Irrigation Management in Colorado: Survey Data and Findings

by

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Executive Summary

Very little is known about how many producers adopt irrigation technologies developed by researchers at Colorado State University. The few surveys that have been done suggest that producers are not making full use of available technology. Tight profit margins and environmental impacts, such as groundwater pollution, make it important to understand why producers are not adopting irrigation technologies at a faster rate. This information, in turn, would help CSU focus its research and extension programs to better serve Colorado producers.

We conducted a survey of irrigation management practices in Colorado to better understand what irrigation technologies and management practices producers use and why. In a joint effort by the Department of Agriculture and Natural Resource Economics and the Department of Soil and Crop Sciences, researchers and extension professionals gave producers an opportunity to provide feedback about our programs. Specifically, we asked about the management practices that producers are currently using, how those management decisions are made, and the relative importance of various factors in those decisions. The survey was mailed in early 1997 to 3,281 irrigators identified through the Colorado Agricultural Statistics annual crop production survey. Over 40% of the surveys were returned as useable responses. Basic data and results are provided in this report. Analyses and interpretations will follow in later reports.

The survey contained six sections. Section 1 asked for information about the entire farming operation including farm size, commodities produced, the types of irrigation systems in operation, and best management practices (BMP's) used. In Section 2, *Describe a Representative Irrigated Field*, we asked producers information about the irrigation system used on and the water applied to a field that is most representative of

their farm. The representative field was also referenced in Section 3, *Management of the Representative Field*. In this section, producers identified methods used to decide when and how much water to apply, changes in management, and resources applied to the representative field. In Section 4, *Technology Comparison,* respondents were asked to rank alternative irrigation systems on different attributes. Section 5, *Water Management Decisions*, rates decision factors, quality of information available to the farmer, and the work conducted by CSU on water management. The last section, Section 6, *Personal Information*, elicited demographic information about the respondent including experience, education, gross sales, and off-farm employment.

Colorado irrigators are highly experienced with an average of 31 years of irrigation experience. They tend to be well educated, with two-thirds having completed at least some college or vocational training. Over one-third of respondents had gross farm sales of less than $50,000 annually, while only 4% grossed over $1,000,000. Collectively, 43% of the respondents grossed between $50,000 and $250,000. Over one-third of respondents had off-farm employment, but 40% of their income was still derived from the farm. Although there was much regional variability, the average whole-farm size for the sample was 2,009 acres (median was 480) with an average cropped area of 529 acres, of which 387 acres, or 73%, was irrigated.

Surface water accounted for nearly three-quarters of the irrigation water used by all respondents, with the balance coming from groundwater. Many respondents rely on water from both surface and aquifer sources. Statewide, gravity (flood, siphon tubes, gated pipe, and other gravity) and sprinkler systems (center pivot and other sprinkler) account for nearly equal proportions of irrigated acreage, but the distribution is much more variable regionally.

While results varied widely by region and farm demographic, overall we found many of the common Best Management Practices were widely adopted. For example, eighty-four percent of respondents reported at least one irrigation system upgrade somewhere on their farm. Additionally, two-thirds of Colorado producers used soil test analysis to help determine their fertilizer rate. However, crediting of other nutrient sources such as past manure applications, legume crops, or irrigation water was cited much less frequently. Among pest and pesticide management practices, field scouting was widely used (64%) with more producers reporting using field scouting than pesticides. However, use of resistant varieties or banding/spot application for pest control were not widely reported and only half of all pesticide users reported keeping records of pesticide applications.

Overall, Colorado irrigators consider their water sources to be highly reliable. For example, 65% of respondents described their water supply as highly reliable, providing adequate water ten years out of ten. This result varied greatly by region, especially in the Arkansas Valley where lower water reliability was reported. We also found that some producers have concerns about the quality of their irrigation water for crop production. Fifteen percent of respondents cited concerns about their irrigation water quality. Irrigators in the South Platte and the Arkansas Valley most frequently indicated concern. The most common water quality concern statewide is salinity; with sediment, sewage, and nitrate contamination also cited with some frequency.

