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Economic Evaluation of Stockwater Development Practices on Mountain Cattle Ranches in Utah

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ECONOMIC EVALUATION OF STOCKWATER DEVELOPMENT PRACTICES ON MOUNTAIN CATTLE RANCHES IN UTAH

by

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INTRODUCTION

The state of Utah is comprised of 52.7 million acres of land of which 86 percent is covered by range vegetation. (12) This rangeland provides part or all of the feed for approximately 430,000 head of cattle and 1,300,000 sheep. (9) Rangeland products constitute from 33 to 40 percent of the agriculture income within the Intermountain Region. (10) Utah's vast rangeland area represents a basic resource of considerable importance to her economy.

Utah's rangeland characteristically is not abundantly supplied with available water. In recent years water development has become an important part of range management programs and it is likely to increase with the passage of time. Several factors may contribute to this trend. (1) The drought condition which has prevailed in Utah during recent years has had a serious effect on water supplies. Water development has become a necessity to maintain an efficient ranch operation. (2) Costs to the rancher have been increasing while prices have been declining. A means whereby he can maintain or increase his income is a prime consideration. Water development represents a possibility for investment at favorable returns. (3) Development of new grazing lands through range revegetation programs might profitably be complemented by some type water development. (4) Development of new materials and ways to provide stockwater has given ranchers new opportunities for water development in extremely limited situations.

A rancher who contemplates the cost of water development might ask of its economic feasibility. Will it pay for him to make this type of investment? It is not enough, however, to know an investment will pay. He should have some idea of the expected rate of return on investment to compare it with that of other range improvement practices and alternative investments.

Review of Literature

Information previously written on stockwater development has been principally of a descriptive nature with emphasis on the methods and procedures of development. A publication by the Virginia Extension Service explains the process of developing small springs and seeps. (13) Brief details of material specifications and methods of installation are discussed. Some information pertaining to concrete watering tanks is also given.

A publication from the University of Wyoming Experiment Station has information on reservoirs for range stockwater. (2) It contains instructions on locating reservoirs, detail of construction, and illustrations of the type of reservoirs used. The University of Wyoming Extension Service also has a publication on sealing farm ponds and reservoirs with the use of bentonite. (11) Details of the sealing procedure and its efficiency are discussed in the paper.

A publication by the Oklahoma Extension Service has information on wells for supplying irrigation water. (4) The circular discusses underground water, specifications and drilling, and the development process, pumping costs, and expected life of wells.

The use of a budgeting procedure has been supported by Heady (6) for use in situations where costs and returns have been predicted. This type of analysis is used in this study on stockwater development. The internal rate of return analysis as a means for deciding the profitableness of range improvement practices has been used by Gardner (5) and supported by discussions from Alchian (1) Lorie and Savage, (7) and Dean. (3)

Economic Framework and Conceptual Solution

A rancher contemplating water development is concerned with the extent of development that will give the highest net return. To determine the extent of development offering profit maximization, the rancher must look at the total cost of each development in relation to the expected revenue from each. Development to the extent that addition to expected revenue from the last development is equal to addition in total cost, defines the point of highest net return. Graphically the theoretical framework of the problem assumes the form outlined in figure 1.

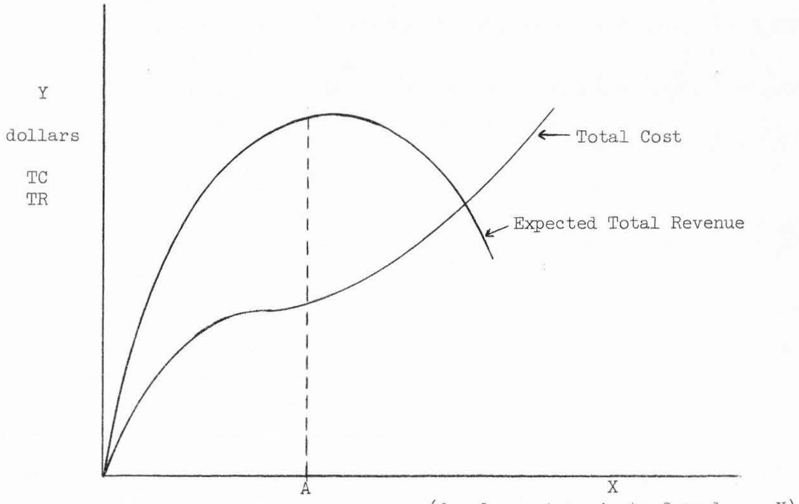


Figure 1. Extent of development for profit maximization from total functions

Total cost of development incurred by the ranch is shown by the (TC) function in figure 1. This function increases at a decreasing rate for each project until the most likely possibilities of development have been initiated or diseconomies of scale in development are met, after which the less likely development possibilities are initiated so total cost increases at an increasing rate. Total costs include the cost of initial investment plus all variable costs including annual maintenance and operation.

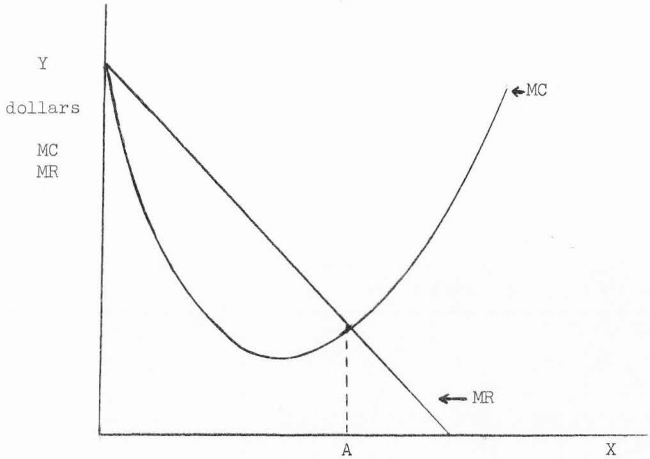
Returns from the various investments are represented by the expected total revenue function (figure 1). The shape of this function is dependent on the expectations of the ranch. A rancher will rationally invest in a succession of developments offering the greatest expected profit so the expected total revenue function begins with a steep slope and gradually becomes flater with each successive development. A point is reached in which the revenue from each successive development is negative so the total expected revenue function turns down. Negative marginal returns on investment in stockwater development results when such a high level of development projects occur they interfere with the production and operation of the ranch.

A rancher's expected revenue from development may come from such benefits as increased animal unit months on the range, increased weight production per animal unit, decreased death loss, decreased labor requirement or decreased non-range supplement feed requirement.

A rancher motivated by profit maximization will develop to the extent where the difference between total cost and expected total revenue is greatest. Graphically this would be development to a point where the greatest distance exists between the total cost and expected revenue curves, or where the additions to total cost are equal to the expected additions to total revenue Point A (figure 1).

Geometrically the point of profit maximization may be shown by marginal analysis as depicted in figure 2. The marginal cost of development decreases as the total cost increases at a decreasing rate. As the total cost function reaches a point of inflection from increasing at a decreasing rate to increasing at an increasing rate, marginal cost starts upward and increases with each development as shown by the (MC) function in figure 2.

Because rational ranchers first develop the projects with highest expected profitability, marginal productivity diminishes with each development as shown by the (MR) function. Marginal return is positive until the expected total revenue function turns down, after which it is negative. Intersection of the two functions denotes the extent of development at which profits can be maximized (Point A) since at that point the marginal costs and marginal revenues are equal.



x = (development projects from 1. . .N)

Figure 2. Function depicting profit maximization, marginal analysis

Empirical Problems

Conceptually the situation is viewed as a continuous function, although the variables are of a discontinuous nature. That is, addition of the variable factor is possible only in a complete form such as one, two, or three springs or wells. When looking at this situation from an economic standpoint, the same set of principles and logic applies to continuous as well as discontinuous inputs. The use of continuous principles eliminates the need of refinements which would eventually reach the same decision. (6)

Reliable benefit data over the complete range of possible development may be difficult to obtain. The difficulty of measuring benefits and the limited instances of development make accurate quantifications difficult.

Estimates of the expected benefits are important because they determine the shape of the expected revenue curve and consequently influence the extent of development feasible. Expectations may vary greatly between ranchers. The type of development possible on each ranch and the relative amount of benefit gained from each development may show some variation.

Objectives of Study

1. To determine the costs of selected water development practices.
2. To investigate the type of benefits resulting from selected water development practices.
3. To determine the economic impact of various water developments on the typical size ranch operations.

Empirical Procedures

A small and medium size typical mountain cattle ranch was constructed in 1961 by Dr. N. K. Roberts. (8) These ranches were adjusted to 1962 price levels and will serve as the basic ranch organization for this study. Adjustment was accomplished by the use of appropriate index numbers of product and factor prices as determined by the United States Department of Agriculture. The two size ranches were constructed by using the number of breeding cows as an indicator of size. Two ranch types were selected - "small" and "medium". The small size includes ranches with 48 breeding cows in the beginning inventory. When all animals making up the herd were converted to animal units (AU's), the small ranch had 95 AU's. The medium ranch has 150 breeding cows or 240 AU's. The small ranch represents the modal class in the distribution and the medium size was introduced to investigate scale effects on income (if any) for this type ranch.

