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Economic analysis of range improvements

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Quick Facts

Range improvements are structures, practices or developments that increase the sustainable yield of goods and services from rangeland while maintaining or improving its condition.

Profitability is one important criterion that should be used in deciding whether to implement any range improvement.

Costs for range improvements often are paid out initially, but returns flow back to the investor in annual increments.

Present value analysis is a method commonly used to determine the profitability of range improvements.

Range improvements are structures, practices or developments that increase the sustainable yield of goods and services from rangeland. Improvements can vary from sophisticated grazing systems to simple water developments. These improvements maintain or improve range condition for a particular use or combination of uses.

Range improvements must produce tangible benefits to the range user and the resource. One important criterion is the ability of that improvement to produce a reasonable return on investment.

Time Value of Money

Most range improvements are long-term investments. The largest portion of costs for improvement practices are paid out initially and returns come back to the investor in annual increments. In some cases, returns may not be produced until a few years after the initial investment. Because of this time difference, a simple comparison of the total costs and returns for an improvement will not provide an accurate picture of its return on investment. Therefore, when calculating the profitability of any range improvement, it is important to consider not only total costs and returns, but when they occur.

Money has a time value. A dollar earned today is more valuable than a dollar earned in the future. This is true because a dollar earned today could be invested and be accruing interest. For example, if an investment returned $100 in one year, that investment would be better than one that returned $100 at the end of two years. The return from the first investment could be reinvested to return more than $100 by the second year.

Present value analysis is a method commonly used to determine the economic feasibility of range improvements. This method takes into account the time value of money by "discounting" the value of future costs or returns to their value today. Once monetary values have been adjusted in this way, a direct comparison of costs and returns can be made.

To perform present value analyses, it is necessary to understand how to discount stocks and flows of money. The amount of the initial investment and/or annual net income flow is multiplied by a discount rate. Discount rates usually are provided in tables, such as Tables 1 and 2, although hand-held financial calculators and computer spreadsheet software programs also can make such calculations. The correct discount rate depends on the rate of return of the next best investment (also called "opportunity cost") and the number of years the investment is made. Table 1 provides discount rates for stocks (a single sum received at one point in time) while Table 2 provides rates for flows (an amount received annually for several years).

The following two examples illustrate the use of discount rates. Suppose an investment at 7 percent interest will return $100 in six years. To find the present value of that $100, multiply by the

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Table 1: Discount rates for stocks (sums received or paid out at a single point in time).[1]

	6%	7%	8%	9%	10%
1	.9434	.9346	.9259	.9174	.9091
2	.8900	.8734	.8573	.8417	.8264
3	.8396	.8163	.7938	.7722	.7513
4	.7921	.7629	.7350	.7084	.6830
5	.7473	.7130	.6806	.6499	.6209
6	.7050	.6663	.6302	.5963	.5645
7	.6651	.6227	.5835	.5470	.5132
8	.6274	.5820	.5403	.5019	.4665
9	.5919	.5439	.5002	.4604	.4241
10	.5584	.5083	.4632	.4224	.3855

[1]*For discount rates not included use the formula:*

$V_0 = \frac{V_n}{(1+i)^n}$, where V_n is the future value of a stock at the end of n years, V_0 is the present value of V_n, i equals the interest rate and n is the number of years over which the stock is to be discounted.

Table 2: Discount rates for flows (amounts received annually over a period of several years).[1]

	6%	7%	8%	9%	10%
1	0.943	0.935	0.926	0.917	0.909
2	1.833	1.808	1.783	1.759	1.736
3	2.673	2.624	2.577	2.531	2.487
4	3.465	3.387	3.312	3.240	3.170
5	4.212	4.100	3.993	3.890	3.791
6	4.917	4.766	4.623	4.486	4.355
7	5.582	5.389	5.206	5.033	4.868
8	6.210	5.971	5.747	5.535	5.335
9	6.802	6.515	6.247	5.995	5.759
10	7.360	7.024	6.710	6.418	6.145

[1]*For discount rates not included use the formula:*

$V_0 = \frac{R[(1+i)^n - 1]}{i(1+i)^n}$, where V_0 is the present value of the annual flow over n years, R is the amount received each year, i is the interest rate and n is the number of years over which R is to be discounted.

appropriate discount rate. The discount rate from Table 1 that corresponds to 7 percent and six years is 0.6663 and this multiplied by $100 equals the present value of that stock sum, or $66.63. Again, suppose an investment is made at 7 percent over a six-year period, but in this case it returns $100 per year. Multiplying the $100 annual return by the appropriate rate from Table 2 for 7 percent and six years (4.766) gives the total present value of that income flow over the investment period, or $476.60.

