

Limited Irrigation Adoption and Water Leasing in Colorado

James Pritchett¹, Jennifer Thorvaldson¹ Neil Hansen² and Ajay Jha²

¹Department of Agricultural and Resource Economics, Colorado State University

²Department of Soil and Crop Sciences, Colorado State University

Abstract. Burgeoning populations are increasing municipal water demand in the West, a phenomena that is changing rural and urban economies. Agricultural water is a preferred source for meeting growing demands, but transfers often require formerly irrigated land to be fallowed removing a key base industry from rural regional economies. It is no surprise that large scales transfers are greeted with highly-charged, emotionally contentious debates. One alternative to ‘buy and dry’ strategies is gaining interest. The alternative allows farmers to lease a portion of their water portfolio to cities. Leased water is generated as farmers reduce the consumptive use of their cropping operations by limiting irrigation. Examples of limited irrigation strategies include timing irrigations during vegetative growth and adopting innovative crop rotations. Importantly, the limited irrigation cropland remains in production so that rural economies suffer reduced effects vis a vis buy and dry activity. But will farmers adopt limited irrigation strategies if water lease markets materialize? This research examines producers’ potential adoption of limited irrigations strategies and their perceptions of lease arrangements. Potential adoption is gauged from a producer survey of South Platte River Basin farmers in Colorado, a basin experiencing significant population growth in the midst of significant agricultural production. More than 60% or respondents indicate a willingness to lease garnering between 50,000 and 60,000 acre feet of potential water supplies.

1.0 Introduction.

Burgeoning populations are increasing municipal water demand in the West, a phenomena that is changing rural and urban economies. Agricultural water is a preferred source for meeting growing demands, but transfers often require formerly irrigated land to be fallowed removing a key base industry from rural regional economies. Increasing demands and limited alternatives suggest a water reallocation from agricultural to municipal use (Colorado Water Conservation Board, 2004). It is no surprise that large scales transfers are greeted with highly-charged, emotionally contentious debates. While buyer and seller presumably benefit from the transaction, stakeholders believe that rural economies are at risk.

Thorvaldson and Pritchett document irrigated agriculture’s economic activity in the four river basins listed in Table 1. Notable is the South Platte, which expects to fallow as many as 226,000 (twenty-two percent) of its acres in the next twenty-five years. An irrigated acre generates nearly \$700 of economic activity in the basin, so potential losses are substantial in sparsely populated rural areas with few other alternatives.

Negative local impacts and associated publicity are incentive enough to find alternatives to standard “buy and dry” practices that fallow large swaths of formerly irrigated farmland. Stakeholders believe that leases, rather than permanent transfers, may

avoid these negative externalities. Rotational fallowing and limited irrigation are two alternatives being explored¹. Both involve agricultural water right holders signing leases with cities rather than selling water rights. Leasing of this type is rare in Colorado², and it is uncertain if leasing markets will evolve. Following the example of Michelson and Young (1993), necessary conditions for water lease markets include a critical mass of willing leasers and water right holders so that both are reasonably assured of a mutually beneficial transaction; that the gains from leasing exceed its transactions costs; and that leasing contracts can be written, monitored and enforced effectively.

Table 1. Economic activity generated by irrigated agriculture i^a

Basin	Population Increase by 2020 (%)	Additional Annual Water Demand (AF)	Forecasted Fallowing of Irrigated Acres	Economic Activity \$/ac
Arkansas	55%	98,000	23,000 to 72,000	\$428
Rio Grande	35%	43,000	60,000 to 100,000	\$1,235
South Platte	65%	409,700	133,000 to 266,000	\$690

^aPopulation, water demand and lost irrigated acres drawn from the Colorado Water Conservation Board, Statewide Water Supply Initiative (2004). Thorvaldson and Pritchett (2006) provide economic activity estimates.

This article’s objective is to focus on agricultural water right holders. Specifically, the research considers whether farmers are willing to sign leases if suitably compensated; what remuneration is needed for a farmer to enter into a lease agreement, how much water the farmer will release when compensated; and what characteristics are shared by farmers willing to lease.