A purposive sampling procedure was used to obtain data from ranchers who had completed various types of water development. Physical data as well as cost and actual benefits were obtained from personal interviews with the ranchers. Cost data was supplemented by information from retail agencies handling items used in stockwater developments. Additional cost and physical data for selected water development practices were obtained from offices of the Agricultural Stabilization and Conservation Service, the Bureau of Land Management, and the United States Forest Service.

The various water development alternatives were incorporated into the financial structure of the typical ranches through use of a budgeting procedure. Annual operating costs for the typical ranch were adjusted to show the economic impact of the development practices.

Assuming a market rate of interest at 7 percent and using the costs of development and typical maintenance and operating costs, the annual net cash flow necessary to pay back the investment plus the interest is determined. Internal rate of return analysis is further used to calculate rates of return for actual water development practices.

Further empirical procedures used in constructing the typical ranches will be discussed in the next section of the paper.

Assumptions

It is assumed in this study that sufficient information is available to select a typical ranch situation that will be applicable for ranchers of the mountain type, and the various selected water developments incorporate typical characteristics in a manner to provide useful information to ranchers. The study is limited to primary developments in the manner of springs or seeps and stockwells. Each improvement practice will consider the initial development as well as a means of conveying and storing the water.

A static ranch operation is assumed in which there is no change in inventories of livestock, equipment, or buildings and improvements between the beginning and end of the year. The ranch is a cow-calf-yearling type operation with the alternative levels of cattle prices being 1962 Ogden prices.

In contemplating a water development project, a certain amount of risk is involved pertaining to success of the project. For this study it is assumed that the stockwater development practices are of a successful nature. That is, the amount of water obtained is sufficient for the operation, and of a quality desirable to livestock. The life of the various water development projects is assumed to be 20 years which is consistent with information from the survey. Benefits would accrue and maintenance costs are incurred proportionately over the 20 year period.

Order of Presentation

The order of presentation for the remainder of the study will be: First, a description of the two typical Utah mountain type cattle ranches. This includes a description of the physical characteristics, management characteristics and the internal structure. Secondly, a description of the various stockwater development practices used on these ranches. The third section is the economic impact analysis in which the costs are budgeted into the financial structure of the ranch to determine the necessary economic adjustments to make the development feasible. Fourth, a discussion of the type of benefits to be expected, derivation of the necessary net cash flow over time to make development feasible and actual examples of benefit measurement by calculating an internal rate of return on investment. The final section is a summary and conclusions drawn from the study.

ORGANIZATION OF TYPICAL MOUNTAIN CATTLE RANCHES[1]

Mountain cattle ranches are located throughout Central Utah in the area of the high Wasatch and Uintah mountains. These ranches are organized primarily with privately owned land but permits are held to graze public land administered by the United States Forest Service during the summer months.

Physical Setting

The general physical features of mountain ranches vary throughout the area. High mountain peaks and plateaus with lush valleys and meadows throughout sets the area as unique. Elevation ranges from 4,500 feet in some of the lower valleys to 14,000 feet at the peaks. Cattle grazing takes place at elevations all the way from 4,500 feet to as high as terrain and vegetation will permit. Topography varies from flat valley floors to gentle slopes and on to the steep, rugged mountains. Soils range from deep heavy clays and sands in the valleys to coarse gravels on the benches to shallow, rocky soils at higher elevations.

Relatively short growing seasons, high rainfall, and heavy snow covers are common. Farming and early grazing at lower elevations begin in late April and early May. Areas at mid elevations provide grazing in June but the snow pack at higher elevations prevents entry until July.

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1 The descriptions used here are extracted from a paper written by Dr. N. K. Roberts titled, Mountain Cattle Ranches--Economic Organization and Adjustments to Grazing Fee and Permit Changes, (unpublished). Some revisions have been made and the ranches adjusted to 1962 prices. (8)

Grazing is permitted on mountain ranges to early October after which the milder climates in the valleys encourages use of meadows and crop residues.

Precipitation ranges from 8 inches a year at lower elevations to over 40 inches in the higher mountains. The most common range being between 12 and 30 inches a year. Most of the precipitation is in the form of snow. Heavy snow packs at high altitudes provide the water for numerous streams which keep the valley green through irrigations.

Vegetative cover is as heterogeneous as topography and climate which makes it attractive to livestock producers. Within relatively close proximity, introduced forages and grain are produced for winter and supplement feeding; seasonal grasses, shrubs and forbs become available on adjacent slopes as the growing season progresses. Varieties of grass, shrubs and forbs are numerous and change with elevation, slope, and climatic variations. Tree density increases with elevation, terrain type, soil type, and climate.

Ranch Sizes

Sizes of typical mountain ranches tend to be relatively small. A frequency distribution is highly skewed with the modal size being about 50 breeding cows. Available data indicate that only a few ranches of this type exceed 500 breeding cows.

Dependency on Public Lands

Typical mountain cattle ranches depend on land administered by the Forest Service for about 22 percent of the annual feed requirement. The balance of required feed is met by feeding (58 percent) and grazing (20 percent). These ranches do not typically use land administered by the Bureau of Land Management.

Management Characteristics

In general, management practices are similar for both typical ranch sizes. A cow-calf-yearling type operation is predominant. Cows are bred to calve in the period from March to July. Cows, calves, and bulls graze Forest Service lands from June to October. The breeding period extends from June to November. Early calves are sold during October and November when they come off the forest. Some calves are fed on the farm during the fall and winter then sold in March and April. Cows are culled after coming off the forest and again before going on the next season. Private ranges and meadows are grazed heavily in the spring and late fall. Crop aftermath grazing occurs in the late fall. Alfalfa, barley, and corn silage is produced to winter all stock. Sale of irrigated farm crops is only a minor source of income.

Livestock Inventories and Investment

Herd inventories include mature cows, bulls, replacement heifers (coming two years), steer and heifer calves (coming one year), and saddle horses. (Appendix A, table 16) The investment in bulls and horses is considered as one-half of replacement costs because they are capital investments and assumed to be at half life. All other livestock are valued at 1962 Ogden price levels for class and grade. Bulls were depreciated on the basis of four years and horses eight years.

Land Inventories

Land inventories include irrigated cropland, native and improved grass, and rangeland. (Appendix A, table 17) Native and improved grass and hayland were impossible to separate so they were included as one category. Alfalfa, barley, and corn for silage were the dominate cultivated crops. Typically neither size ranch operated with leased land.

Buildings and Improvements

Investment in buildings and improvements for the medium size ranch was nearly twice that of the small ranch. A list of typical items and average investment is contained in Appendix A, table 18 and 19. Physical descriptions for buildings and improvements were obtained from the survey. Average inventory value is 1962 replacement cost divided by two since these facilities are on the average at half-life for the population.

Ranchers operating mountain type cattle ranches in the sample area typically live in towns located in the valleys. Dwellings were therefore excluded from the building inventory.

Depreciation was calculated according to the straight line method. Barns were typically in an older condition so they were assumed to be depreciated out and no depreciation charge was made. Repair charges are based on information from the survey and secondary sources.

Machinery and Equipment

Mountain cattle ranches are oriented toward livestock operation which causes a relatively low investment in machinery and equipment. (Appendix A, table 20 and 21) This was partly due to the older type condition of the machinery and equipment on the ranches. Inventories include such items as tractors, trucks, pickups, and cars. Standard haying equipment includes mowers, tractors, side delivery rakes, balers, and wagons. Tillage and other cropping equipment consisted of plows, disks, harrows, ditchers, and manure spreaders. Inventories also included livestock handling equipment and small tools used on the ranch.

Medium ranches typically had about $1,100 more invested in machinery and equipment than small ranches. The typical medium ranch had a one and one-half ton truck, a used type tractor, and additional smaller equipment which were not typical on the small size ranch.

Average investment was based on 1962 replacement costs divided by two. A straight line method was used to calculate depreciation. Repairs and operating costs were based on survey data and supplemented by secondary sources.

Summary of Investment

Total investment includes the value of the land (including grazing permits), buildings and improvements, machinery and equipment, and livestock (table 1). Land values were established by ranch, real estate, and credit agency surveys. Irrigated grass land was priced at $150 per acre; irrigated cropland at $250 per acre; and rangeland at $20 per acre. Grazing permit values were set from information gathered in the sample area. Forest Service permits were valued at $20 per animal unit month.

