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INTRODUCTION

Private wells that give insufficient water, poor quality water, or both are why many South Dakota rural residents have joined rural water systems.

The first large rural water system in the state was organized in 1962 to serve 700 rural residents near Rapid City. As of 1982, there were 30 systems fully operational or in some stage of construction (South Dakota Association of Rural Water Systems). An additional 20 systems were in the planning or organizational stage (Ullery). Capital investment averages $4.5 million per system and $4,700 per hook-up. Inflation is likely to increase the cost in future years.

Systems are usually not completely financed by members. Traditionally, subsidies have included low-interest loans and grants from the state and Farmers Home Administration (FmHA).

Recent federal budgets cuts may reduce monies available from the FmHA. If so, the state of South Dakota may be called upon to provide additional funds. But state monies are also limited, and rural water systems must compete with irrigation and other water development projects for these funds. We must be able to closely estimate the returns beforehand from each of the competing uses for state funds so that we make the "best" investment choice.

Returns to the investor and the public from projects involving irrigation, hydroelectric power, and recreation have been widely evaluated and documented. Similar returns from constructing rural water systems have not. Feasibility studies are usually conducted prior to the construction of any system and each individual must assess personal benefits from joining a system, but there is little research on the contribution of rural water systems to the state's economy.

In an earlier study at SDSU, Lundeen and Janssen estimated the effects of installation of a rural water system on public sector revenues and expenditures. Other researchers have investigated the returns to private individuals in increased property values, increased livestock numbers, new construction, and decreased maintenance costs (Smythe; Toman; Nelson et al; Young et al). The specific objective of the present study is to estimate the returns to the agricultural sector of the state's economy.

Rural water systems could contribute to an increase in farm income either through increases in productivity or production or through decreases in production costs.

An ensured supply of good quality water may increase agricultural productivity in several ways, the most obvious of which is increased yields from irrigation. The cost of purchasing water from rural water systems to irrigate field crops is prohibitive; such an option is not considered in this report.

Water from rural water systems also may be used for irrigation of lawns, trees, shrubs, and gardens, but the dollar addition to state farm income is very slight.

Livestock watering appears to be a reasonable option; significant contributions to farm income seem feasible.

Possible impacts of rural water systems on livestock production in the following areas were included in the study:

1. increased productivity because of good quality water;

2. production of added livestock if sufficient water were available; and

3. losses averted because of sufficient water during drought.

Two methodologies were used to estimate the impacts of a rural water system. First, livestock production of members and nonmembers was compared to determine any significant differences between the groups. The impacts of the rural water system, as stated by members, were then quantified in a simulation model.

Survey Procedures

Mail surveys were conducted in two counties that have rural water systems in operation. Moody County is located in the eastern part of South Dakota; Tripp County is located west of the Missouri River in the south-central part of the state. Moody County has adequate precipitation to sustain growth of feed grains; much of the livestock consists of fed cattle. Tripp County, on the other hand, has lower precipitation; livestock consists mostly of feeder cattle.

Besides these obvious differences, the two counties were also selected because of their below-normal precipitation in 1980. Drought conditions were necessary to the study to test relationships among drought, livestock production, and rural water systems.

The survey itself focused primarily on livestock production and consisted of six sections:

1. sources of water and relative importance of each for livestock use;

2. types of feeding systems;

3. factors limiting livestock production during a normal year;

4. effects of drought on livestock production;

5. number of livestock on hand and sold each year from 1979 to 1982; and

6. opinions of members as to relationship between quality of water and livestock productivity.

Questionnaires were sent to all members of both systems who used more than 20,000 gallons of water per month since it was assumed they were livestock producers. The remaining recipients were selected randomly from county directories. The response rate for usable surveys was 34%. After elimination of incomplete questionnaires, there were 172 usable responses, 106 from Moody County, (83 from rural water system members and 23 from nonmembers) and 66 from Tripp County (36 from rural water system members and 30 from nonmembers).