The research approach is to gather stated preferences from South Platte basin farmers. Research results are particularly useful for policy makers who may need to alter existing institutions so that the transactions costs of leases do not outweigh the potential gains from trade. The results are also of interest to farmers and municipal water providers that are actively engaged in developing water leasing alternatives.

2.0 Methods

A questionnaire was designed and prior to mailing, the survey was reviewed by an advisory committee of farmers, field extension personnel, university extension specialists, water conservancy district employees, and municipal water provider representatives. Recommendations from these experts were incorporated into the questionnaire. The questionnaire’s sections include: farmer and farm operation

¹ With rotational fallowing, a large group of agricultural water right holders sign a long term lease agreement with a municipality, but then rotate fallowing from one farm to the next annually to lost economic activity over a greater landscape. Limited irrigation decreases a crop’s consumptive use without fallowing, and the water savings are leased.

² Leasing agricultural water to farmers is standard practice in Colorado, and municipal water suppliers do frequently lease out of basin water to farmers. These leases do not require legal oversight, but the leases described in this section would require approval.

characteristics, that include irrigation water source, the prevailing crop rotation and financial demographics; and attitudes about leasing arrangements including willingness to participate, compensation and contract provisions.

The questionnaire was mailed to South Platte basin farmers who reported more than fifty irrigated acres in the 2002 Census of Agriculture. Mailing began during the first week of September 2007 using procedures outlined by Dillman (2007) with a postcard reminder mailed ten days later, and a second survey mailing twenty-one days after the initial mailing. Of the 1,731 successful mailings, 329 (or 19%) were returned and could be used in the analysis.

3.0 Results

3.1 Leasing Attitudes

A leasing market’s success or failure will have much to do with farmers’ attitudes about leasing. Attitudinal surveys are often scored using a Likert scale, which generates data in the form of ordinal, or ordered, responses. Probably the most common example, and the one used here, is the extent of agreement with a view: *strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree.*

In order to measure these perceptions, respondents were asked to signal their agreement to several statements by using the Likert scale. If a respondent strongly agreed with the statement, the response was given a 5 value, whereas agreed, neutral, disagreed and strongly disagreed responses were given values of 4, 3, 2, and 1, respectively. The average rating among survey respondents was tabulated, and the percent of those who agreed with the statement (those responding with a 5 or 4) was calculated along with the percentage that disagreed with the statement (those responding with a 1 or 2). The results to a subset of the questionnaire’s leasing attitude statements are listed in table 2.

Table 2. Respondents’ attitudes about water leasing opportunities

Leasing attitude statement	Average Ranking	Percent Agree	Percent Disagree
1. I am willing to participate in a lease if paid enough.	3.55	61.1 %	18.9 %
2. I am willing to incorporate a fallow period into my crop rotation if I am compensated enough.	3.48	63.0%	19.0%
3. I am willing to reduce my farm’s consumptive water use, either by irrigating less or planting less water using crops, in order to fulfill conditions of a lease.	3.19	49.0%	29.0%
4. I am willing to lease my senior water rights and keep junior water rights if suitably compensated.	3.08	35.0%	25.0%
5. I am willing to negotiate directly with a municipality to establish a water lease.	3.21	47.5 %	29.1 %
6. I plan to sell water rights within the next 5 years.	2.07	6.6 %	63.3 %

As indicated in table 2, sixty-one percent of respondents indicate that they would be willing to sign a lease arrangement if suitably compensated, a value that stands a test of internal validity when juxtaposed against similar questions occurring later in the survey. Rotational fallowing is acceptable to 63% of respondents as indicated by statement 2 in table 2. Limited irrigation strategies are less popular (statement 3), perhaps because little is known about the financial ramifications of the strategy. Likewise, statement 4 indicates that respondents are reluctant to lease senior water rights and retain junior water rights. Less than half of all respondents are willing to negotiate directly with a municipality to lease water, perhaps leaving negotiations to their existing ditch companies, mutual associations or an institution that may evolve in the future. Perhaps even more interesting, fewer than seven percent of respondents expect to sell their water rights within five years. If water sales were more likely, the chance of successful water leasing arrangements between farmers and water providers would be less likely.