Flood and siphon tube systems were installed an average of nearly 75 and 35 years ago, respectively. The average age of all other systems falls below 20 years. Nearly all center pivot users had upgraded their system in some manner, but less than 40% of the flood systems in any of the three western regions have been upgraded. Field leveling and lining ditches occurs frequently with flood systems in the eastern regions and for siphon tube systems across the state. An upgrade that very few producers in Colorado have adopted is flow meters, a tool for keeping track of water application.

The majority of respondents indicated that they knew their system's efficiency, but their estimates of application efficiency tended to be much higher than commonly measured values obtained from research and field demonstration projects, especially among surface irrigators. Only slightly over one quarter of respondents reported they knew the amount of water applied to their representative field, and less than one-sixth of respondents indicated keeping records of water application.

The majority of producers (51%) said they used "crop appearance" as the primary method to determine when to irrigate their crops and nearly one third cited a "fixed number of days" between irrigations. Irrigation scheduling methods such as using accumulated ET or available soil moisture was selected by only about one quarter of the respondents, but more frequently by center pivot users and groundwater users. Producers cited "same amount each time" and "crop determines" as their primary methods to determine how much water should be applied. There was also notable variation among some demographic groups and regions in the level of irrigation scheduling and water application decision-making.

Finally, when looking at how producers rated the quality of information provided by CSU Cooperative Extension and other sources for crop production and irrigation management decisions, we found Cooperative Extension received an average rating of 3.0 or “Good”. This rating compares to consultants, soil testing labs, and chemical dealers receiving ratings of 2.6 to 2.7 and neighbors, the NRCS, Water Management District, and Popular Press with ratings of 3.0 to 3.8 respectively. However, producers rated research and extension activities at CSU as “Good” to “Very Good”. The striking result is the number of respondents (50%) who believe they have not directly used CSU’s work in their operation.

This survey provides us with quantitative data on how Colorado producers are managing their irrigation water. The age of many irrigation systems, the lack of “scientific” management practices, and the limited knowledge of how much water is being applied represent significant barriers to improving water conservation and quality in Colorado. These data should cause us to reevaluate current extension and research programs and question whether high-tech solutions are appropriate for many Colorado producers. On a positive note, we documented widespread understanding and adoption of some Best Management Practices and irrigation system upgrades among producers. This information, combined with producers’ ratings of CSU work on water issues, indicates the success of past research and outreach efforts.

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Purpose of Report

Land Grant Universities helped reduce water scarcity in the West with research that enhances irrigation efficiency. Technologies such as surge valves and low energy precision application (LEPA) make water usage more efficient and uniform. Better management techniques such as irrigation scheduling can also boost efficiency and yields. Colorado State University (CSU), the Agricultural Experiment Station, and Cooperative Extension commit millions of dollars annually in faculty time and other resources to improve irrigation management and technology. However, little is known about how many producers adopt technologies that CSU researchers identify as beneficial. Information that is available varies widely.

A few studies have been conducted concerning irrigation practices used, including Agricultural Census (1996), Tri-State G&T Irrigation End-Use Survey (1995), and Klein & Smith Irrigation Practices Survey (1995). These surveys suggest that producers are not making full use of available technology that research has identified as beneficial, but do little to explain why. Tight profit margins and environmental impacts, such as groundwater pollution, make it important to understand why producers are not adopting irrigation technologies at a faster rate.

The purpose of this report is to summarize data from a survey of Colorado irrigators that is more extensive and comprehensive than past efforts. The survey was conducted to determine which management practices producers are currently using, how those management decisions are made, and the relative importance of various factors in those decisions. This knowledge creates an opportunity for extension efforts to be directed toward the needs of their clients and for them to communicate needs back to researchers, who can better fit their research programs to address clientele needs.