Analysis Steps

The analysis of any range improvement using a partial budget and present value analysis can be applied through the following steps.

1. List the sources of additional costs and returns from the proposed improvement.
2. Calculate the present dollar values of individual added costs over the life span of the improvement and total these amounts.
3. Calculate the minimum amount of return (e.g. pounds of livestock gain, pounds of forage) required to cover the costs of the improvement. If the break-even value appears unattainable, then the improvement will not be profitable. If the required response appears attainable, go to step 4.
4. Calculate the present values of individual added returns and total these amounts.
5. Subtract the present value of the total added costs from the present value of the total added returns to determine the net present value for the improvement.

Example Analyses

To understand how to analyze the economic feasibility of range improvements work through the following two scenarios. Steps 1 through 5 are applied in each example.

Water Development. A 640-acre pasture produces 400 pounds of forage per acre. Although the pasture is accessible to livestock during grazing season, it remains unused because the nearest water source is almost 2 miles away. The producer would like to install a water tank so livestock use the forage, and grazing is more uniformly distributed. The water would be delivered to the tank through a pipeline from an existing source. The question is: "Will this project be profitable?"

The first step is to list the added costs and returns produced by the water development, as shown in Table 3. The added costs include materials and labor. All costs, except maintenance, are borne initially. The added return from the project is an annual flow of additional forage over the estimated 10-year life span of the improvement.

The second step is to estimate the present dollar values of the added costs. The tank maintenance cost ($100 per year) is a flow that must be discounted. Using an interest rate of 10 percent (the return produced from the next best investment) and an estimated project life span of 10 years, the factor given in Table 2 is 6.145. Multiply $100 by 6.145 to get $615. This is the total present dollar value for maintenance over the life of the project.

Once the present value of the costs have been calculated, calculate the break-even value. What needs to be known is the minimum level of annual return (either in dollars or production units) that must be produced by the improvement to cover the annual cost of that improvement.

There are advantages to calculating the break-even response before estimating the individual added returns. It is easier to accurately estimate the dollar values of itemized costs for an improvement than the dollar values of itemized returns. Use this cost information to determine how much of the return is necessary each year to cover costs. If this break-even value is not attainable, then no further analysis is necessary. The improvement will not be profitable. A number of possible range improvement alternatives can be examined quickly in this way.

Table 3: Economic analysis for a hypothetical stockwater development with a useful life span of 10 years and a 10 percent opportunity cost.

Added Costs:	Present Value	Your Values
Initial costs:		
Tank, float valve, cement	$ 800	________
Installation labor	200	________
Pipe, trenching, labor	5,808	________
Total Initial Costs	$6,808	
Future costs:		
Maintenance ($100/year)	$ 615	________
$100 * 6.145 = $615		________
Total Added Costs	$7,423	________

Break Even Requirement:

A. Annual equivalent of total present value of costs:

$\frac{\$7423}{6.145} = \$1208/\text{year}$

B. Annual return:

Forage available = 320 AUMs

Forage value = $8/AUM

C. Break-even response:

$\frac{\$1208}{\$8/\text{AUM}} = 151 \text{ AUMs}$ $\frac{\$1208}{320 \text{ AUMs}} = \$3.78/\text{AUM}$

Added Returns:

	Present Value	Your Values
Available forage	$15,731.00	________
320 AUMs * $8/AUM = $2560		
$2560/year * 6.145 = $15,731		________
Total Added Returns	$15,731.00	________
Net Present Value	$8,308.00	________

Table 3 illustrates the break-even value calculations as a three-step procedure. First, calculate the annual equivalent of the present value of the total added costs for the improvement. To do this divide the total present value of added costs by the discount rate for 10 percent and 10 years, or 6.145 (Table 2). This converts the total added costs ($7423) for the improvement over its 10-year life to an annual cost flow. In other words, the initial costs and maintenance of the water development will be equivalent to $1208 per year. Second, estimate the dollar value of one unit of the return (use a conservative market value) and the quantity of the return produced each year from the improvement. For the water development, the added return is estimated at 320 AUMs[2] per year with a market value of $8 per AUM. Third, divide the annual equivalent cost by the value of one unit of the return or by the total number of units produced annually to find the break-even value. To cover the costs of the water development, a minimum of 151 AUMs must be available each year and the market value of an AUM must be at least $3.78 for the 320 AUMs to cover the improvement costs. These calculations show the improvement to be a promising investment.

Next, estimate the value of the added returns.

