497 per km (\$800 per mile)—includes 4 strands of wire and steel posts at 7.82 m (25 ft) intervals.
Spreader dikes	\$300 each—1.8 m (6 ft) wide at top, 1.8 m wide at bottom, 274.3 m (900 ft) long, 15¢ per m ³ pushing charge.
Charcos	\$3,000 each (including silt "settling tank")
Clearing heavy cover	\$39.54 per hectare (\$16/acre)
Clearing light cover	\$37.07 per hectare (\$15/acre)
Seed—blue panicgrass	\$1.32 per kg (\$.60/lb.) @ 5.45 kg per hectare (5 lb./acre)
Lehmann lovegrass	\$4.41 per kg (\$2/lb.) @ 1.09 kg per hectare (1 lb./acre)
Seeding application	\$1.53 per hectare (\$.70/acre) using fixed wing aircraft.
Corrals	\$680 per set
Maintenance	\$15,970 annually for fence, charco, dike, corral and eradicating woody growth using .36 kg (1/3 lb.) 2,4,5-T in a 1:7 mixture of diesel fuel and water once every 5 years of \$1.23 per hectare (\$.50/acre) per year.

¹ 1967 price.

or light cover. The mesquite densities were easily recognized on the photos and, when combined with field checks, resulted in fairly accurate estimates of total clearing cost (Table 1). The aerial photos were also invaluable for estimating fencing costs as well as determining the number of charcos, corrals, and spreaders needed.

Visual evaluation of reseeded species on a seven-year-old pasture indicated that blue panicgrass (*Panicum antidotale*) was dominant on well flooded areas (10.16 to 45.72 cm of water each flooding) and that Lehmann lovegrass (*Eragrostis lehmanniana*) was best on areas of light inundation (less than 10.16 cm of water per inundation). The studies were done in November, at the end of the growing season but prior to grazing. Clippings from blue panicgrass plots, on what was judged to be maximum cover, yielded 4,360 kg per hectare (4,000 lb./acre) oven dry weight (O.D.W.). There seemed to be two very definite classes of cover. One class which averaged 75% of maximum blue panicgrass cover and which occurred on well flooded areas was designated as "heavy production." This level, with a 70% use factor (average amount grazed of each plant) im-

plies a net yield of 2,290 kg of useable O.D.W. forage per hectare (2100 lb./acre). The areas of light blue panicgrass production were estimated to be about 10% of maximum cover which again with a 70% use factor, yields 305 kg of useable O.D.W. forage per hectare (280 lb./acre). An average of 60 plots in areas sown to Lehmann lovegrass yielded 196 kg of useable O.D.W. per hectare (180 lb./acre) when computed at an 80% use factor.

The aerial photographs were then used to determine the potential acreage which would yield heavy and light blue panicgrass production and those areas which should be seeded to Lehmann lovegrass. This was relatively easy as the areas of woody growth, which are also excellent indicators of potential forage production, were strikingly apparent on the photos. In some cases there were spots which were not inundated and therefore would not be expected to yield any forage production. Returns were computed by calculating the number of cows the pastures would support and then determining the value of calves sold. Mature cows were expected to consume about 9.08 kg (20 lb.) O.D.W. forage per day (Morrison, 1948, Appendix Table 3). Calves by their

mother's sides will consume what is considered to be a negligible quantity, but which in any event is more than offset by the "occasional use" of pastures for fattening weanling calves prior to shipment to market. From these assumptions, the areas of heavy production may be expected to provide 259.5 cow grazing days per hectare (105 cow days/acre), the areas of light blue panicgrass production 34.6 days (14 days/acre) and Lehmann lovegrass 22.2 days per hectare (9 days/acre). All potential pastures delineated on aerial photographs could be expected to carry about 2,160 cows per year (reduced from 2,609 by a factor of about 83% to account for bulls and replacement heifers). It must be kept in mind, however, that the pastures are designed for use only four months a year rather than on a year long basis.

To compute returns, heifer calves were assumed to average 164 kg (364 lb.) each and sell at \$.53/kg (\$24/cwt) steer calves to average 175 kg (388 lb.) each and sell at \$.57/kg (\$26/cwt) and cull cows to average 360 kg (800 lb.) each and sell for \$.33/kg (\$15/cwt) (Dickerman and Martin, 1967). Reservation-wide, current average death loss is about 7% (Whitfield, 1967).

Plan "A"

In this case, which is typical of the present operation on the five established pastures, the pastures would be developed with no restrictions placed on livestock numbers grazing on the open range. The pastures thus assume a supplementary rather than the intended complementary role. The stockmen could be expected to increase their herd size by some percentage of the full capacity of the pastures so that the open range would still be overgrazed and the calf crop could not be expected to rise above the present 45%. Experience with the five experimental pastures also indicates that on an average, 60% of pasture potential (proper use) has been utilized. With a 70% use factor, this means that 42% of total forage

(.60 × .70) is consumed. If no management training or restrictions were placed on the proposed pastures, annual direct benefits⁴ from the sale of cull cows and calves (less replacement heifers) would be \$50,025. (Secondary benefits⁵ will be considered as negligible.) Total annual cost would be \$85,570. This includes a 50-year period of analysis at 8% interest, \$15,970 maintenance cost, \$20,570 with interest at 8% on additional cows, minus \$2,625 annual cost of corrals and charcos which could be allocated to other open range use. The benefit-cost ratio of .60:1 indicates that \$.40 is being lost on every dollar invested.