The following pages are divided into three major sections. First, we describe the survey procedures and response rates. Second, we provide a brief description of basic findings. Finally, we provide a comprehensive set of tables and figures that summarize our data. The primary purpose of this report is to summarize data. It is a description of what we found. A variety of analyses will follow in future reports.

Survey Procedures and Response Rates

An advisory committee of researchers and extension personnel representing the major irrigation-related disciplines at Colorado State University was appointed and consulted throughout the development of the survey. This committee helped define a general set of questions. As prescribed by Dillon (1978), cooperating producers assisted in pre-testing the survey that was ultimately mailed to a representative sample of Colorado irrigators.

The survey was divided into six main sections with a total of 48 questions. The entire survey instrument is included as Appendix A. Section 1, *General Farm Information*, asked for information about the entire farming operation including farm size, commodities produced, the types of irrigation systems in operation, and best management practices (BMP's) used. In Section 2, *Describe a Representative Irrigated Field*, producers were instructed to think of a specific field that best represented their entire farm for answering questions. This section elicited information about a particular field, the irrigation system used, and the water applied to this field. The representative field was also used in Section 3, *Management of the Representative Field*. In this section, producers identified methods used to decide when and how much water to apply, changes in management, and resources applied to the representative field. In Section 4, *Technology Comparison*, respondents were asked to rank alternative irrigation systems on different attributes. Section 5, *Water Management Decisions*, rates decision factors, quality of information available to the farmer, and Colorado State University's work on water management. The last section, Section 6, *Personal Information*, elicited information about the respondent including experience, education, gross sales, and off-farm employment.

The USDA National Agricultural Statistics Service (NASS) provided names for the mailing. NASS was used to obtain a representative sample of all irrigators in the state. Irrigators were drawn from the sampling frame for the Colorado Agricultural Statistics annual crop production survey, and limited to those producers who irrigated any crops, and had at least 40 acres of cropland. These criteria yielded a list of 3,281 addresses distributed across the state as shown in Table 1. Appendix Table B1 details this distribution at the county level.

Table 1. Number of Surveys Mailed by Region and Farm Size

	Farm Size[a] (acres)							
Region	Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
South Platte	93	237	205	190	139	65	39	968
Eastern Plains	1	17	35	69	194	130	82	528
Arkansas Valley	23	56	51	66	43	23	43	305
San Luis Valley	20	62	68	89	70	20	8	337
Mountains	17	46	38	51	64	62	57	335
Western Slope	82	220	168	125	109	43	61	808
Colorado	236	638	565	590	619	343	290	3,281

[a] Includes all irrigated and dry cropland, pasture, and rangeland.

The surveys were mailed the first week of February 1997. As prescribed by Dillman (1978), reminder postcards were sent three and ten days following the initial mailing of the survey. In his Total Design Method, Dillman suggests sending the survey again to non-respondents two weeks after initial mailing. However, because of NASS's confidentiality requirement, it was not possible to identify who had and had not responded, so no follow-up surveys were sent.

To control for the diversity of irrigation practices in Colorado, six geographic regions were identified: the South Platte, the Eastern Plains, the Arkansas Valley, the San Luis Valley, the Mountains, and the Western Slope (Figure 1). These regions were selected based on known differences in water distribution and management. The South Platte region includes counties obtaining most of their water from the South Platte River or its alluvial aquifer, whereas the Eastern Plains are characterized by the primary use of groundwater from the Ogallala aquifer. The Arkansas Valley is characterized by use of the Arkansas River as the primary source for irrigation. The San Luis Valley region obtains water primarily from the Rio Grande River and the valley's shallow aquifer. The