Based on these stated preferences, respondents have a favorable view of the impact that leases will have for farmers and rural communities. Many respondents are willing to sign leases if suitably compensated. In the next section, attention is focused on those survey respondents who were willing to lease or indicated a price at which they were willing to lease water³.

3.2 Respondents Willing to Lease: Characteristics, Prices, and Fallowed Land

Identifying characteristics of potential lesser will identify willingness to participate at a basin level. Consequently, the unobserved continuous measure "willingness to participate in a lease agreement" is specified to be a linear function of explanatory variables, plus an error term. The following explanatory variables are included in this study:

1. Demographic and socioeconomic characteristics of the farmer
2. Characteristics of the farm.
3. Opinions of water leases and agriculture.

Table 3 displays the results of the ordered logit results from regressing willingness to lease on farm and farmer characteristics. Variables that have a statistically significant negative impact on willingness to lease include debt ratio, which may indicate a more urgent need to sell water rights; percent groundwater use, high levels of which preclude one from leasing water; and proximity to urban centers, which implies increased pressure for urban development and thus increased chances of selling the water rights. Variables that have a statistically significant positive effect on willingness to lease include number of irrigated acres, which may indicate the amount of water available for lease; concern for rural communities; and willingness to work with municipalities and other organizations, which is necessary to establish a lease agreement.

³ In one survey section, respondents were asked to indicate if they were willing to enter into a water lease if compensated enough, and in a later section respondents were asked to indicate how much they must be compensated to forgo irrigation for one year. If respondents agreed or strongly agreed with the former, or indicated a lease amount to the latter, then their responses tabulated as potential lessees.

Table 3. Ordered logit results from regressing willingness to lease on farm and farmer characteristics.

Explanatory Variable	Coefficient	Standard Error	z-Statistic	Probability
Age	0.13	0.21	0.64	0.52
Second job	-0.10	0.19	-0.52	0.61
Debt ratio	-0.40	0.22	-1.81	0.07
Education level	-0.02	0.06	-0.36	0.72
Groundwater use	-0.01	0.00	-3.16	0.00
Plans to upgrade irrigation system	0.05	0.22	0.24	0.82
Plans to sell water	0.13	0.40	0.33	0.74
Proximity to urban center	-0.89	0.23	-3.89	0.00
Irrigated acres	0.00	0.00	1.93	0.05
Concern for rural communities	0.49	0.22	2.24	0.03
Willingness to work with municipalities	0.39	0.08	4.55	0.00
Willingness to work with other organizations	0.38	0.10	3.69	0.00
LR statistic (12 df)	80.39	LR index (Pseudo-R2)		
Probability(LR stat)	3.48E-12	0.220661		

3.3 Pricing Water Leases

The price at which farmers are willing to lease water is important. As noted previously, a necessary condition for leasing to occur is that the gains from leasing, calculated as the price difference between the willingness to accept on the part of water right holders and the willingness to pay of water providers, must exceed the transactions costs⁴ of executing the lease else a leasing agreement will not be reached.

In an open ended question, respondents were asked to indicate the *minimum* price they must be paid in order to forgo irrigation for one year as part of a leasing arrangement – an example of rotational fallowing. These responses were collected in the histogram shown in figure 1, which measures pricing intervals as column bars whose labels refer to the intervals’ uppermost bound. The proportions of respondents that fall within the interval are measured on the vertical axis. As an example, the proportion of respondents indicating a payment in the range of \$50 per acre to \$225 per acre is measured as 23%.

⁴ Transactions costs include, but are not limited to, the costs of collecting, conveying and treating water, legal costs, financing costs of paying the lease, risk premium associated inadequate supplies during drought, and the costs to maintain fallowed farmland.