The inclusion of all large water users from each system biased the sample. We cannot predict that the results would hold true for a population, either system-wide or county-wide. Results reported reflect data for survey respondents **only.**

Statistical Analysis

Data collected from the mail surveys were organized into a computer file using the Virtual Storage Personal Computing (VSPC) system. The coding and arrangement formats for the data were in accordance with the rules of the Statistical Analysis System (SAS). SAS programs were later used for statistical analyses in the study. T-test analyses were used to test for differences in livestock production between members and nonmembers of rural water systems.

In addition, the SAS programs were used to compute various descriptive statistics such as frequencies, means, and percentages. These figures are used in this report to reveal certain characteristics of groups of the survey respondents.

Simulation Model

A computer simulation model was developed and data from the surveys were used in the model to quantify various impacts of the rural water systems on the agricultural economy.

The model was:

$$W = f(X,Y,Z)$$

Where W = The increase in revenue* to the agricultural sector due to the use of rural water systems.

X = Losses averted during drought because of use of rural water systems.

Y = Increased revenue due to greater livestock capacity because of rural water.

Z = Increased revenue due to greater productivity because of good quality water.

Variable X is affected by five subvariables. The equation is:

$$X = f(A,B,C,D,E)$$

Where A = Trucking costs.

B = Livestock boarding fees.

C = Revenue lost from livestock not purchased due to drought.

D = Revenue lost from selling livestock early.

E = Frequency of droughts.

Variable X is included in the model on the premise that a lack of water during drought would force producers to move livestock to pastures with a sufficient supply of water, sell livestock early, or not make intended purchases of livestock. The "frequency of drought" variable was included to enable increases in revenue to be stated in annual terms; i.e., if a drought occurs every 5 years, one fifth of the revenues generated are included in the model.

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*The term "revenue" as used throughout this report includes two factors. When referring to increased production or productivity, increased revenues consist of returns to labor and management per additional head of livestock as stated in the cited livestock budgets. In these budgets, total receipts minus total direct costs and total fixed costs equal returns to labor and management. This is not synonomous with profit in the usual economic sense but is a reflection of income accruing to the producer which, in turn, may be spent in the South Dakota economy.

The second factor consists of decreased production costs which occur because of the availability of rural water during drought. Everything else remaining the same, decreased costs will result in added net income to the producer.

Trucking cost coefficients were obtained from the Public Utilities Commission and boarding fee coefficients from agricultural economists at SDSU. Frequency of drought coefficients were obtained from the climatologist at SDSU (U.S. Dept. of Commerce). Average returns to labor and management for each type of livestock were obtained from livestock budgets published by the Economics Department at SDSU (Allen and Aanderud). The remaining data were available from the survey.

The second major variable, Y, is the summation of the increased revenue from all livestock types due to the capacity to raise more livestock made possible by rural water. The numbers for additional livestock were obtained through survey responses of rural water system members **only**.

The last major variable, Z, deals with the effects of good quality water on agricultural productivity.

The equation is:

$$Z = f(H,I,J)$$

Where H = Feed costs saved by better weight gain.

I = Increased revenue from decreased infant mortality.

J = Reduced veterinarian costs for livestock because of the availability of good quality water from a rural water system.

Empirical quantitative data on increases in productivity were not available from the survey, so the model was run using sensitivity analyses assuming 1%, 2.5%, and 5% increases in productivity. These assumptions were based on researchers' judgment and review of literature, as discussed in the following section. For example, increased revenues were calculated by assuming that average daily gain would increase by each of the above percentages. This gave a range of revenue increases. Similar calculations were made for each of the productivity variables. The survey did provide respondents' opinions on whether or not they had experienced increased productivity due to the rural water system.

Because it was assumed that respondents would be able to provide the most accurate information on livestock numbers currently in inventory, the model was run using 1982 livestock numbers and prices. However, in 1982 a recession was affecting cattle prices. To show the effect of a recession on the model's outcome, it was also run using 1982 livestock numbers and 1980 prices, a year when cattle and input prices were higher.

For each county, the model was run 12 times, resulting in a range of possible increases in revenue.

Tables 1 and 2 show the number of survey respondent producers and livestock by type for members and nonmembers of rural water systems. These figures were used in the various parts of the simulation model.