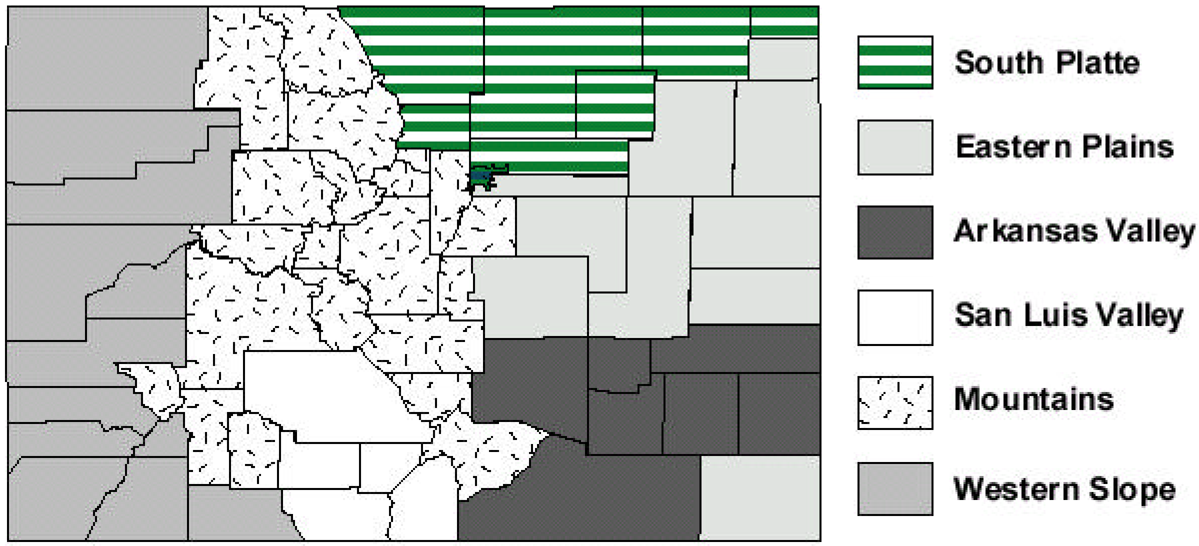

Figure 1. Regional grouping of survey responses by county given.

Western Slope gets water primarily from rivers, such as the Yampa and Colorado. Finally, counties in the Mountain region are characterized primarily by the use of individual surface diversion from streams and rivers.

Over the following weeks, 1,319 usable responses were returned. This accounted for over 40 percent of the surveys mailed. If adjusted for undeliverable surveys and non-usable (incomplete) returns, the overall response rate was 42 percent.

Response by Region and Farm Size

NASS was able to provide a summary of the number of surveys mailed to each county and farm-size category based on previous responses to their survey efforts (Appendix Table B2). Using that information, an estimate of response rate by region and farm size was generated (Table 2). Response rates across regions were relatively similar to the overall response of 40 percent, with the Eastern Plains being lowest at 35 percent and the Mountains and San Luis Valley highest at 43 percent.

Table 2. Percentage of Surveys Returned by Region and Farm Size

	Farm Size[a] (acres)							
Region	Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
South Platte	52	39	40	38	43	32	23	40
Eastern Plains	100	65	34	48	37	32	17	35
Arkansas Valley	65	54	47	39	35	17	16	40
San Luis Valley	45	52	35	43	51	30	0	43
Mountains	47	52	47	47	44	35	33	43
Western Slope	61	51	44	41	30	30	13	42
Colorado	56	47	42	42	39	31	20	40

[a] Includes all irrigated and dry cropland, pasture, and rangeland.

There is, however, a systematic difference in response rate when considering farm size. Across the state, the smallest farms (less than 100 acres) responded at the greatest rate (56 percent) while the largest farms (over 5,000 acres) provided the lowest response (20 percent). In fact, at the state level, the response rate for each farm-size category is less than for all categories with less acreage. Similar trends hold within each region. County-level response rates are included in Appendix Table B3.

There are several possible reasons to explain the lower response rate for larger farms. First, larger farms tend to be more diversified, especially into grazing and dryland farming enterprises, so it is more likely that an irrigation enterprise may take on relatively less importance in their operation, reducing interest in the survey. Second, large farms with a higher proportion of irrigation often have a number of individuals involved in management. There may have been some difficulty in getting the survey to the appropriate individual to respond to it.