Table 1. Summary of investment by size for typical ranches, Utah, 1962

Item	Size of Ranch	
	Small (48 cows)	Medium (150 cows)
	dollars	dollars
Owned land	45,500	84,300
Grazing permits	5,200	11,600
Buildings and improvements	4,847	8,150
Machinery and equipment	8,263	9,360
Livestock	10,388	26,485
Total Capital Investment	74,198	139,895

Looking at investment in capital items per cow, the small ranch has a higher dollar per cow investment than the medium. The small ranch has a total capital investment per cow of $1,329 while the medium has $755. Capital investment per cow is 76 percent greater for the small ranch (table 2).

Table 2. Investment in capital items per cow for typical ranches, Utah, 1962

Item	Size of Ranch	
	Small	Medium
	dollars/cow	dollars/cow
Land	948	562
Grazing permits	108	77
Buildings and improvements	101	54
Machinery and equipment	172	62
Total Capital Investment	1,329	755

Labor Requirements

Total labor use for the two size ranches was seven man-months for the small and 20 man-months for the medium. (Appendix A, tables 22 and 23) The operator of a typical small ranch provides six months labor besides holding an off-farm job. Hired labor provided the additional one month at such busy times as the haying season. The typical medium size ranch operator provides 11 man-months labor with the additional nine man-months being hired seasonal labor during the months of July, August, and September.

Operator labor was charged at the rate of full-time hired help. All other labor was charged at the rate for seasonal employment.

Feed Sources

Livestock feeds (hay, silage, and barley) were all produced on the ranch. Total cash expenditures for feed amounted to the cost of salt and the cost of Forest Service permits. (Appendix A, table 24 and 25)

Livestock Production and Sales

Livestock production numbers and weights were obtained from the ranch survey. Livestock prices are 1962 prices for class and grade at the Ogden market, adjusted for assumed marketing costs. The prices used reflect normal net prices at the ranch. (Appendix A, table 26 and 27)

The only evidence of market weight difference between the two typical size ranches was in cows. The small ranch marketed heavier cows than the medium.

Crop Production and Sales

Typically ranchers produced irrigated crops primarily to supply their livestock feed requirements. Native and improved grass land production was utilized by the stock. Alfalfa hay, barley, and corn silage produced in excess of feed requirements was sold. Yields of production were obtained from the survey and prices are 1962 crop prices. (Appendix A, tables 28 and 29)

Annual Costs and Expenses

Costs and expenses of a typical ranch operation include those for which there is an actual cash outlay (cash costs) and those in which no direct cash payment is made (non-cash costs). (Appendix A, table 30) Cash costs include ranch operating expenses which have been transferred from previously discussed tables and other costs which were obtained from surveys of ranches, tax commissions and other agencies providing services to ranchers. Non-cash costs include depreciation, death loss of bulls and horses, interest on cash costs, operator and family labor, and interest on investment.

Death loss was figured as 5 percent of the average inventory value. Interest on cash costs were figured at 6 percent for a six month period while interest on investment is 5 percent per year of the total investment.

Ranch Income and Expense Summary

Using 1962 prices, total gross receipts for the small and medium ranches were $7,830 and $19,959 respectively, (table 3). Total ranch operating expenses amounted to $6,483 for the small ranch and $12,249 for the medium, leaving respective net ranch incomes of $1,347 and $7,710. When all costs including operator and family labor and interest on investment were included, return to management showed a loss of $4,553 per year for the small ranch and $3,300 for the medium.

Comparative Ranch Summary

Comparison between the two ranch sizes show a marked difference in production per animal unit. However, sales per AU were much closer, (table 4). The small ranch has greater beef production because it holds some of the steer calves and sells them as yearlings whereas the medium ranch sells them all as calves. Greater differences are noted in comparing the ranches on a per breeding cow basis. These variances are due to the differing herd compositions.

Considerable differences in total cost per AU and per breeding cow were noted. The medium sized ranch is in the most favorable position when looking at cash and non-cash costs. This difference is reflected in the net ranch income and the return to management where the medium ranch is the most favorable.

Table 3. Income and expense summary for typical ranches, Utah, 1962

Item	Size of Ranch	
	Small	Medium
	dollars	dollars
Receipts:		
Cattle sales	5,556	14,403
Crop sales	2,274	5,556
Total Ranch Income	7,830	19,959
Expenses:		
Cash costs	4,805	9,579
Non-cash costs	1,678	2,670
Total Operating Expenses	6,483	12,249
Net Ranch Income	1,347	7,710
Operator and family labor	2,190	4,015
Interest on investment	3,710	6,995
Return to Management	-4,553	-3,300

Table 4. Comparative summary of typical ranches, Utah, 1962

Item	Unit	Average/animal unit* 95 AU	240 AU	Average/breeding cow 48 Cows	150 Cows
Annual beef production	lbs.	296	268	585	429
Annual beef sales	dols.	58.48	60.01	115.83	96.02
Annual crop sales	dols.	23.94	23.15	47.38	37.04
Gross ranch income	dols.	82.42	83.16	163.21	133.06
Costs:					
Cash	dols.	50.58	39.91	100.10	63.86
Non-cash	dols.	17.66	11.13	34.96	17.80
Total costs	dols.	68.24	51.04	135.06	81.66
Net ranch income	dols.	14.18	32.13	28.06	51.40
Return to management	dols.	-47.93	-13.75	-94.85	-22.00

* Basis for calculation of animal units:

Cows. . . . . 1.0 animal unit
Heifers coming (2). . . .8 animal unit
Steers coming (1 yr). . .6 animal unit
Heifers coming (1 yr) . .6 animal unit
Calves under (6 mo) . . .4 animal unit
Bulls . . . . 1.25 animal unit
Horses . . . . 1.5 animal unit

Horses were not used in calculating the summary above.

STOCKWATER DEVELOPMENT PRACTICES

A survey of ranchers who have completed stockwater development practices served as a basis for constructing various type developments. Data over the range of possible development was limited so the typical characteristics that were noted have been used to construct various stockwater developments for several possible situations. The characteristics typical for each situation are discussed in conjunction with each case of stockwater development discussion.

Small Spring Development

Small type spring developments are used typically by ranchers on inaccessible or high areas of the range. The topography is steep and rough which greatly limits grazing use without adequate watering facilities. It has been found that harnessing low producing seeps could be very beneficial in these areas. A trickle of water as little as two quarts per minute, harnessed and stored would supply enough water for 35 head of cattle. (13)

Topography conditions necessitate that all development work be done manually and materials be packed into the area of the spring. Actual development work involves locating the spring and digging it back to a central source where a concrete collection box is constructed. Four inch tile pipe is often used to direct the water to the collection box. The concrete box is normally one and one-half feet square and three feet deep. A one and one-half inch galvanized pipe about 20 feet in length carries water from the box directly to a trough. Ranchers prefer long shallow bottom troughs for use in these areas. The spring area is fenced to keep stock from the immediate area. Because of the nature of the area where small springs are located, special precautions are taken by ranchers to locate the watering trough away from flood danger. A list of costs and materials for developing a typical small spring are contained in table 5.

Large Spring Development

Large spring developments are typically used in areas where spring and seep water is scarce. Water is developed at one point and conveyed over some distance to where it is used. It provides for more extensive use of range lacking in stockwater. Large spring developments include the initial development work, construction of a large capacity storage facility and laying inch plastic pipe from the source to the point of use. In this analysis, the distance is assumed to be one mile (5,280 feet).

A storage facility which provides a reliable structure at relatively low cost is a concrete watering tank. For use in this study, a 7,000 gallon concrete type storage tank has been planned. The structure is 25 feet square with sides 20 inches high. Six inch walls and a four inch bottom of steel reinforced concrete provides a reliable structure. It provides a watering facility near the spring site in which the cattle can drink directly from as well as storage to feed the pipeline which may have as many float controlled watering troughs as desired.

Plastic line is layed on a surveyed slope from one to three feet in the ground. Information from the study shows that Soil Conservation Service personnel often aid in laying the pipe correctly and obtaining the right slope. A caterpillar and a heavy ditcher is used for making and covering

Table 5. Development costs of a small spring, Utah, 1962

Item	Type	Size	Amount	Cost/unit	Total cost
				dollars	dollars
Machinery:					
Truck*	pickup		7 hrs.	3.00	21.00
Labor:					
Man			48 hrs.	1.50	72.00
Horses			6 hrs.	.75	4.50
Materials:					
Pipe	galv.	1 1/2 in.	20 ft.	.52	10.40
	tile	4 in.	9 ft.	.35	3.15
Cement			1 bag	1.50	1.50
Sand and gravel					1.00
Lumber	No. 2	2" by 12"	10 ft. (2)	.13/bd. ft.	5.20
Poles			12	1.00 ea.	12.00
Posts			8	1.00 ea.	8.00
Trough	shallow bt. 2' by 1'8" long				42.00
Misc. supplies					1.00
TOTAL COST					181.75

* Provides transportation to and from spring development

the pipeline trench. An itemized list of materials and costs for a typical large spring development is shown in table 6.