It is often asserted that adding management training in a situation such as this will reap large benefits. Hypothesizing that 90% of pasture potential could be obtained with guidance by a full time range conservationist and a Papago counterpart for a two-year period suggests direct benefits of \$75,030 from the sale of calves and cull cows. This return assumes that calf crop does not change. Annual costs would be the same as before except that \$2,630 must be added as an annual training program charge for a total of \$88,200. (The training cost, although only for a two-year period, is spread over the 50-year time stream.) The benefit-cost ratio of .85:1 indicates that even though training is added there will be a negative net return when no restrictions are placed on herd increase.

Plan "B"

In this plan, total reservation cow numbers will be assumed to remain constant by addition of growth restrictions concomitant with pasture development which also gives a nearly optimal open range carrying

capacity. Direct benefits would accrue in the form of reservation-wide increased calf crop and reduced death loss.

The benefits of Plan "B" must be calculated somewhat differently from Plan "A" where return to the pastures was computed as an annual return to added investment (cows). When cow numbers are assumed to be constant, a marginal basis, i.e. the added calf crop and reduced death loss of the cows which are grazed on these pastures, is the correct procedure to be used. Utilizing the pastures four months of the year would provide 5,850 cows with forage for four months (90% of proper utilization). Critical to the analysis is the validity of counting all calves of the additional calf crop (25%) as being sold, whereas in Plan "A" the additional cows had to have replacement heifers deducted. Total benefit is \$172,650 compared to a cost of \$71,780 (\$51,650 amortized investment, \$15,970 maintenance, and \$4,160 management training). The ratio is 2.44:1. It is also probable that the rest of the cows on the open range (7,425 head), while not directly utilizing the pastures, could also be expected to have an increased calf crop. It seems logical that the calf crop will be somewhat less than those cows on proposed pastures however. Speculating a 15% increase (to a total of 60%) yields additional calves worth up to \$150,000.

A check on the aforementioned ratios can be made by evaluating the pastures on the opportunity cost method. Each animal unit month (AUM) of grazing from the proposed pastures costs \$2.16 to produce. This figure was arrived at by dividing the annual potential months of grazing (\$1,300) into the annual capital plus maintenance cost (\$67,625). Gardner (1962, p. 59) presented an estimate of \$3.19 for the value of an AUM of range grazing and \$2.91 was estimated by Jefferies (1964, p. 76). Thus the cost per AUM is found to be lower than independent estimates of the market value for forage. This adds

⁴ Direct Benefits—The value of the immediate products or services resulting from the measures for which project costs and associated measures were incurred.

⁵ Secondary Benefits—The value added over and above the value of the immediate products or services of the project as a result of activities stemming from or induced by the project.

support to the conclusion that investment in pastures would be desirable under appropriate management conditions.

Summary and Conclusions

Two alternative development plans for potential flood irrigated pasture were considered in light of special cultural problems affecting range utilization practices. A benefit-cost analysis was performed to determine what effect different methods of management had on returns for this common property range resource. In one plan (A), in which herd numbers were assumed to be unrestricted, the annual benefits were found to be less than annual costs, principally because of continued low expected calf crop. In the second plan (B), herd numbers were assumed to be held constant so that calf crop could be expected to increase, thus increasing returns. It was concluded that the investment would be desirable only under this latter plan. The positive ratios obtained indicate that the improvements will yield a positive return over costs. The conclusions are, however, valid only for an opportunity cost of 8%. It should also be pointed out that the use of benefit-cost ratios is maximized when ratios are available for comparison between alternative investment projects.

The results of this analysis further suggest that unregulated common property resources are special

cases. In this instance the reason is that calf crop, the all important factor for computing returns, is consistently low. This very definite management problem is aggravated by undisciplined group policy-making.

Experimental pasture production studies indicated the hardiness, viability and high yields of blue panicgrass. The fairly low cost of \$2.16 for each animal unit month of grazing attests to the potential value of this grass in the southwest, given full utilization.

The method selected to compute the returns is, as has been demonstrated, also vital. It is not sufficient to state simply that calves are being sold, the question is, are additional cows to be bought for stocking the pastures or are predevelopment herd numbers to be maintained, i.e. are the pastures supplementary or complementary? The rule of thumb for the former is: compute benefits as an annual return to added investment (cows). When pastures are complementary, however, so that numbers remain constant, the benefits are derived as additional calves, or as additional weight gains. It becomes obvious that simple calculation of forage yields will not suffice under questionable management situations and that this holds for individual owner as well as group owner situations. The critical methodology is that of actual pounds of beef sold, not optimal or "paper" computations.

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