Summary and Discussion of Survey Data

Respondent Characteristics

Personal characteristics of producers can give some insight into explaining why they take different actions in managing their enterprises (Table 3). The survey shows that Colorado irrigators are highly experienced, with an average of 31 years or irrigation experience. All regions were similar except the Eastern Plains, which was lower at 25 years. Major development of irrigation in this region did not occur until the 1970s. This does not provide the opportunity for the number of producers to have 40 to 50 years of experience as observed in the other regions.

Statewide, producers' educational experiences were divided by near even thirds among those with a high school background, those with some college or vocational degree, and those earning a college degree. Some differences were evident across regions. The Arkansas Valley had the lowest proportion of graduate degrees (3 percent) but also the lowest proportion with a high school education (27 percent). At 32 percent, the Eastern Plains had the highest proportion of those with a bachelor's degree, while the Mountains and Western Slope had the most producers with post-graduate degrees at 15 and 13 percent, respectively.

Gross farm sales for Colorado irrigators show some interesting distributions. For the entire state, over one-third grossed less than $50,000 annually, while only four percent grossed over $1,000,000. Collectively, 43 percent of the respondents grossed between $50,000 and $250,000 while 17 percent grossed between $250,000 and $1,000,000. Differences in gross sales between regions are obvious. On the Eastern Plains three-quarters of the producers had annual sales exceeding $100,000, whereas this was true for less than one-quarter of those responding from the Mountains and Western Slope. Differences in the typical scale of operations and value of product likely account for these differences.

Trends in off-farm employment follow a related pattern. Statewide averages show that over one third of respondents had off-farm employment. Regions with lower gross sales tended to have greater off-farm employment. The low-grossing Mountains and Western Slope had the highest off-farm employment at 45 and 38 percent, respectively, while the high-sales Eastern Plains had the lowest off-farm rate at 20 percent.

For Colorado irrigators with a job off the farm, 40 percent of their income was still derived from the farm. This ranged from 35 percent in the San Luis Valley and the Western Slope to 49 percent in the Eastern Plains. Among all respondents, 81 percent of their total income came from farm operations, ranging from 91 percent in the Eastern Plains down to 76 percent in the Mountains and Western Slope.

Farm Resources

<u>Land</u>

Farm resources differ greatly by region (Table 4). The average farm size for the state was 2,009 acres, ranging from 890 acres in the San Luis Valley to 3,015 acres on the Western Slope. The inclusion of a few very large operations in the sample pulls these averages up so the median farm size is also included to characterize the typical operation.

Significant variation exists in the average cropped area across regions. The area cropped in the Eastern Plains is more than twice the statewide average while the Western

Slope is less than half. Variation in average area irrigated is less, but similar patterns exist with the Eastern Plains averaging much more and the Western Slope much less. Note that for all regions, the majority of cropped acres that respondents farm are irrigated. The average cropped area for all respondents was 529 acres, of which 387 acres, or 73 percent, was irrigated. The proportion of cropped area irrigated ranges from 100 percent in the San Luis Valley down to 53 percent in the Eastern Plains.

Statewide, producers leased or rented an average of 29 percent of their irrigated acres. In the three mountainous western regions, a much smaller fraction of the irrigated acres were leased or rented. Higher percentages of rented acres were found in the regions comprising eastern Colorado.

Water Sources

Water sources had the greatest variation across regions. Surface water accounted for 72 percent of the irrigation water used by all respondents with the balance coming from groundwater. Surface water sources supplied practically all of the irrigation water in the Mountains and Western Slope regions. The Arkansas Valley used primarily surface water, with only 12 percent coming from a groundwater source. In the South Platte region, two-thirds of the water used for irrigation came from surface water sources, primarily out of the South Platte River. The San Luis Valley is similar with almost two-thirds of the water coming from a surface source. In contrast to the other regions, farmers on the Eastern Plains obtained 92 percent of their irrigation water from a groundwater source.