[2]*AUM (animal-unit month) is the amount of forage consumed by a 1,000-pound cow in one month. In general usage, this amount is considered 800 pounds of forage on a dry matter basis.*

The project is expected to add 320 AUMs, valued at $8 per AUM, over a 10-year period. The annual value of this income flow is $2560. Multiply $2560 by the discount factor from Table 2 for 10 percent over 10 years (6.145) to get the total present value for that flow, or $15,731.

The net present value for the improvement is calculated in the last step. Net present value is the present value of total added returns minus present value of total added costs, or $15,731 - $7,423 = $8,308. With the information in Table 3, the producer can decide if the water development project will be profitable. The answer is: "Yes."

Range Seeding. A ranch currently supports 100 head of brood cows that graze on a Forest Service allotment during summer. Herd size is limited primarily by a lack of forage during the spring and fall, and high winter feed costs. The producer owns 1,000 acres of poor condition spring-fall range that has a high potential for establishing a crested wheatgrass seeding. The seeding is expected to increase forage production by 500 pounds per acre, increase calf crop from 70 percent to 80 percent and weaning weights from 350 pounds to 375 pounds, and reduce winter feeding by 60 days. The producer plans to buy steers to graze forage not used by the cows to provide additional income. On the other hand, the seeding would require building 2 miles of fence, paying the seeding costs, the grazing deferment costs, steer purchases, added steer and calf costs, and increased grazing fees. The question is whether or not this seeding would be profitable.

The analysis assumes that the total life of the seeding is 20 years. This includes 18 years of grazing use and 2 years of deferment to allow the seeded stand to establish. Note that an allowance for seeding failure is made in the initial costs given in Table 4. This risk of failure estimate allows for a one-in-five chance of failing to achieve a satisfactory grass stand. Reseeding costs are built into the analysis. Also, 75 percent cost-share is available for this project, so calculations were made with and without this cost-share money.

Fence maintenance, grazing deferment, added calf costs, steer purchases, direct steer costs and added grazing fees are treated as future costs. With the exception of grazing deferment, the present values of future costs are calculated in two steps. First, the estimated annual costs are discounted as flows over the 18 years when the seeding is grazed and those costs are incurred. Next, these values are discounted back over the two-year deferment as stocks to find the present value of future costs. Fence repair costs were discounted similarly, but the calculations assume that repairs will not be necessary during the first five years of improvement life. Therefore, fence maintenance costs were discounted as a 15-year flow and to present value as a stock using the discount rate for five years at 10 percent.

Grazing deferment costs were considered equal to the price that the producer must pay to lease pasture until the new seeding is ready for grazing. Four months of grazing must be leased during each year of deferment. The annual deferment

Table 4: Economic analysis of a hypothetical 1000-acre range seeding with a 20-year expected life and a 10 percent opportunity cost.

Added Costs:	Present Value	Cost Share	W/75% Your Values
Initial costs:			
Plowing ($9/ac.)	$ 9,000	$ 2,250	
Drilling ($8/ac.)	8,000	2,000	
Seed ($40/ac.)	40,000	10,000	
Weed control ($30/ac.)	30,000	7,500	
Fence (materials, labor, 2 * $2000/mi.)	4,000	1,000	
Risk of failure [20% * (seed + drilling + weed control costs)]	15,600	3,900	
Total Initial Costs	$106,600	$26,650	
Future costs:			
Fence maintenance ($100/yr for 15 years)	$ 472	$ 472	
$100 * 7.606 = $761			
$761 * 0.6209 = $472			
Grazing deferment (2 years)	5,555	5,555	
4 months/yr. * 100 AUMs = 400 AUMs			
400 AUMs * $8/AUM = $3200			
$3200 * 1.736 = $5555			
Added calf costs	339	339	
$5/head * 10 calves = $50			
$50 * 8.201 = $410			
$410 * 0.8264 = $339			
Yearling steer purchase	57,187	57,187	
30 head @ 375 lbs.			
11,250 lbs. * $0.75 = $8438			
$8434 * 8.201 = $69200			
$69200 * 0.8264 = $57187			
Added steer costs	1,017	1,017	
$5/head * 30 head = $150			
$150 * 8.201 = $1230			
$1230 * 0.8264 = $1017			
Grazing fees	1,132	1,132	
3 months * $1.86/head/month			
$5.58/head * 30 head = $167			
$167 * 8.201 = $1370			
$1370 * 0.8264 = $1132			
Total Future Costs	$ 65,702	$65,702	
Total Added Costs	$172,302	$92,352	$

Break Even Requirement:

A. Annual equivalent of total present value of costs:

1. Without cost share:
$\frac{\$172,302}{0.8264}$ = $208,497
$\frac{\$208,497}{8.201}$ = $25,423 (annual cost)

2. With cost share:
$\frac{\$92,352}{0.8264}$ = $111,752
$\frac{\$111,752}{8.201}$ = $13,627 (annual cost)

B. Annual return:
70 calves * 25 lbs.
10 calves * 375 lbs.
30 steers * 700 lbs.
Total lbs. beef = 26,500

C. Break even response:
1. Without cost share: $\frac{\$25,423}{26,500 \text{ lbs.}}$ = $0.96/lb.
2. With cost share: $\frac{\$13,627}{26,500 \text{ lbs.}}$ = $0.51/lb.