INCREASED PRODUCTIVITY DUE TO GOOD QUALITY WATER

Livestock producers, especially pork producers, who are members of a rural water system have indicated faster gains and lower mortality rates after switching to rural water from another source.

Animal scientists and microbiologists conducting studies of the effects of nitrates, salts, sulfates, and other substances in water on livestock productivity have reached varying, sometimes conflicting results. Therefore, a consensus has not developed on the effect of poor quality water on livestock production.

TABLE 1. Number of producers and livestock by type, Tripp County survey respondents.

	Nonmembers		Members		Totals	
	No. of producers	No. of livestock	No. of producers	No. of livestock	No. of producers	No. of livestock
Milk cows	1	5	2	105	3	110
Heifers	2	24	2	212	4	236
Beef cows	17	1637	19	3070	36	4707
Cattle over 500 lb	3	555	4	3200	7	3755
Cattle under 500 lb	8	430	9	999	17	1429
Sow-2 litter	9	563	9	350	18	913
Feeder pigs	8	3160	8	2640	16	5800
Sheep	1	65	0	0	1	65

Total number of respondent producers in Tripp County was 66, including 36 members and 30 nonmembers.

TABLE 2. Number of producers and livestock by type, Moody County survey respondents.

	Nonmembers		Members		Totals	
	No. of producers	No. of livestock	No. of producers	No. of livestock	No. of producers	No. of livestock
Milk cows	6	127	12	720	18	847
Heifers	5	82	9	462	14	544
Beef cows	13	643	28	1859	41	2502
Cattle over 500 lb	9	987	27	2987	36	3974
Cattle under 500 lb	7	422	17	1121	24	1543
Sow-2 litter	3	112	13	764	16	876
Feeder pigs	6	2275	30	11599	36	13874
Sheep	3	720	5	1287	8	2007

Total number of respondent producers in Moody County was 106, including 83 members and 23 nonmembers.

High levels of salts, nitrates, and sodium sulfates are found in water classified as "poor quality." The National Academy of Science has indicated that water containing more than 7000 milligrams per liter of total soluble salts should generally not be used for livestock.

In a study of 167 surface waters analyzed and reported in South Dakota Farm and Home Research (Olson et al), 74% tested more than 7000 miligrams of soluble salts per liter. Of the 393 ground waters sampled, 8% tested more than 7000 milligrams per liter. This was not a random sample because only those suspected of high salt content were tested. But the study does show that there are water sources in South Dakota with high salt content.

Olson et al estimated that better quality water could improve South Dakota livestock production efficiency by 5%. They also stated that each percent of improvement across the state could add another $10,000,000 to the market value of South Dakota livestock.

Nitrates also affect water quality. Water containing sufficient nitrates to cause livestock poisoning is very seldom found in South Dakota (Olson, Emerick, and Lubinus).

Sodium sulfates in water could also affect livestock production. However, Paterson et al found that sodium sulfates are not a factor in swine reproduction. They added between 320 and 5060 ppm of sodium sulfate to the drinking water of pregnant sows and of young pigs, but found no significant differences in gestation or lactation gains. Nor did they find differences in the number or weight of pigs at birth. However, other investigators have reported that high levels of sulfate in the water cause scouring in young pigs.

Unfortunately, without testing a water sample it cannot be determined if the water from a specific source contains salts in excess of "harmful" limits. Without these water quality tests, or without scientifically controlled feeding and watering trials, it is difficult to prove or disprove that switching from one source of water to another will actually improve livestock productivity efficiency.

Nonetheless, some rural water system members feel, from their own observation and experiences, that they have detected an increase in the efficiency of their livestock production after using rural water for livestock watering. The survey provided some information as to how strong a consensus there is on this subject among members of the rural water systems in Tripp County and Moody County.

Survey Results

Rural water system members were asked to indicate their opinion on productivity improvements in three areas: 1) increased average daily gain (ADG), 2) decreased newborn mortality rates, and 3) decreased medicine costs due to decreases in sickness (Table 3).