In the Arkansas Valley, surface water accounts for 88 percent of use, but only 68 percent of respondents in the region were totally dependent on these sources. Both the

San Luis Valley and the South Platte rely upon surface water to provide about two-thirds of their needs. However, 43 percent of South Platte respondents are entirely dependent upon surface water compared to 37 percent of those in the San Luis Valley. In fact, for 45 percent of those in the San Luis Valley, surface water provides less than two-thirds of their irrigation needs while this is true for only 37 percent of producers in the South Platte.

Irrigation Systems

Statewide, gravity (flood, siphon tubes, gated pipe, and other gravity) and sprinkler systems (center pivot and other sprinkler) account for nearly the same proportion of irrigated acreage at 52 and 48 percent, respectively (Table 5). In the Eastern Plains sprinkler systems (primarily center pivots) serve 90 percent of the acres. In the Arkansas Valley and the Mountains, gravity systems serve over 90 percent. On the Western Slope gravity systems account for 80 percent of acres, though other sprinklers (predominantly side roll systems) are important. Finally, a mixture of sprinkler and gravity systems serves the South Platte and San Luis Valley with 47 and 58 percent of each respective region served by sprinklers.

Among all respondents, center pivots dominated sprinkler usage except on the Western Slope where side roll systems are prevalent. Flood systems account for over half of the gravity-served acres in the state. Flood irrigation was nearly the exclusive gravity method in the Mountains and San Luis Valley and dominant in the Arkansas Valley and Western Slope. Siphon tubes were the dominant gravity system in the South Platte.

While center pivots account for nearly one half the total acreage served, less than one-third of respondents use these systems. Conversely, flood irrigation accounted for about a quarter of the acres, but more than one half of respondents use this system. Similarly, for gated pipe, siphon tubes, and other sprinkler systems, the proportion of farmers using these technologies is higher than the proportion of acres that they serve. This holds across the entire sample and, in many cases, regionally. For example, note that only 13 percent of the South Platte acreage is served by gated pipe, but that 45 percent of producers use this technology. Each statistic will clearly have different implications in the development of policy, research, and extension programs.

A final aspect of farm-wide use of irrigation systems is the percent of farm irrigated acres served by a particular type of system (Table 5). For example, the respondents that use gated pipe on their farms use this technology on an average of 42 percent of their irrigated acreage. When producers chose to install a certain application system, that technology is commonly used on a significant portion of their farm. Statewide, the chosen system type accounts for 41 to 78 percent of the irrigated acreage on the farm.

Farm Products

<u>Crops</u>

Producers in Colorado grow a diverse set of crops and livestock. Survey responses were grouped into broad crop categories to facilitate summarization (Table 6). Alfalfa or other hay is the most common crop with 77 percent of producers in the survey growing it. Within each region farmers chose to grow hay more frequently than any other crop, except for the Eastern Plains. The selection of non-hay crops varies across region. Corn and wheat are dominant crops among the three eastern regions with beans also being important in the South Platte and Eastern Plains. Potatoes, barley, and wheat are the major crops grown in the San Luis Valley. Producers in the eastern regions and the Western Slope frequently grow crops not falling into these categories. Dryland crops are important in the Eastern Plains whereas vegetables and other specialty crops are frequently grown in the Arkansas Valley and the South Platte. Fruit and vegetable production are also prevalent on the Western Slope.

On a statewide basis, wheat is the largest cropping enterprise with an average of 442 acres per farm. Potatoes and corn are next with 376 and 359 acres, respectively. Examination of the table, however, reveals that the average per-farm-acreage of each crop grown varies widely from region to region and from crop to crop.