Stockwells

Characteristically stockwells have a six inch casing drilled to a depth of from 100 to 300 feet. The amount of water desired, height of lift and source of power available determine the manner in which the well is equipped. This necessitates, that for illustration, several different types of stockwells be planned. Each type is equipped according to the above criteria.

High storage capacities at wells is desirable to reduce too frequent pumpings and make a project more dependable. Many types of storage facilities are used, with some being very inefficient because of high water loss. The 7,000 gallon concrete storage tank planned earlier provides adequate storage for the type I, II, and III stockwells. The type IV stockwell is powered by the wind which is not always dependable, so a larger storage capacity is desirable. Ranchers with these type developments commonly have a storage facility with galvanized steel sides and a concrete bottom. The facility is quite easily constructed in relatively isolated and rough areas. The side sheets are bolted together to form the ring in which concrete is then poured to cover the bottom. At least four inches concrete is desirable in the bottom for safe storage. The storage facility planned in the type IV stockwell development has a 31 feet diameter circular ring, three feet high with a four inch concrete bottom. The facility has a capacity of over 14,000 gallons which should be adequate for this type development.

The installation charge made on all stockwells assumes the dealer of

Table 6. Development costs of a large type spring, Utah, 1962

Item	Type	Size	Amount	Cost/unit	Total cost
				dollars	dollars
Machinery:					
Caterpillar	D-2		55 hrs	3.00/hr	165.00
Truck*	pickup		15 hrs	3.00/hr	45.00
Labor:					
Man hours			150 hrs	1.50/hr	225.00
Materials:					
Pipe	plastic	1 in.	5280 ft	.09/ft	475.20
	tile	4 in.	12 ft	.35/ft	4.20
	galv.	1 1/2 in.	40 ft	.52/ft	20.80
Cement			2 bags	1.50/ea	3.00
Sand and gravel					2.00
Poles			12	1.00/ea	12.00
Posts			4	1.00/ea	4.00
Trough	steel	395 gal.			52.00
Float valve assembly					5.00
Fittings					10.00
Misc. supplies					10.00
Storage facility**	concrete	7,000 gal.			320.00
TOTAL COST					1,353.20

* Provides transportation to and from spring development

** Includes the following costs of constructing watering tank:

Redi-mix concrete. . .	11 yds. at $15/yd.	165.00
1/2 in. reinforcing rod	450 lbs at $13.30/cwt	60.00
Labor	50 hrs at $1.50/hr	75.00
Transportation		20.00
		320.00

the pumping equipment makes the installation at contract price. This charge varies with the distance from the place of business so it is assumed that the distance be about 50 miles.

Type I stockwell

The well designated as Type I, has a six inch casing drilled to a 100 foot depth. Water is lifted 50 feet to the storage facility by a power pump jack. The pump jack is driven by a 2 Hp gasoline engine. This type pumping setup will give dependable shallow well pumping service. Table 7 contains a list of costs and materials for this type stockwell.

Type II stockwell

The well designated as Type II has a six inch casing drilled to a 250 foot depth. Water is lifted 150 feet to the concrete storage facility. Electricity is available in the area and provides an excellent power source so the well is equipped with a 1 Hp submersible type pump.

The cost to the rancher of installing electricity to a well site depends on many variables. Such variables as: length of line, whether line is straight or curved, whether well is used for both household and livestock purposes, amount of annual electricity use expected, cost of right-of-way if any, and general topography of country have an effect on price to the rancher. For illustration it is assumed the electric line installation is approximately 1/4 mile at a cost to the rancher of $595. It is possible for ranchers contemplating a power source to get an estimation of electricity installation cost from the power company.

A list of costs and materials for a Type II stockwell is contained in

Table 7. Development costs of a type I stockwell, Utah, 1962

Item	Type	Size	Amount	Cost/unit	Total cost
				dollars	dollars
Drilling well*		6 in.	100 ft.	6.00/ft.	600.00
Equipping well:					
Power pump jack					219.00
Cylinder		3 1/2 in.			40.00
Engine		2 hp.			45.00
Drop pipe	galv.	2 in.	50 ft.	.71/ft.	35.50
Pump rod	steel	1/2 in.	50 ft.	.25/ft.	12.50
Installation**					200.00
Misc. supplies					20.00
Storage facility***	concrete	7,000 gal.			320.00
TOTAL COST					1,492.00

* Includes cost of pipe and drilling

** Contract installation cost 50 miles from dealer-installer place of business

*** Includes labor, materials, and transportation for constructing facility (table 6) Charge does not include purchasing concrete forms.

table 8.

Type III stockwell

The type III stockwell also has a six inch casing drilled to a 250 foot depth and is pumping from 150 feet. Electric power is not feasibly available in the area necessitating use of another source of power to drive the pump. The project includes a 3 Hp gasoline type engine with a reciprocating type pump. This unit has proven to be a reliable deep-well unit and will deliver over 400 gallons water per hour. Table 9 contains a list of costs and materials for developing a type III stockwell.

Type IV stockwell

The well designated as type IV has a six inch casing drilled to a 300 foot depth. Pumping is required from a 200 foot level. The stockwell is located in a quite isolated area of the range so a pumping unit requiring little maintenance and operating requirement is desirable. Utilization of the wind as a source of power to drive a windmill provides an installation that would work well in this situation. A reliable pumping unit includes a 12 foot diameter windmill situated on a 27 foot tower. The unit includes 2 1/2 inch galvanized drop pipe in which is run the wood pump rod to the working barrel. This type setup greatly simplifies the changing of the leathers so it is desirable in deep well units of this type.

With an adequate water storage facility available, this type unit will provide economical and durable service for a long period of time. The water storage facility planned in the project is a galvanized steel tank with a concrete bottom. The facility has a capacity of over 14,000 gallons which is adequate for the number of cattle on the typical ranches

Table 8. Development costs of a type II stockwell, Utah, 1962

Item	Type	Size	Amount	Cost/unit	Total cost
				dollars	dollars
Drilling well*		6 in.	250 ft.	6.00/ft.	1500.00
Equipping well:					
Pumping unit	submersible	1 hp.			310.00
Electric wire			150 ft.	.24/ft.	36.00
Well seal		1 in.			9.35
Pipe	galv.	1 in.	150 ft.	.35/ft.	52.50
Pump installation**					200.00
Electricity installation***					595.00
Storage facility****	concrete	7,000 gal.			320.00
TOTAL COST					3,022.85

* Includes cost of pipe and drilling

** Contract installation cost 50 miles from dealer-installer place of business

*** Assumes the distance electric line must be run to provide service 1/4 mile The $595 cost figure is provided by the area power company for the conditions and situation of this well.

**** Includes labor, materials, and transportation for constructing facility (table 6) Charge does not include purchasing concrete forms.

Table 9. Development costs of a type III stockwell, Utah, 1962

Item	Type	Size	Amount	Cost/unit	Total cost
				dollars	dollars
Drilling well*		6 in.	250 ft.	6.00/ft.	1500.00
Equipping well:					
Pumping unit	Reciprocating				186.00
Engine	4 cycle	3 hp.			57.60
Pump rod	Wood/galv.	1 1/8 in.	150 ft.	.40/ft.	60.00
Cylinder		2 3/4 in.			44.00
Pipe	galv.	2 in.	150 ft.	.71/ft.	106.50
Installation**					200.00
Storage facility***	concrete	7,000 gal.			320.00
TOTAL COST					2,474.10

* Includes cost of pipe and drilling

** Contract installation cost 50 miles from dealer-installer place of business

*** Includes labor, materials, and transportation for constructing facility (table 6). Charge does not include purchasing concrete forms.

used. Costs and materials for developing a type IV stockwell are summarized in table 10.

It is intended that one of the above water development practices typifies particular ranch situations. A rancher is best aware of his own situation and can adapt a particular plan to his immediate water needs.

Table 10. Development cost of a type IV stockwell, Utah, 1962

Item	Type	Size	Amount	Cost/unit	Total cost
				dollars	dollars
Drilling well*		6 in.	300 ft.	6.00/ft.	1800.00
Equipping well:					
Windmill		12 ft.			476.00
Tower		27 ft.			254.00
Working barrel	2 1/4 in. by 25 in.				40.80
Drop pipe	galv.	2 1/2 in.	200 ft.	1.00/ft.	200.00
Pump rod	wood	1 1/8 in.	230 ft.	.42/ft.	96.60
Misc. equipment**					50.00
Installation***					300.00
Storage facility****	galv. steel concrete	14,000 gal.			473.00
TOTAL COST					3,690.40

* Includes cost of pipe and drilling

** Additional material for equipping well: stuffing box, pump standard, and etc.

*** Contract installation cost 50 miles from dealer-installer place of business.

**** Includes the following costs for constructing watering tank:

Bottom-less tank.	31 ft. diameter . . . 3 ft. high	223.00
Freight		40.00
Redi-mix concrete . . .	10 yds at 15.00/yd	150.00
Labor	40 man hours at 1.50/hr. . .	60.00
		$473.00

TYPICAL RANCH BUDGET ADJUSTMENTS

Investment in a water development project causes certain adjustments in the typical ranch budget. The initial cost of water development is considered as an improvement and is depreciated over the expected life of the project. Information from the survey indicated expected life of projects to be around 20 years which is the assumed expected life for this analysis. The project would not be valueless after this 20 year period but it is assumed that at this time certain installations of the project would have to be replaced. The use from the initial investment would be gained and the rancher would have to invest more. Depreciation costs appear in depreciation charges for buildings and improvements in the non-cash section of annual operating costs (Appendix A, table 30).