Simulation Results

Productivity gains were simulated under two scenarios. In the first scenario, the numbers of livestock owned by member and nonmember respondents were summed to simulate "what if" a rural water system were in use by all respondents throughout the study area. As noted earlier, sensitivity analyses assuming productivity increase of 1%, 2.5%, and 5% were run for each county with prices prevailing in the years 1980 and 1982 for each assumption.

For Tripp County respondents and using 1980 prices, potential increased revenues ranged from $22,535 to $108,867. With 1982 prices, increased revenues ranged from $21,180 to $102,337. In Moody County, increases at 1980 prices ranged from $29,150 to $140,679; figures for 1982 prices were in the $29,955 to $130,104 range.

In the second scenario, productivity increases were assumed for only that percent of livestock for which members had indicated productivity gains (see Table 3). Under this assumption for Tripp County respondents, using 1980 prices, increased revenues ranged from $3,781 to $18,242. With 1982 prices, increased revenues ranged from $3,563 to $17,194. In Moody County, increases at 1980 prices ranged from $7,144 to $34,472; figures for 1982 prices were in the $6,521 to $31,473 range.

Figures cited do **not** reflect observed changes in productivity but rather a range **"if"** certain assumptions are true; i.e., if good quality water does increase livestock productivity, if all respondents from both counties were rural water system members (in the first scenario), and if all water was of "poor quality" prior to the installation of the systems. The potential increases cited above are relatively small, but they relate to only 172 respondents from both counties. On a county-wide or state-wide basis, the increases could be substantial.

TABLE 3. Number of respondents on the rural water system indicating that better quality water improved their livestock productivity through increased average daily gain, decreased newborn mortality rates, or decreased medicinal costs.

	Tripp*		Moody**	
	Cattle/Dairy	Hogs	Cattle/Dairy	Hogs
Number of respondents indicating:				
Increased average daily gain	8 (22.9%)	6 (27.3%)	21 (28.0%)	20 (43.5%)
Decreased newborn mortality rates	2 (5.7%)	3 (13.6%)	6 (8.0%)	11 (23.9%)
Decreased medicinal costs	3 (8.6%)	3 (13.6%)	15 (20.0%)	18 (39.1%)

*Total rural water system members in Tripp County responding to this question included the following:

35 beef and/or dairy producers
22 hog producers

**Total rural water system members in Moody County responding to this question included the following:

75 beef and/or dairy producers
46 hog producers

AVERSION OF LOSSES DURING DROUGHT

A hook-up to a rural water system during drought may prevent an early sell-down of herds or reduce costs of shipping livestock to other water-sufficient locations.

Survey Results

This hypothesis was addressed in the study by asking respondents to rank factors that limited their livestock production during drought periods. In Tripp County, 6% and 7% of rural water system members and nonmembers respectively said lack of water had limited livestock production during droughts. In Moody County, 1% of members and 0% of nonmembers cited lack of water as a limiting factor. There appears to be no appreciable difference between members and nonmembers; however, members did not indicate if the lack of water had occurred since joining the system or prior to that.

With the exception of one dairy producer in Tripp County, beef producers were the only ones indicating they sold livestock early due to lack of water during their area's last drought period. The percentage (16% for members and 14% for nonmembers) of responding beef producers in Tripp County forced to sell beef earlier than planned is about equal for rural water system members and nonmembers. However, it should be noted that all of the rural water system members reported that the sales took place in 1976 or earlier—before installation of the rural water system.

As in Tripp County, the percentage of responding beef producers in Moody County forced to sell beef earlier than planned due to a shortage of usable water is about the same for rural water system members and nonmembers.

One of the two rural water system members indicating early sales sold in 1978. This was after the installation of the rural water system; however, the respondent did not report the date on which he joined. The other respondent failed to report either the date at which he sold his animals or the date at which he joined the system. The nonmember indicating the forced sale of beef due to drinking water shortages also did not list the date at which such sales occurred.

The evidence does not strongly support the hypothesis that nonmember livestock producers are more susceptible to forced livestock sales than are member producers.

The data from Tripp County do provide limited support for the hypothesis in that there were six rural water system member respondents reporting forced sales of livestock because of insufficient water supplies before the installation of the rural water system, and none reporting such sales after the installation. Nonmembers in Tripp County reported two instances of forced sales before the installation of the rural water system and two forced sales after.