Among crops that are widely grown by the respondents, the majority of acreage is irrigated. On average, better than 80 percent of the acreage of each of the field crops grown are irrigated with the exception of wheat in the South Platte and wheat and "other crops" in the Eastern Plains. This provides an indication that the sample primarily represents individuals who are active in irrigation enterprises, not merely irrigating a few acres.

Livestock

The majority of producers in each region have some livestock on the farm (68 percent statewide) (Table 7). Of these, the vast majority are beef cows with stocker and fat cattle exhibiting some prevalence. Sheep are found on nearly 10 percent of operations in the San Luis Valley and the Western Slope.

On average, producers with beef cows own about 150 head. Specialization in the other livestock types tends to result in greater herd numbers than beef cows. Average swine herds are known to be larger than reported but none of the large-scale operations appear in the sampling. Across the state, nearly half of the respondents had greater than 50 head of animals. Only in the South Platte and the San Luis Valley were herds of this size less common with frequencies of 36 and 42 percent respectively.

Management Practices on Whole Farm

Respondents were asked to identify practices regularly used anywhere on their farm for with respect to irrigation, fertilizer, and pest management. Many of the possible responses are recommended Best Management Practices (BMPs) to maintain productivity and protect environmental quality (Waskom et al., 1994). The results are summarized in Table 8. The most conspicuous finding is that the number of producers reporting use of BMP's varies widely by region. Some of this variation can be attributed to the different major crop rotations grown in each region and the applicability of BMPs for different areas. For example, corn grown under center pivot irrigation systems dominates the Eastern Plains while the major crop grown in the Mountains is meadow hay under flood irrigation.

Irrigation Upgrades

The first set of farm-level management questions asked for upgrades installed on irrigation equipment. Because more in-depth questioning of a selected field was presented subsequently, these questions were framed to characterize farm-wide adoption. Table 8 shows that 84 percent of respondents employed at least one of the identified upgrades. The three western regions, however, each had greater than 15 percent of the respondents making none of these upgrades. Measurement devices such as flumes, weirs, or flow meters were among the more common upgrades.

Fertilization Practices

Fertilizer practices are also an integral part of irrigated agriculture. Other than their own experience, the survey data show that Colorado producers rely upon soil test analysis more than any other method to determine their fertilizer rate. In some regions (South Platte and Eastern Plains) a large majority of irrigated producers are using this practice. Soil testing is the basis for sound fertilizer management and producers have recognized the economic and agronomic benefits of this practice. The percent of crop acres sampled also reflects the varied crop rotations around the state. For instance, producers in the San Luis Valley said they sampled about 50% of their acreage on average in 1996. A two-year potato to small-grains rotation is common in the San Luis Valley, and producers most likely sample fields to be planted into potatoes. The percentage of producers using soil testing also increases as the number of crops grown increases (Table 9).

Fewer producers take into consideration other nutrient sources such as past manure applications, legume crops, or irrigation water than do soil testing. The majority of producers who used manure on the representative field (69%) reported using manure credit on any fields. Although we cannot quantify how many pounds of nutrients that producers credit toward manure applications, these results suggest a general awareness of manure as a nutrient source. Producers in some areas of the state (namely the South Platte) use manure from livestock they do not own.

The nutrient sources that respondents were least likely to credit toward their fertilizer rate were irrigation water and previous legume crops. Only one quarter of the producers growing alfalfa or beans statewide reported using a legume credit when determining their fertilizer rate. Only a few producers credit their water as a nutrient source. Crediting nitrate-nitrogen from irrigation water is primarily practiced by producers using groundwater in the San Luis Valley and the South Platte. Both regions have large areas with groundwater high in nitrate-nitrogen (Austin et al., 1995ab) that can be used by a crop when applied with the irrigation water. The San Luis Valley also has a USDA Water Quality demonstration project that has promoted this practice since 1991.