Besides the original development cost, a rancher's operating costs will be increased by annual maintenance and operating charges resulting from use of the development. This cost appears in the cash cost section of total annual operating costs (Appendix A, table 30).

Annual Operating Cost Changes

Total annual operating costs for the typical ranches before development were $6,483 for the small ranch and $12,249 for the medium as shown in Appendix A, table 30. Table 11 is a summary of adjusted annual operating costs for Appendix B, tables 31, 32, 33, 34, 35, 36, and the net increase resulting from the various type water developments.

Variation in increased annual operating costs between the small and

Table 11. Summary of adjusted annual operating costs and net increase resulting from the various type water developments, Utah, 1962

Type Water development	Adjusted annual operating cost Ranch size		Net increase Ranch size	
	Small	Medium	Small	Medium
	dollars	dollars	dollars	dollars
Small spring	6,502	12,269	19	20
Large spring	6,572	12,338	89	89
Type I stockwell	6,726	12,544	243	295
Type II stockwell	6,774	12,549	291	300
Type III stockwell	6,792	12,631	309	382
Type IV stockwell	6,678	12,445	195	196

medium ranch for a small type spring and the Type IV stockwell was due to whole dollar rounding. Variation in annual operating costs between the ranches for Type I, II, and III stockwells was due to greater cost of operation on the medium ranch because of a greater water requirement.

Although the Type IV stockwell which was powered by a windmill, represented the highest initial investment, its increased annual operating cost was lowest for all wells. This was due to the low cost of operating and maintaining a windmill setup. Once the windmill is equipped, annual operating costs amounted to just oiling and minor repairs. Whereas the other type stockwells require operation payment for the power source they are using. The main increased operating costs of a Type IV stockwell are depreciation of the improvement.

For water development to be economically feasible, a rancher's total annual benefits would have to be equal to the change in annual operating costs plus the yearly compounded interest on investment.

BENEFITS FROM STOCKWATER DEVELOPMENT

The actual benefits that can be attributed solely to water development are numerous but in most instances difficult to measure. While many benefits may be readily apparent, ranchers experience difficulty in attaching quantitative estimates to them.

Ranchers who had water developments were asked to make estimates of conditions before and after development on such items as: animal unit months (AUM's) carried on the range, weaning weight of calves, and also weight of cows as they came off the particular range, death loss, labor requirement, non-range feed and salt requirement, and any additional benefits.

Results of the survey were seriously limited because only a few ranchers could state measureable before and after changes. Actual rancher estimates of benefits from stockwater developments were obtained for use in the internal rate of return analysis. Only three ranchers were willing to give such quantitative estimates. A small type spring development (5 springs) showed an estimated increase in calf weaning weight of 10 pounds, an increase in cow weight of 50 pounds, and an increase of 270 AUM's derived from the development. Another, a large type spring development (2 springs), shows an increase of 147 AUM's gained on the range from the development. The third, a Type II stockwell, shows benefits of 225 AUM's and 25 pounds increased weaning weight per calf.

The comment most frequently given by ranchers was that stockwater development gave better stock distribution on the range. This resulted in both the stock and the range being in better condition. It increased such measurable items as AUM's on the range and weight increase per animal unit (AU). It further benefited the range, in that areas of over grazing were reduced and the overall range was in an improving condition. No attempt was made in this study to measure these forage improvement benefits although they should eventually show up in increased AUM's or increased weight per AU.

Additional AUM's resulted from conditions where the development brought new range into use or where a rancher was able to hold his stock on the range for a longer period because of a more adequate water supply. Increased weight per AU often resulted because the distance cattle had to travel for water was reduced. This additional weight was evident in the cow as well as the calf.

A well developed stock watering system resulted in a much more dependable and handier operation. There were conditions where the labor requirement was reduced because of the development. This might be in less time spent for stock supervision or under conditions where stock water was being hauled to the cattle and this job was eliminated.

Stockwater development is used many times in conjunction with other improvement practices. There were instances of well developed watering systems making it possible to fence a range into pasture. Fencing practices have proven very beneficial to the range but how much benefit to attribute the necessary water development is not known. Water development is also used many times to get better utilization from range vegetation programs. The water development complements the range improvement but its actual benefit is difficult to calculate.

Internal Rate of Return[1]

In deciding whether to invest in a water development, a rancher should be concerned with the economic yield on investment. The "internal rate of return" analysis as presented by Dr. B. D. Gardner (5) provides a valid criteria for determining the profitability of range improvement practices.

To explain the internal rate concept, we assume an hypothetical water development situation as depicted in figure 3. The rancher is at time period 0 and must decide whether or not to invest C dollars in a stockwater development project this year. If the project is initiated, it is assumed that it will yield an annual increase in gross returns of R dollars which will last for n years. The added expense of operating and maintaining the development is represented by E dollars for n years. Without the improvement, the returns from the range would be equal to Q over the project life or N years. The ordinal distance, S, is the total annual returns after the improvement practice. Area X represents the increased net returns that result from the improvement; that is the annual values of R dollars for n years minus E dollars for n years (area Y). Area W is captured whether or not we improve and is, therefore, irrelevant in the improvement decision. Area X minus the sum of the investment C appears to be the profit from the improvement. This is not the case, however, since the time problem must be

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[1] Analysis adapted from paper by Dr. B. D. Gardner, The Internal Rate of Return and Decisions to Improve the Range. (5)

accounted for.

Unless cost and returns value streams are expended and received respectively over equivalent time periods, they are not directly comparable for purposes of making economic decisions. In the example it is assumed that investment costs are incurred in the present year as the improvement is made. However, annual costs of operation and maintenance as well as returns are realized each year for as long as the project lasts.

The value streams can be made comparable by discounting them to the present. An investment outlay of C dollars is assumed in the present year and thus has a present value of C dollars. This outlay is assumed to produce a series of future annual incomes of R dollars for n years minus E dollars for n years, all discounted to year 0. Using the internal rate of return calculus, the economic yield of C dollars will be the compounded rate of interest, which makes the present value of area X equal to C as illustrated in table 14. It is this rate of interest which makes the present value of costs and returns equal, and is called the internal rate of return.

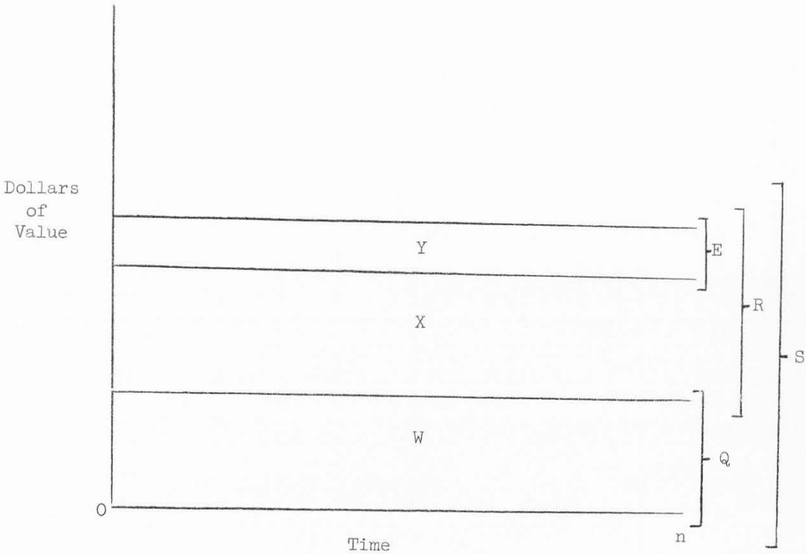

Figure 3. Hypothetical water development situation

Formula Presentation

The water development situation may be demonstrated by the following formula:

$$C = (R - E) \left[\frac{1-(1+i)^{-n}}{i} \right]$$

Where:

C = the initial investment cost

R - E = annual value of net returns due to project

i = the internal rate of return

n = the expected life of the project

The internal rate of return (i) may be solved for by use of a present value table. Calculating by the trial and error method, gives the rate of return that equates the present value of the expense and returns stream.

In the absence of adequate benefit data, two approaches are used for viewing benefits. One method makes use of various development costs to determine the annual increased returns necessary to pay back the initial investment with the market rate of interest of 7 percent. The other method of viewing benefits uses estimates from actual water developments to calculate internal rate of return on investment.