Rather than sell livestock when drinking water supplies are low or nonexistent, some producers may choose to ship their livestock to other geographic locations where water supplies are more plentiful. This shipment adds to the cost of livestock production through transportation costs and boarding fees. A rural water system may be able to prevent these additional costs by eliminating the need to ship livestock out.

Two beef producing respondents in Tripp County shipped beef animals to other locations due to a shortage of water. Both of these were members of the rural water system although it is unknown whether the shipments occurred before or after they joined the rural water system. None of the nonmember beef producing respondents from Tripp County shipped animals to other places nor did any of the member or nonmember respondents who produced beef in Moody County.

Thus, there is no evidence that members of rural water systems are forced to ship livestock to locations with better water supplies during drought periods less often than nonmembers. The data do suggest that this is an uncommon practice in general. Shipment of livestock to other geographic areas in times of drought because of a lack of feed may be more common.

Simulation Results

Using data from the two respondents in Tripp county who indicated they had transported cattle during droughts, transportation and boarding costs were calculated. Data from each producer were computed individually.

One producer shipped 375 head of cattle 212 miles and kept them at their location for 75 days. The shipping fee was $2,504 and boarding charges* were $2,812. The other producer shipped 30 head of cattle 150 miles and kept them at their location for 120 days. The shipping fee for this producer was only $252. The boarding charges were $838. The total trucking charges (variable A) for the two producers are $2,756. The total boarding charges (variable B) for the two producers are $3,650. Total costs that could have been averted if the two producers in Tripp County would have had an adequate supply of water available were $6,406.

The revenue lost from selling cattle early because of an inadequate supply of water was then simulated. Cattle were divided into two groups, under 500 lb and over 500 lb. Losses were calculated as the daily return to labor and management times the number of days producers indicated they had sold early, assuming cattle and feed prices remain constant over time. Using 1980 budgets, the daily return for animals over 500 lb was $.726 per animal. For 1982 budgets, the figure was $.588. Each producer's loss was calculated individually.

Four producers had cattle over 500 lb that were sold early. Their possible lost revenue is shown in Table 4.

*Boarding fees do not include feed and veterinary costs since it was assumed the producer would have these costs even if cattle were not transported.

TABLE 4. Revenue lost due to early sale of livestock: Cattle over 500 lb, Tripp County respondents.

Producer	No. of days sold early	No. of cattle sold early	Loss at 1980 prices	Loss at 1982 prices
1	30	80	$ 1,742	$ 1,411
2	180	100	13,068	10,584
3	90	50	3,267	2,646
4	210	50	7,623	6,174
		Total =	$25,700	$20,815

Five of the respondents said that their cattle were under 500 lb when they were sold early. A different budget was used for younger cattle because they had lower feed costs and were worth more per pound than heavier cattle in the livestock budgets used in this study.

Four out of the five respondents said they sold their cattle early by more than a half a year but less than a full year. This implies that the cattle were sold sometime before they reached their optimum weight but sometime after they reached 500 lb. Since the selling weight could not be determined, an average of the budgets for over 500 lb and under 500 lb was used. Daily returns to labor and management were estimated at $.653 for 1980 and $.474 for 1982. Table 5 shows the losses for producers with cattle under 500 lb.

The total value for variable D for all the producers who sold early is $119,044 using 1980 prices and $88,500 with 1982 prices. The average number of years between droughts for Tripp County was 4 years. To state in annual terms, the total loss was multiplied by .25. Annual losses, therefore, ranged from $29,761 to $22,125 for nine producers in Tripp County, or an average loss per producer ranging from $3,307 to $2,458 for those who had sold cattle early.

No drought losses could be calculated from responses of Moody County producers.

ADDITIONAL LIVESTOCK PRODUCTION

Under normal weather conditions, producers may have sufficient feed supplies to support more livestock but must restrain herd size because of insufficient water. The assurance of adequate water supplied by a rural water system would allow herd expansion.