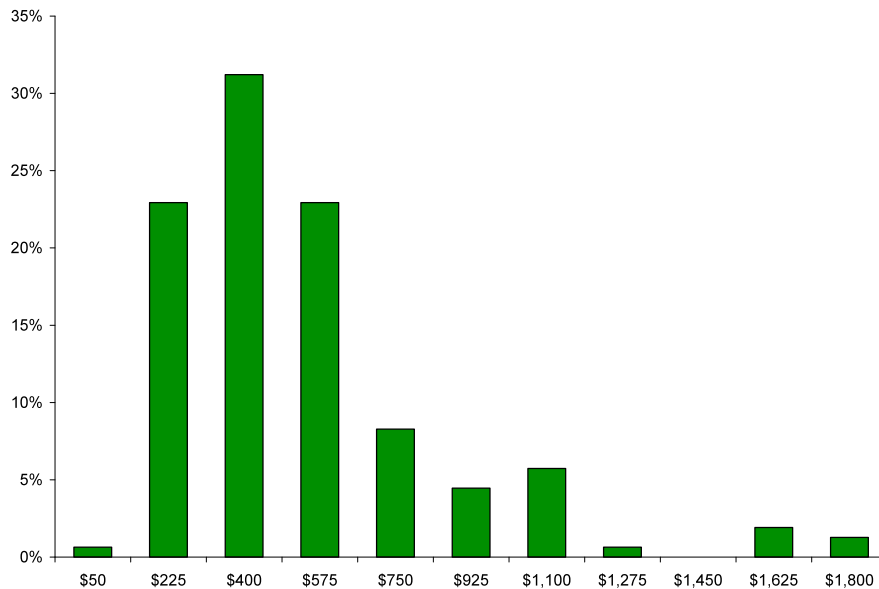


Figure 1. The minimum lease payments respondents seek for forgoing one year's irrigation (\$/ac).

The vast majority (seventy-seven percent) of responses populate an interval between \$225 per acre and \$575 per acre. A market analogy can be found for the lower end of this interval – at the time the survey was received, cash rent for irrigated cropland averaged \$300 per acre with dryland alternatives netting less than \$50 dollars per acre. The opportunity cost of forgoing irrigating cropping can be considered the difference between irrigated and dryland cash rents plus the cost of weed management and irrigation equipment maintenance. If this opportunity cost is \$300 per acre and two acre feet of water may be leased, then the opportunity cost is valued at \$150 per acre foot. It follows then that the present value of a long term lease, assuming a 5% average rate of return, is \$3,000 per acre foot. Recent sales of water bought and sold for agricultural use in the South Platte Basin have traded in the range of \$3,000 per acre foot (Water Colorado).

However, a number of respondents indicated a minimum lease payment of more than \$1,000 per acre as is indicated in figure 1. Following the calculations outlined in the previous paragraph, the imputed value of water in this case is \$10,000 per acre foot or more. Interestingly, this value is representative of recent water sales of agricultural water bound for municipal use (Water Colorado). Perhaps, then, these farmers are calculating a market value for their water rather than a minimum payment to forgo irrigation.

Survey respondents state a willingness to lease water and will do so at a price that is within the bounds of current water transactions. However, it remains to be determined if a sufficient amount of water is available to encourage leasing markets to evolve.

In another open ended question, respondents were asked to indicate the *minimum* price they must be paid in order to forgo one-half of their irrigation water for one year as part of a leasing arrangement – one example of limited irrigation. These results are illustrated in figure 2 along with the rotational fallowing results in figure 1.