Analysis of Benefits From Stockwater Development

Based on various development costs

Table 12 illustrates analysis by using development costs and a present value table. The cost of developing a small spring (table 5) is incurred in year 0 as shown in column 2 at $182.00. The increased cost of maintenance incurred each year over the life of the project is $10. Assuming the borrowing rate of interest to be 7 percent, what is the annual increased returns necessary to yield a 7 percent internal rate of return? In this case an annual return of $27.15 is necessary to make the project feasible and yield a 7 percent return. Table 13 shows the increased returns necessary to accomplish these conditions for the various stockwater developments on the typical ranches.

Table 12. Annual increased returns necessary to make investment in a small spring feasible and cover the borrowing rate of interest (7 percent), Utah, 1962

Year	Increased costs	Increased returns	Net cash flow	Present value of a dollar (7%)	Net present value
	dollars	dollars	dollars		dollars
0	182.00				
1	10.00	27.15	17.15	.935	16.04
2	10.00	27.15	17.15	.873	14.97
3	10.00	27.15	17.15	.816	13.99
4	10.00	27.15	17.15	.763	13.09
5	10.00	27.15	17.15	.713	12.23
6	10.00	27.15	17.15	.666	11.42
7	10.00	27.15	17.15	.623	10.68
8	10.00	27.15	17.15	.582	9.98
9	10.00	27.15	17.15	.544	9.33
10	10.00	27.15	17.15	.508	8.71
11	10.00	27.15	17.15	.475	8.15
12	10.00	27.15	17.15	.444	7.61
13	10.00	27.15	17.15	.415	7.12
14	10.00	27.15	17.15	.388	6.65
15	10.00	27.15	17.15	.362	6.21
16	10.00	27.15	17.15	.339	5.81
17	10.00	27.15	17.15	.317	5.44
18	10.00	27.15	17.15	.296	5.08
19	10.00	27.15	17.15	.277	4.75
20	10.00	27.15	17.15	.258	4.42
TOTAL NET PRESENT VALUE					181.41

Table 13. Annual increased returns necessary to make stockwater developments feasible and cover the borrowing rate of interest (7 percent), Utah, 1962

Type development	Ranch Size	
	Small	Medium
	dollars	dollars
Small spring	27.15	27.15
Large spring	148.00	148.00
Type I stockwell	304.00	354.00
Type II stockwell	421.00	429.00
Type III stockwell	413.00	484.00
Type IV stockwell	358.00	358.00

Based on actual water development projects

Present value tables may also be used to calculate the internal rate of return from actual stockwater developments. Table 14 illustrates the internal rate of return for a rancher who has invested in (2) large type springs. Total development cost of the springs are incurred in year 0 under increased costs of $2,210. The physical features of the springs are similar to the typical large springs (developed earlier) although their average development cost is about $250 per spring less, which is due to the difference in length of pipeline and size of storage facility. Increased costs of maintaining the springs are incurred yearly over the life of the project at $40. Estimations by the rancher of before and after development conditions showed total annual benefits to be an increase of 147 AUM's. When figuring an AUM at $3.50, the total annual increased return amounts to $515. Subtracting yearly increased costs of $40 from the yearly increased returns leaves a yearly net cash flow of $475. The internal rate of return is determined by finding the interest rate which provides the discount factors that when multiplied by the net cash flow yields a total net present value equal to the development cost in year 0. A present value of a dollar interest rate of 21 percent yields a total net present value of $2,216. This figure equates total net present value to development costs in year 0, so the internal rate of return on investment is 21 percent.

The assumption of expected project life to terminate at year 20 with expected costs and returns occurring constantly until that time are for analytical purposes only (table 14). Returns could be expected to increase gradually during the early years of the development. Expected costs would also act in this manner, increasing in later years when the project becomes older and requires more maintenance. Figuring increased costs and returns as constant over time offsets the assumption of the projects usefulness terminating abruptly. By the analysis, no expected returns accrue after the end of the expected life. This is not the case, however, because returns would not end abruptly but might eventually taper off gradually. We must for this analysis work only to a certain point.

Table 15 shows the internal rate of return for three actual water developments. To show variation in expectations, different assumptions are used. This is because in calculating internal rates of return, an expected length of life for the project and prices of benefits over its life must be assumed. The survey showed expected life of these projects to be at least 20 years. However, for illustration an internal rate is calculated at 15 years expected life. Returns over the project life are valued at constant 1962 prices so to present a case where expected prices might change over time, an internal rate is calculated for a reduction in price of $1.00 per hundred for cattle and $.25 per AUM.

The examples of internal rate of return on investment for various water developments are very favorable. Present value tables were not available for internal rates of return over 50 percent so those in excess are shown to be "over 50 percent". These rates of return seem unreasonably high and cannot be expected for all developments. The relative situation has much to do with the amount of benefit possible. In cases where lack of stockwater limits the usefulness derived from a range, extremely high rates of return are possible. The cases of stockwater development used in the internal rate of return analysis are examples in which development has been vital to gaining use of the range. No doubt there are areas of Utah in which water development must precede livestock utilization. It is in these areas that high rates of return on investment are possible.

The cost of the water developments we have considered have been assumed to be paid by the rancher. However, these practices are eligible for (ACP) cost-sharing payments. The maximum Federal cost-share is 50 percent of the actual cost of excavating earth, rock, and gravel plus 50 percent of the actual cost of materials in the permanent structure for springs or seep development. Maximum Federal cost-share for constructing livestock wells is 50 percent of the actual cost of drilling and casing, and 50 percent of the actual cost of a permanent water storage facility. Rancher participation in these Federal programs greatly reduces the investment cost to him thus increasing his internal rate of return on investment.

Table 14. Determining the internal rate of return for a large type spring development (2 springs), Utah, 1962

Year	Increased costs	Increased returns	Net cash flow	Present value of a dollar (21%)	Net present value
	dollars	dollars	dollars		dollars
0	2,210				
1	40	515	475	.827	393
2	40	515	475	.683	324
3	40	515	475	.565	268
4	40	515	475	.467	222
5	40	515	475	.386	183
6	40	515	475	.319	152
7	40	515	475	.264	125
8	40	515	475	.219	104
9	40	515	475	.181	86
10	40	515	475	.150	71
11	40	515	475	.119	57
12	40	515	475	.102	48
13	40	515	475	.084	40
14	40	515	475	.070	33
15	40	515	475	.058	28
16	40	515	475	.048	23
17	40	515	475	.040	19
18	40	515	475	.033	16
19	40	515	475	.027	13
20	40	515	475	.023	11
TOTAL NET PRESENT VALUE					2,216

Table 15. Internal rates of return for actual stockwater developments, Utah, 1962

Type development	(20 yr.) Expected life (1962) price	(15 yr.) Expected life (1962 price)	(20 yr.) Expected life $1/cwt price reduction $.25/AUM price reduction
	percent	percent	percent
Small spring (5)	Over 50	Over 50	Over 50
Large spring (2)	21	20	18
Type II stockwell	Over 50	Over 50	Over 50

SUMMARY AND CONCLUSIONS

Statement of the Problem

Conditions of drought, rising costs, and declining prices, and new opportunities of development have prompted ranchers to invest in range improvement practices. A rancher is interested in whether a project will pay and if the return on investment is equal to that of other range improvement practices or alternative investments. The area of water development offers one possibility of investment in which favorable returns may be gained.

Purpose and Procedure

The purpose of this study was: (1) To determine the cost of selected water development practices, (2) To investigate the types of benefits expected, and (3) To determine the economic impact of these water developments on two typical size ranch operations.

Physical data and some costs of stockwater development practices were obtained from information supplied by governmental offices. Additional data were obtained from a survey of ranchers who had completed water developments. The present cost of materials that make up the developments was obtained from various agencies handling the materials. Data to investigate benefits from water development were obtained from personal interviews with ranchers with development projects. A budgeting procedure was used to determine the economic impact of development.

Findings

Costs of various stockwater developments

Because of the diversity of development projects, six different type water developments were selected. Each type incorporated typical development characteristics of stockwater projects on the ranches. Springs varied in the relative size and length of pipeline so a small and large type spring development has been selected. Stockwells varied in the depth of casing, height of water lift, and the power source used to pump the well. Four type stockwells were selected according to these criteria of variation.

The typical water developments were: a small type spring costing $182; a large type spring costing $1,353.00; a Type I stockwell, total cost $1,492.00; a Type II stockwell costing $3,023.00; a Type III stockwell costing $2,474.00; and a Type IV stockwell, total cost $3,490.00.

Benefits from stockwater development

Benefits from development were investigated from the standpoint of types of benefit possible, amount of annual increased returns necessary to make projects feasible, and internal rates of return from actual water developments.

The type of benefits most frequently gained from stockwater development are: (1) increased animal unit months, (2) increased weight per animal unit while on the range, (3) reduced labor requirement, (4) overall range condition improvement and, (5) much handier and versatile operation.