This study considered two questions in relation to the link between rural water systems and livestock production: 1) have members produced significantly higher levels of livestock than nonmembers in the same area and 2) have members been able to achieve a more stable level of livestock production through periods of drought than have nonmembers in the same area?

TABLE 5. Revenue lost due to early sale of livestock: Cattle under 500 lb, Tripp County respondents.

Producer	No. of days sold early	No. of cattle sold early	Loss at 1980 prices	Loss at 1982 price
5	300	64	$12,537	$ 9,091
6	90	75	4,407	3,196
7	210	25	3,428	2,485
8	330	175	37,710	27,344
9	270	200	35,262	25,569
		Total =	$93,344	$67,685

Survey Results

Members and nonmembers were asked to list the number of livestock on hand for each of the years from 1979 through 1982.

In absolute terms in Tripp County, the average number of animals on hand for all cattle categories was higher for rural water system members than for nonmembers. The average number of animals on hand in the swine categories was lower for rural water system members than for nonmembers.

Only in the category of hog breeding stock did a statistically significant difference in average production levels occur between the two producer groups. In each of the 4 years for which data were available, nonmembers held a significantly higher number of breeding hogs in inventory.

In Moody County, rural water system members averaged higher levels of animals in inventory for all livestock categories. In two instances, the difference in average production between rural water system members and nonmembers was significant—in 1982 for milk cows on hand and in 1981 for beef cows on hand.

Comparison of livestock numbers between rural water system members and nonmembers provides only scattered evidence of any real differences between the two groups' livestock production levels that can be attributed to the presence of the rural water system.

A comparison of changes in average livestock numbers from year to year was also made between rural water system members and nonmembers. It was hypothesized that this comparison would detect changes in livestock inventories made necessary by the spring drought of 1980. However, no statistically significant difference in changes of livestock numbers was found between members and nonmembers.

Simulation Results

Members were also asked if they had increased their livestock numbers as a result of joining the rural water system. The increased numbers reported by producers were multiplied by the average per head return to labor and management. Increases in each livestock category were summed to obtain totals for respondents in each county.

Tables 6 and 7 report the increases in livestock numbers, average return per head, and total increase in revenues for member respondents, using 1980 and 1982 prices. The figures reflect increased revenue only from the 83 rural water system respondents from Moody County and 36 from Tripp County.

AGGREGATED SIMULATION MODEL RESULTS

The results from each section of the model were aggregated to obtain the total impact of the rural water system on livestock production and productivity in each county.

Twelve simulations were run for each county to incorporate productivity increases of 1%, 2%, and 5%, prices of inputs and products for 1980 and 1982, and assumptions of productivity increases for the entire livestock inventory or only a portion of it.

Table 8 summarizes the results with the assumption that the gains in productivity apply to all livestock in inventory. As shown, simulated total increases in returns for the sample in Tripp County range from $104,098 to $239,713. In Moody County the range is from $125,632 to $257,119. As noted earlier, no drought losses were averted in Moody County; therefore the bulk of the increased returns were from productivity gains and capacity to increase herd size.

Table 9 summarizes the results if productivity increases are assumed for only the livestock for which respondents reported gains. Since productivity gains were a large portion of the total returns in Moody County, the reduction of returns from those shown in Table 8 is greatest in Moody County and at the 5% level.

Respondents in Tripp County are mainly cattle producers, while in Moody County respondents raise more swine. Between 1980 and 1982 cattle prices went down. Since Tripp County respondents rely heavily on cattle, their returns from increased production went down substantially from 1980. On the other hand, swine prices went up, so the returns from increased production were not as large in Moody County in 1980 and in 1982.

Results of the model cannot be extrapolated to a county- or state-wide basis because of sample bias. To provide information useful to an individual producer or policymaker, aggregate increases in revenue were converted to increases per animal unit.

Animal units were calculated by multiplying the total number of each type of livestock in inventory in the study by the conversion factor for that type of livestock, obtained from the Management Guide for Planning a Farm or Ranch Business. Adding totals for each type of livestock derives the total animal units in the study. By dividing total increased revenue by the appropriate total animal units, the increase in revenue per animal unit is found (Table 10 and 11).

While these figures cannot be applied directly to other areas, they are indicative of increased returns that may be expected.