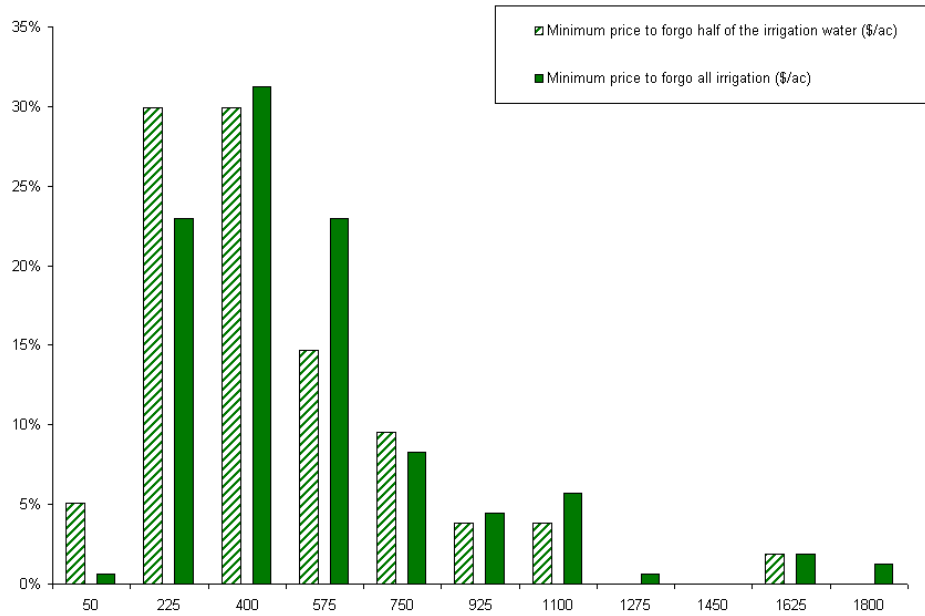


Figure 2. Respondents’ minimum payment to forgo one-half of their irrigation water and to forgo all irrigation water for one year.

Respondents’ need not be compensated as much to forgo limited irrigate when compared to rotational fallowing. However, 60% of respondents need to be compensated between \$225 and \$400 per acre.

3.4 Leased Water Quantities

In the context of rotational fallowing, respondents to indicate the percent of available water that they might be willing to commit to an annual lease, the amount of land that would be fallowed as a result of a lease, and the total irrigated acres that they held. In sum, the respondents to this question indicated they would fallow 33,352 acres that might free between 50,000 and 67,000 acre feet of water annually depending on how water courts evaluate their historical consumptive use. On average, respondents will fallow 200 acres per respondent, but a more detailed illustration these responses is found in figure 3.

The columns labeled on figure 3’s horizontal axis are of two types: the lightly shaded bars indicate the percent of all irrigated acres that respondents were willing to fallow in a lease, while the darker bars indicate the percent of irrigation water that might be committed to a lease. As an example, twelve percent of respondents were willing to fallow fifty percent of their irrigated acreage as part of a leasing agreement, while twenty percent of respondents were willing to commit half of their water to a lease.

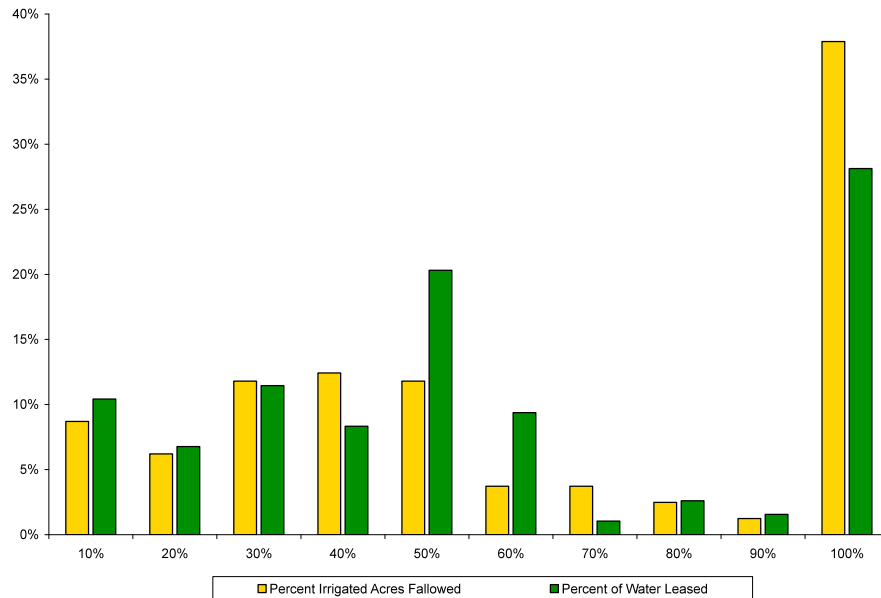


Figure 3. Respondents’ percent of all irrigated acres fallowed and the percent of all water supplies committed to an annual lease.