Using the various costs of development and the annual operating and maintenance costs, the annual increased returns necessary to make investment feasible and cover the borrowing rate of interest (7 percent) were determined. The necessary annual increased returns amounted to $27 for the small spring development, $148 for the large spring, $304 and $354 for the Type I stockwell on the small and medium ranches respectively, $421 and $429 on the small and medium ranch for the Type II stockwell, $413 and $484 for the Type III stockwell on the two ranch sizes, and $358 for the Type IV stockwell on both ranches.

Estimated benefit data from three actual stockwater developments were used for the internal rate of return analysis. A small type spring development (5 springs) had benefit estimates of 10 pounds increased weaning weight per calf, 50 pounds increased weight per cow as they came off the range, and an increase of 270 AUM's. A large type spring development (2 springs) showed benefit of 147 AUM's increase. A Type II stockwell had benefit estimates of 225 AUM's increase and 25 pounds increased weaning weight per calf.

Internal rate of return calculations on the benefits from the three actual development projects showed rates of return to be very favorable. They ranged from 18 percent to over 50 percent depending on the assumptions made.

Economic impact of developments

By budgeting the cost of development and the increased annual maintenance and operating costs into the financial structure of the ranches, the increased annual operating costs are determined. The small spring development increased annual operating costs by $19 and the large spring by $89. The Type I stockwell increased costs by $243 on the small ranch and $295 on the medium; Type II stockwell increased costs by $291 and $300; Type III $309 and $382; and Type IV by $195 for both respective ranch sizes.

Conclusions

Stockwater development is an area of range improvement offering good possibility for favorable returns on investment. Rate of return calculations were limited to actual cases because reliable benefit data of an extent necessary to make generalized statements as to expected rate of returns were not available. The fact that rate of returns from greatly limited observations were favorable does indicate that such returns are possible in the water development area depending on the individual situation. In cases where lack of stockwater seriously limits the usefulness derived from a range, high rates of return are possible. The state of Utah with vast areas somewhat limited by available water offers many possibilities for development with favorable returns.

Viewing benefits from the aspect of the amount of annual increased returns necessary to make development feasible at a 7 percent market rate of interest shows that increased returns necessary for the most expensive water development was $484. Certainly there are many ranchers in the state whose situation would provide a high probability of obtaining increased returns equal or greater to this amount.

A person considering stockwater development should employ experience, common sense, and sound judgement before making final decisions on development.

Suggestions for Further Research

Additional research in the area of stockwater development would be desirable. This study was somewhat limited by the amount of available benefit data and the validity of the rancher estimates. Data were available only for recent projects so it covered only a year or two and not nearly the life of the project. Future studies might: (1) Trace benefits from when a project is initiated over the project life, (2) Investigate more fully the costs and benefits over a greater scope of possible development, (3) Investigate other methods of stockwater development including methods by the use of new products such as plastics.

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APPENDIX A

Table 16. Livestock inventories and investment on typical ranches, Utah, 1962

		Size of Ranch			
		Small		Medium	
Class of livestock	Inventory value per head	Avg. inventory	Investment	Avg. inventory	Investment
	dollars	number	dollars	number	dollars
Cattle:					
Cows *	118	48	5,664	150	17,700
Bulls **	215	2	430	6	1,290
Heifers coming (2)	118	12	1,416	20	2,360
Heifers coming (1)	72	14	1,008	30	2,160
Steers coming (1)	68	25	1,700	40	2,720
Sub-total	xxx	xxx	10,218	xxx	26,230
Horses:					
Saddle ***	85	2	170	3	255
TOTAL INVESTMENT			10,388		26,485

* 2 years old and over

** Depreciation on investment in bulls, $118 per year for small ranches to $354 per year for medium

*** Depreciation on investment in horses, $32 per year for small ranches to $48 per year for medium

Table 17. Land inventories on typical ranches, Utah, 1962

Class of land	Size of Ranch	
	Small Owned	Medium Owned
	acres	acres
Irrigated land:		
Native and improved grass	150	250
Alfalfa	45	60
Barley	40	30
Corn silage	7	18
Rangeland owned	0	990
TOTALS	242	1,348
Federal range permits: *	(Animal month)	(Animal month)
Forest Service	260	580

* Federal range use is calculated on the basis of animal months for all animals over six months of age and does not correspond to AUM's calculated from feeding standards.

Table 18. Investment in buildings and improvements for a typical small size ranch, Utah, 1962

Class of improvement	Description	Number	Average investment
		No.	dollars
Livestock facilities:			
Barns	36' x 36' metal roof	1	1,943
Sheds	16' x 30' pole, metal roof	1	240
Corrals	72' x 60' pole	1	58
Feed	Racks	2	66
Watering facilities:			
Well and pump		1	366
Water tank	90 gal. metal	1	18
Crop facilities:			
Granary	1000 bu. metal	1	219
Stackyard	3 rods x 6 rods wire	1	22
Other facilities:			
Machine sheds	12' x 18' frame, metal roof	1	324
Fences:			
Boundary	4 strand barb	5 mi.	1,326
Cross	4 strand barb	1 mi.	265
TOTAL INVESTMENT			4,847

Note: Annual costs are: depreciation $203, repairs $283.

Table 19. Investment in buildings and improvements for a typical medium size ranch, Utah, 1962

Class of improvement	Description	Number	Average investment
		No.	dollars
Livestock facilities:			
Barns	36' x 70', wood floor composition roof	1	2,520
Sheds	30' x 50', frame, metal roof	1	749
Corrals	60' x 72', (1) 117' x 154' poles (2)	3	416
Feed	Racks	1	33
Watering facilities:			
Well and pump		1	366
Crop facilities:			
Granaries	1000 bu. metal (1) 1000 bu. wood (1)	2	465
Stackyards	3 rods x 6 rods, wire	6	132
Other facilities:			
Machine sheds	18' x 24' frame, metal roof	1	756
Fences:			
Boundary	7 mi.	9 mi.	2,713
Cross	2 mi.		
TOTAL INVESTMENT			8,150

Note: Annual costs are: depreciation $464, repairs $533.

Table 20. Investment in machinery and equipment for a typical small size ranch, Utah, 1962

Item	Number	Average investment
	No.	dollars
Tractors	2	2,674
Trucks	1	1,145
Auto (ranch share)	1	680
Haying equipment	4	1,760
Tillage equipment	2	436
Other crop equipment	2	487
Livestock equipment	4	436
Ship equipment and small tools		520
Gas tanks and pumps		125
TOTAL INVESTMENT		8,263

Note: Annual costs are: depreciation $1,150, repairs $559, operating costs $501.

Table 21. Investment in machinery and equipment for a typical medium size ranch, Utah, 1962

Item	Number	Average investment
	No.	dollars
Tractors	3	3,087
Trucks	2	1,919
Auto (ranch share)	1	680
Haying equipment	5	1,924
Tillage equipment	3	469
Other crop equipment	3	600
Livestock equipment	10	488
Shop equipment and small tools		104
Gas tank (overhead)		89
TOTAL INVESTMENT		9,360

Note: Annual costs are: depreciation $1,439, repairs $893, operating costs $795.

Table 22. Labor use and costs for a typical small size ranch, Utah, 1962

Worker	Number	Labor used	Wage rate **	Total cost ***
	No.	man-months	dollars/month	dollars
Family:				
Operator *	1	6	365	2,190
Hired:				
Day laborers	2	1	260	268
TOTALS		7		2,458

* Operator and unpaid family labor charged for at the same rate as equivalent hired workers.

** Cash wage rate. Board and room values accounted for elsewhere.

*** Including cost of social security and workman's compensation insurance payments

Table 23. Labor use and costs for a typical medium size ranch, Utah, 1962

Worker	Number	Labor used	Wage rate **	Total cost ***
	No.	man-months	dollars/month	dollars
Family:				
Operator *	1	11	365	4,015
Hired:				
Seasonal workers	3	9	260	2,411
TOTALS		20		6,426

* Operator and unpaid family labor charged for at the same rate as equivalent hired workers.