TABLE 6. Increased revenue due to greater capacity for more livestock by using rural water as reported by member respondents: Tripp, 1980 and 1982.

Livestock category	Increased* no. of animals	Return to labor and management: 1980 prices	Return to labor and management: 1982 prices	Increased revenue from greater capacity: 1980 prices	Increased revenue from greater capacity: 1982 prices
Milk cows	33	586.92	546.76	19,368.36	18,043.08
Beef cows	135	6.83	-----**	922.05	-----**
Cattle on feed over 500 lb	1,700	43.03	20.37	73,151.00	34,629.00
Sow-2 litter	20	210.76	223.65	4,215.20	4,473.00
Feeder pigs	310	5.89	6.60	1,825.90	2,046.00
			Total =	$99,482.51	$59,191.08

*Refer to Table 1 for total number of animals in inventory at time of survey.

**Beef cows showed a negative return in 1982 and were not included.

CONCLUSIONS

Water development is an issue of paramount importance to South Dakotans. Some funds have become available for development, but the number of projects competing for limited funds is large. Thus, some estimate of the returns from investing in alternative projects is needed to aid in determining which projects should be funded.

The returns from investing in rural water systems lie in improvements in the quality of life, possible increases in revenues for the public sector, and in increases in the state's agricultural income, the emphasis of this study.

Rural water system members did not produce significantly higher levels of livestock nor did they have more stable livestock production. Rural water system members, on average, had greater numbers of livestock but there was little evidence to connect these increases with rural water system use. It may be the other way around: large producers may tend to join the systems. Some members reported increased productivity due to the rural water system.

In the second part of the study, a simulation model was used to quantify the impacts of the systems as reported by members in a survey. Generally, in contrast to the comparative part of the study, the simulated monetary impacts

TABLE 7. Increased revenue due to greater capacity for more livestock by using rural water as reported by member respondents: Moody, 1980 and 1982.

		Return to labor and management		Increased revenue from greater capacity	
Livestock category	Increased* number of animals	1980 prices	1982 prices	1980 prices	1982 prices
Milk cows	86	586.92	546.76	50,475.12	47,021.36
Heifers	63	141.83	-----**	8,935.29	-----**
Beef cows	83	6.83	-----**	566.89	-----**
Cattle on feed over 500 lb	333	43.03	20.37	14,328.99	6,783.21
Cattle under 500 lb	40	17.31	-----**	692.40	-----**
Sow - 2 litter	125	210.76	223.65	26,345.00	27,956.25
Feeder pigs	2,563	5.89	6.60	15,096.07	16,915.80
			Total =	$116,439.76	$98,676.62

*Refer to Table 2 for total number of animals in inventory at time of survey.

**These livestock categories showed a negative return in 1982 and were not included.

were rather large and positive. However, the following limitations should be noted.

First, because all large water users in each county were included in the sample, the results are valid for the sample only.

Second, the large increases in revenue per animal unit that were derived in this study are not totally reliable. Ways to measure the effects of good quality water on livestock productivity are not available, and the effects were estimated. Literature on the subject includes claims that productivity could be increased over 5% with better quality water. The percentages used in this study could be conservative and, in fact, may be underestimating the increased revenue that good quality water may provide.

Third, the increase in revenues cited in this report generally constitute returns to labor and management and, therefore, are not synonomous with profit. Nor are the costs of joining the rural water system and purchasing water considered. The individual producer should examine the feasibility of a rural water system through benefit/cost analysis.

TABLE 8. Simulated annual increased revenue from installation of a rural water system in selected study areas, respondents only.

Items impacted	Tripp County 1980 prices	Tripp County 1982 prices	Moody County 1980 prices	Moody County 1982 prices
Aversion of drought losses	31,363	23,727	-0-	-0-
Capacity for increased basic herd size	99,483	59,191	116,440	98,677
*Gains from productivity increases with assumed gains of				
1%	22,535	21,180	29,150	26,955
2.5%	55,734	52,393	72,032	66,624
5%	108,867	102,337	140,679	130,104
Total increased revenue with assumed productivity gains of				
1%	153,381	104,098	145,590	125,632
2.5%	186,580	135,311	188,472	165,301
5%	239,713	185,255	257,119	228,781

*Assuming productivity increases apply to all livestock in inventory by respondents - members and nonmembers.