In examining figure 3, respondents tend to cluster into two groups – those that are willing to commit all of their land and water to a lease (right-hand side of the figure), and those that are willing to commit half of their holdings or less to a leasing arrangement. The latter half could be problematic in reducing transactions costs for leasing arrangements – it may simply cost more to collect, treat and transport water from many small sources than a few large sources.

Leasing to these survey respondents may not prevent rural economies from suffering; after all, if leases fallow all of the acres on a set of clustered farms, the regional economic base may shrink just as if a ‘buy and dry’ transaction had occurred. Indeed, this is the impetus for designing rotational fallowing institutions that spread fallowed acres over a large geographic area.

A limitation of this section’s discussion is particularly noteworthy. Water is characterized as a homogeneous commodity in the previous analysis; in reality, the prior appropriations doctrine creates a heterogeneous water product whose value varies with the seniority of its appropriation. Under the prior appropriations doctrine, those holding water rights with the earliest appropriation dates are satisfied first, and these water rights are the most valuable to municipalities. Therefore, a leasing market may prove to be too “thin” if the water made available by farmers is of relatively junior priority, and municipal water providers instead seek scarcer, senior water rights.

4.0 Conclusions and Future Opportunities

Reallocation of water from agricultural to municipal use is inevitable given the rapid population growth of the heavily urbanized West. These water transfers are controversial largely because they may fallow large swaths of irrigated lands that are in

turn a significant portion of the local rural economic base. In place of these ‘buy and dry’ transfers, stakeholders are interested in the opportunity to create water leasing markets to partially meet future demands.

This study focuses on the stated preferences of South Platte Basin farmers who answered a questionnaire mailed in September 2007. Analysis of the submitted questionnaires indicates that a significant amount of water may be leased at a reasonable price. Important characteristics of those willing to lease include owning a large number of irrigated acres, having concern for rural communities, and being willing to work with municipalities and other organizations to orchestrate lease agreements.

Researchers have the opportunity to perform more work before leasing markets evolve in the South Platte Basin. In particular, the willingness to pay of municipal water supplies needs to be revealed, and the transactions costs of leasing markets examined. Transactions costs have been measured by Colby (1990); an update is needed to determine if leasing arrangements incur the same costs as permanent water transfers. If so, then the gains from leasing may evaporate. Monitoring lease arrangements may be costly, but if monitoring does not occur seniority water rights may decrease in value. Alleged lack of enforcement precipitated the shut down of more than 440 groundwater wells in Colorado. Similar problems might limit leasing opportunities.

References

- Colby, B.G. (1990), "Transaction Costs and Efficiency in Western Water Allocation." *American Journal of Agricultural Economics*. December. pp. 1184-1192.
- Colorado Water Conservation Board. 2004. Statewide Water Supply Initiative. Denver, CO. <http://cwcb.state.co.us/IWMD/General.htm>
- Daykin, A.R. and P.G. Moffat. 2002. "Analyzing Ordered Responses: A Review of the Ordered Probit Model." *Understanding Statistics*. Vol. 1. Issue 3. pp: 157-166.
- Dillman, D. (2007) *Mail and Internet Surveys: Tailored Design Method*. (2nd Ed). Hoboken, NJ: John Wiley & Sons.
- Kennedy, P. (2003) *A Guide to Econometrics*. (5th Ed). Cambridge, MA: The MIT Press.
- Kimball, A. 2005. "Selling Water Instead of Watermelons: Colorado's Changing Rural Economy." *The Urban/Rural Edge*. Issue 8.
- Michelsen, A. and R. Young. 1993 "Optioning Agricultural Water Rights for Urban Water Supplies during Drought." *American Journal of Agricultural Economics*, 75:1010-1020.
- Thorvalson, J and J. Pritchett. 2006. *Economic Impact Analysis of Irrigated in Four River Basins in Colorado*. Colorado Water Resources Research Institute. Completion Report No 207. Fort Collins, CO. <http://www.cwrri.colostate.edu/pubs/series/completionreport/crlist.htm>
- Water Colorado. Online trading and water information firm. www.WaterColorado.com
- Western Governors' Association. 2006. *Annual Report: Building a Sustainable West*. Denver, CO. <http://www.westgov.org/wga/publicat/annrpt06.pdf>