** Cash wage rate. Board and room values accounted for elsewhere.

*** Including costs of social security and workman's compensation insurance payments.

Table 24. Feed use and costs for a typical small size ranch, Utah, 1962

Kind of feed	Unit	Total amount fed	Purchases		
			Amount	Price	Cost
		unit	unit	dollars/unit	dollars
Alfalfa hay	ton	166			
Corn silage	ton	130			
Barley	cwt	419			
Salt	cwt	15	15	1.34	20
Total purchased feeds					20
Owned land:					
Irrigated pasture	AUM	146			
Aftermath grazing	AUM	90			
Sub-total		236			
Federal range permits:					
Forest Service	AUM	260		.60	156
TOTAL RANGE AND PASTURE		496			156

Table 25. Feed use and costs for a typical medium size ranch, Utah, 1962

Kind of feed	Unit	Total amount fed	Purchases Amount	Purchases Price	Purchases Cost
		unit	unit	dollars/unit	dollars
Native and improved grass hay	ton	208			
Alfalfa hay	ton	45			
Corn silage	ton	91			
Barley	cwt	490			
Salt	cwt	49	49	1.31	64
Total purchased feeds					64
Owned land:					
Irrigated pasture	AUM	375			
Rangeland	AUM	385			
Aftermath grazing	AUM	30			
Sub-total		790			
Federal range permits:					
Forest Service	AUM	580		.60	348
TOTAL RANGE AND PASTURE		1,370			348

Table 26. Production and sales of cattle for a typical small size ranch, Utah, 1962

Class of cattle	Number sold	Average weight	Total weight	Average price	Total value of sales
	No.	pounds	cwt	dollars/cwt	dollars
Cows	10	1,157	116	12.30	1,427
Yearling heifers	2	750	15	24.20	363
Heifer calves	7	400	28	23.40	655
Steer calves	10	420	42	27.30	1,147
Yearling steers	10	800	80	24.55	1,964
TOTAL SALES *	39		281		5,556

* Value of beef used in the home included as a sale.

Table 27. Production and sales of cattle for a typical medium size ranch, Utah, 1962

Class of cattle	Number sold	Average weight	Total weight	Average price	Total value of sales
	No.	pounds	cwt	dollars/cwt	dollars
Cows	16	1,000	160	12.30	1,968
Yearling heifers	10	750	75	24.20	1,815
Heifer calves	35	400	140	23.40	3,276
Steer calves	64	420	269	27.30	7,344
TOTAL SALES *	125		644		14,403

* Value of beef used in the home included as a sale.

Table 28. Crop production and sales for a typical small size ranch, Utah, 1962

Crop	Unit	Acres	Average yield	Total production	Sales	Price	Value of sale
			units	units	units	dollars	dollars
Hay:							
Native and improved grass	ton	150					
Alfalfa	ton	45	4	180	31	22.50	698
Feed grain:							
Barley	cwt	40	25	1,000	685	2,30	1,576
Other crops:							
Corn silage	ton	7	20	140			
TOTAL SALES							2,274

Table 29. Crop production and sales for a typical medium size ranch, Utah, 1962

Crop	Unit	Acres	Average yield	Total production	Sales	Price	Value of sale
			units	units	units	dollars	dollars
Hay:							
Native and improved grass	ton	250	1	250	42	18.00	756
Alfalfa	ton	60	3	180	135	22.50	3,038
Feed grain:							
Barley	cwt	30	25	750	260	2.30	598
Other crops:							
Corn silage	ton	18	15	270	179	6.50	1,164
TOTAL SALES							5,556

Table 30. Annual costs and expenses of operating typical ranches, Utah, 1962

Item	Size of ranch	
	Small	Medium
	dollars	dollars
Cash costs:		
Grazing fees:		
Forest Service	156	348
Labor hired	268	2,411
Feed purchased	20	64
Repairs and maintenance:		
Buildings and improvements	283	533
Machinery and equipment	559	893
Veterinary services and supplies	82	167
Taxes:		
Cattle	92	191
Real estate	607	946
All other property	209	141
Seed and fertilizer	354	532
Machine operating costs	501	795
Machine hire	855	1,251
Licenses	12	71
Insurance	102	217
Utilities*	250	250
Irrigation water	334	466
Miscellaneous**	121	303
Total cash costs	4,805	9,579

(continued)

Table 30. (continuation)

Item	Size of ranch	
	Small	Medium
	dollars	dollars
Non-cash costs:		
Depreciation:		
Buildings and improvements	203	464
Machinery and equipment	1,150	1,439
Horses	32	48
Bulls	118	354
Bull death loss	22	65
Horse death loss	9	13
Interest on cash costs	144	287
Total non-cash costs	1,678	2,670
Total operating costs	6,483	12,249
Operator and family labor	2,190	4,015
Interest on investment	3,710	6,995
TOTAL RANCH COSTS AND EXPENSES	12,383	23,259

* Includes ranch share of electricity, telephone, gas, and domestic water.

** Miscellaneous costs include twine.

APPENDIX B

Table 31. Adjusted costs and expenses of operating typical ranches with a small type spring development project, Utah, 1962

Item	Size of ranch	
	Small	Medium
	dollars	dollars
Cash costs*	4,805	9,579
Project maintenance**	10	10
Total cash costs	4,815	9,589
Non-cash costs:		
Depreciation:		
Buildings and improvements	203	464
Development project	9	9
Machinery and equipment	1,150	1,439
Horses	32	48
Bulls	118	354
Bull death loss	22	65
Horse death loss	9	13
Interest on cash costs	144	288
Total non-cash cost	1,687	2,680
TOTAL OPERATING COST	6,502	12,269

* Cash costs before development; for itemized list of cash costs see appendix A, table 30

** $10.00 per spring which is nominal because maintenance labor is considered under allowance for operator and family labor

Table 32. Adjusted costs and expenses of operating typical ranches with a large type spring water development project, Utah, 1962

Item	Size of ranch	
	Small	Medium
	dollars	dollars
Cash costs*	4,805	9,579
Project maintenance**	20	20
Total cash costs	4,825	9,599
Non-cash costs:		
Depreciation:		
Buildings and improvements	203	464
Development project	68	68
Machinery and equipment	1,150	1,439
Horses	32	48
Bulls	118	354
Bull death loss	22	65
Horse death loss	9	13
Interest on cash costs	145	288
Total non-cash cost	1,747	2,739
TOTAL OPERATING COST	6,572	12,338

* For itemized list of cash costs see appendix A, table 30.

** Charge is nominal because maintenance labor is considered under allowance for operator and family labor.

Table 33. Adjusted costs and expenses of operating typical ranches with a type I stockwell, Utah, 1962

Item	Size of ranch	
	Small	Medium
	dollars	dollars
Cash costs*	4,805	9,579
Stockwell operation and maintenance**	163	213
Total cash costs	4,968	9,792
Non-cash costs:		
Depreciation:		
Buildings and improvements	203	464
Stockwell development	75	75
Machinery and equipment	1,150	1,439
Horses	32	48
Bulls	118	354
Bull death loss	22	65
Horse death loss	9	13
Interest on cash costs	149	294
Total non-cash costs	1,758	2,752
TOTAL OPERATING COST	6,726	12,544

* For an itemized list of cash costs see appendix A, table 30.

** Includes gasoline, oil, engine replacement, and pumping time for operating the well four months for all animals.

Table 34. Adjusted costs and expenses of operating typical ranches with a type II stockwell, Utah, 1962

Item	Size of ranch	
	Small	Medium
	dollars	dollars
Cash costs*	4,805	9,579
Stockwell operation and maintenance**	136	144
Total cash costs	4,941	9,723
Non-cash costs:		
Depreciation:		
Buildings and improvements	203	464
Stockwell development	151	151
Machinery and equipment	1,150	1,439
Horses	32	48
Bulls	118	354
Bull death loss	22	65
Horse death loss	9	13
Interest on cash costs	148	292
Total non-cash costs	1,833	2,826
TOTAL OPERATING COST	6,774	12,549

* For an itemized list of cash costs see appendix A, table 30.

** Includes electric power and pumping time for operating the well four months for all animals.

Table 35. Adjusted costs and expenses of operating typical ranches with a type III stockwell, Utah, 1962

Item	Size of ranch	
	Small	Medium
	dollars	dollars
Cash costs*	4,805	9,579
Stockwell operation and maintenance**	179	250
Total cash costs	4,984	9,829
Non-cash costs:		
Depreciation:		
Buildings and improvements	203	464
Stockwell development	124	124
Machinery and equipment	1,150	1,439
Horses	32	48
Bulls	118	354
Bull death loss	22	65
Horse death loss	9	13
Interest on cash costs	150	295
Total non-cash costs	1,808	2,802
TOTAL OPERATING COST	6,792	12,631

* For an itemized list of cash costs see appendix A, table 30.

** Includes gasoline, oil, engine replacement and pumping time for operating the well four months for all animals.

Table 36. Adjusted costs and expenses of operating typical ranches with a type IV stockwell, Utah, 1962

Item	Size of ranch	
	Small	Medium
	dollars	dollars
Cash costs*	4,805	9,579
Stockwell operation and maintenance**	10	10
Total cash costs	4,815	9,589
Non-cash costs:		
Depreciation:		
Buildings and improvements	203	464
Stockwell development	185	185
Machinery and equipment	1,150	1,439
Horses	32	48
Bulls	118	354
Bull death loss	22	65
Horse death loss	9	13
Interest on cash costs	144	288
Total non-cash costs	1,863	2,856
TOTAL OPERATING COST	6,678	12,445

* For an itemized list of cash costs see appendix A, table 30.

** Includes minor repairs and oil for the windmill.