Fourth, it must be pointed out that other factors besides rural water affect a producer's decision to buy or sell livestock. High feed prices could prevent a producer from buying livestock. If cattle prices are too low, the producer may decide to hold cattle until prices rise. In this study, it was assumed that these factors were held constant.

The following conclusions are implicit in the results of this study.

The increase in revenue per animal unit is fairly substantial for each category, and between the two counties the increase per animal unit is fairly close (Tables 10 and 11).

Although results from two study areas are not enough to generalize for the state as a whole, they do provide an indication of how much a producer in South Dakota might be able to increase revenue by being on a rural water system.

The ripple effect of possible increases in revenue to livestock producers will be felt in the rest of the economy as increased revenue is used to purchase feed, equipment, additional

TABLE 9. Simulated annual increased revenue from installation of a rural water system in selected study areas, respondents only.

Items impacted	Tripp County 1980 prices	Tripp County 1982 prices	Moody County 1980 prices	Moody County 1982 prices
Aversion of drought losses	31,363	23,727	-0-	-0-
Capacity for increased basic herd size	99,483	59,191	116,440	98,677
*Gains from productivity increases with assumed gains of				
1%	3,781	3,563	7,144	6,521
2.5%	9,341	8,804	17,643	16,110
5%	18,242	17,194	34,472	31,473
Total increased revenue with assumed productivity gains of				
1%	134,627	86,481	123,583	105,197
2.5%	140,187	91,722	134,083	114,786
5%	149,088	100,112	150,912	130,150

*Assuming productivity increases apply only to that percentage of livestock for which rural water system members noted productivity gains (see Table 3).

livestock, and personal items. Also, this increased revenue may increase the amount of taxes being paid into the state through sales taxes.

The findings of the study indicate that rural water systems do have an effect on the agricultural sector, particularly if producers have had poor quality water previously. Even though a problem exists with measuring productivity, there is still a substantial increase in revenue even with an increase in productivity as low as 1%.

TABLE 10. Simulated per-animal-unit increased revenue from installation of rural water system in selected study areas, respondents only.

Items impacted	Tripp County 1980 prices	Tripp County 1982 prices	Moody County 1980 prices	Moody County 1982 prices
Aversion of drought losses	3.24	2.45	-0-	-0-
Capacity for increased basic herd size	10.27	6.11	11.55	9.79
*Gains from productivity increases with assumed gains of				
1%	2.33	2.19	2.89	2.67
2.5%	5.75	5.41	7.15	6.61
5%	11.23	10.56	13.96	12.91
Total increased revenue with assumed productivity gains of				
1%	15.84	10.75	14.45	12.47
2.5%	19.26	13.97	18.70	16.40
5%	24.74	19.12	25.51	22.70

*Assuming productivity increases apply to all livestock in inventory by respondents-members and nonmembers.

Total animal units in Tripp County study area = 9,690.15
Total animal units in Moody County study area = 10,078.7

TABLE 11. Simulated per-animal-unit increased revenue from installation of a rural water system in selected study areas, respondents only.

Items impacted	Tripp County 1980 prices	Tripp County 1982 prices	Moody County 1980 prices	Moody County 1982 prices
Aversion of drought losses	3.24	2.45	-0-	-0-
Capacity for increased basic herd size	10.27	6.11	11.55	9.79
*Gains from productivity increases with assumed gains of				
1%	.39	.37	.71	.65
2.5%	.96	.91	1.75	1.60
5%	1.88	1.77	3.42	3.12
Total increased revenue with assumed productivity gains of				
1%	13.90	8.93	12.26	10.44
2.5%	14.47	9.47	13.30	11.39
5%	15.39	10.33	14.97	12.91

*Assuming productivity increases apply only to the percentage of livestock for which rural water system members noted productivity gains (see Table 3).

Total animal units in Tripp County study area = 9,690.15
Total animal units in Moody County study area = 10,078.7

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