Added Returns:	Present Value	
Reduced feed costs	$ 40,664	
100 head * $1/day = $100		
$100/day * 60 days = $6000		
$6000 * 8.201 = $49,206		
$49,206 * 0.8264 = $40,664		
Increased weaning weights	8,899	
70 calves * 25 lbs. = 1750 lbs.		
1750 lbs. * $0.75/lb. = $1313		
$1313 * 8.201 = $10,768		
$10,768 * 0.8264 = $8,899		
Increased calf crop	19,064	
10 calves * 375 lbs. = 3750 lbs.		
3750 lbs. * $0.75/lb. = $2813		
$2813 * 8.201 = $23,069		
$23,069 * 0.8264 = $19,064		
Steer Sales	92,511	
30 steers * 700 lbs. = 21,000 lbs.		
21,000 lbs. * $0.65/lb. = $13,650		
$13,650 * 8.201 = $111,944		
$111,944 * 0.8264 = $92,511		
Total Added Returns	$161,118	
Net Present Value (w/o cost share)	-$11,184	
Net Present Value (w/75% cost share)	$68,766	

cost is $3200 and is discounted as a flow to present value over the two-year deferment period.

Break-even value calculations in Table 4 are made with and without cost-sharing. The calculations follow the same procedure used in the water development example, with one minor variation. Because the seeding will not begin to produce returns until two years after money is invested, two years of interest must be charged to the seeding. That interest either would have been paid on a loan to begin the improvement or lost because the producer's own money was invested in the seeding rather than elsewhere at 10 percent. To account for this interest cost, the total added costs are compounded over a two-year period at 10 percent. To do this divide the total added costs by the discount factor for two years and 10 percent. The new values, $208,497 and $111,752, are then payed off over the remaining 18 years of seeding life. Use the discount factor for 18 years and 10 percent, or 8.201 to arrive at the annual equivalent of total costs.

The annual return was estimated as the pounds of beef produced. This included 70 calves weighing 25 pounds more at weaning, 10 additional 375-pound calves and 30 steers weighing 700 pounds each for a total of 26,500 pounds of beef. Divide the annual equivalent costs by the total pounds of beef produced annually. This gives the break-even values of $0.96 per pound without cost-share and $0.51 per pound with cost-share. From these values, it is clear that only the cost-share option appears profitable. It is unlikely that the producer will receive an average price of $0.96 per pound of beef in every year over the next 20 years.

Added returns from this improvement include reduced winter feeding costs, increased weaning weights, increased calf crop and receipts from steer sales. The seeding also increases forage production, but the value of that extra forage is equal to the value of steer sales because the grass is harvested by the steers. All added returns are flows discounted over the 20-year life of the seeding. Because returns are not expected until after the second year of deferment, their income flows are discounted over an 18-year period, and then discounted to present value.

In the last step of the analysis, present value of total added returns from this improvement are subtracted from present value of total added costs to find the net present value. The net present value over the 20-year life of the seeding without 75 percent cost-share results in a loss of $11,184; net return with cost-share is a positive $68,766. Therefore, the seeding appears to be a good investment if it is cost-shared.

Other Considerations

While net return and break-even value information provide important economic measures of the profitability of range improvements, other factors require consideration. Biological, ecological and production concerns should enter into the decision. A producer should know how a particular improvement affects present and future cash flow. Certain improvements may make it more difficult to meet financial obligations on time or restrict cash availabilty. Producers also need to consider whether sufficient cash is available to cover the large initial expenses required. Some improvements may be cost-shared through local Agricultural Stablization and Conservation (ASC) offices. This can help ease the initial investment problem. Finally, the effect of any range improvement on income taxes should be assessed, preferably by a competent agricultural tax accountant.

Several sources of assistance are available to producers. Colorado State University Cooperative Extension and USDA-Soil Conservation Service personnel can help estimate and quantify the expected benefits of improvement practices and provide technical assistance for planning and implementation.