Pest and Pesticide Management

The results for pest and pesticide management practices show that field scouting was the most widely used pest management technique among respondents (Table 8). Producers were asked to include all weed, insect, and disease control practices used. On average, more producers reported using field scouting than pesticides. The percentage using field scouting increases when the data is sorted by pesticide users and nonusers as in Table 10. Determining pesticide applications by field scouting is widely considered a basic practice for integrated pest management (IPM). When using IPM, producers reduce their reliance on pesticides by applying only when potential crop damage exceeds the cost of application.

More pesticide users are using pest management BMP's than those producers not reporting pesticide use. However, some "non-pesticide" users reported using such pesticide management practices as "economic thresholds" and "banding or spot application." Often the term "pesticides" is confused with only meaning insecticides and not herbicides and fungicides. The responses suggest that misinterpretation about the term "pesticides" may have occurred in this instance. Nevertheless, the results show that among producers reporting pesticide use, field scouting, crop rotation, economic thresholds, and tillage are also popular tools used for pest management.

The results show that using resistant varieties and banding or spot application are not widely used practices. Varietal resistance is both a disease and insect pest prevention tool, but most producers apparently select varieties based upon yield potential with resistance being a secondary goal. Banding and spot application for weed and insect control reduces how much pesticide is required. Still, these practices require more management and are often not available when using commercial applicators. Only a minority of producers use intensive management techniques such as pest forecasting and biological controls. These practices require additional time and locally adapted information that is not available for many crops.

One practice that varied significantly by region, but was lower than expected statewide, was pest and pesticide record keeping. Half of all pesticide users (Table 10) reported keeping these records. These records are important for monitoring pests, keeping track of plant back restrictions, and are required by law for restricted use pesticides (RUPs). Economic thresholds were used by more than 50% of pesticide users. However, these thresholds are not available for all crops and areas of the state. More producers reported using consultants for pest and pesticide than for fertilizer and irrigation management advice. This fact is readily explained by the higher cost of pesticides and the labor needed for good pest control.

Representative Field

The diversity of most Colorado farms makes it very difficult to obtain information on specific irrigation management decisions across the entire farm. To facilitate detailed questioning of how those decision are made, each respondent was asked to identify a specific field on their farm that was representative of their farm. All of the questions in this section of the survey were specific to that identified field.

Land

Across the state, the average field size was 67 acres (Table 12). Average field size ranged from 127 acres on the Eastern Plains to 37 acres in the Arkansas Valley. The large field sizes in the Eastern Plains correspond to the typical size of the quarter-section center pivots that are common there. Median values for field acreage are also reported to off-set the distorting effect of several larger fields in each region.

Twenty-three percent of the representative fields were identified as rented or leased. The proportion of rented fields was higher for the three eastern regions than for those to the west. Soil texture varied dramatically within each region. Comparisons between regions are difficult at best.

For those using gravity systems, length of row and field slope are factors in system efficiency, irrigation timing, and labor requirements. All of the regions except the Western Slope had average row lengths of about one quarter mile and substantially similar distributions. Row lengths on the Western Slope were generally much shorter. Field slopes were found to be the greatest for the Western Slope and the Mountains with the San Luis Valley having the least slope under gravity systems.

Water Sources

The survey identified the proportion of respondents indicating a primary reliance on groundwater, a ditch company, or a private diversion right direct from a stream, respectively (Table 13). Paired with this value is an indication of the proportion of these individuals that have access to supplemental sources of water. For instance, 69 percent of the representative fields in the South Platte rely on a ditch company for their primary source of water and 45 percent of the farms also have a supplemental source.

Groundwater serves as the primary source for the vast majority of the Eastern Plains fields (90%) and a significant number of South Platte and San Luis Valley fields (33 and 38%, respectively). However, very few fields in the Eastern Plains (2%) have access to supplemental water, whereas many in the South Platte and San Luis Valley do (20 and 39%, respectively).

Ditch companies provide the primary source of irrigation water to the majority of representative fields (57%). Thirty-four percent of those fields also have a supplemental source. Direct diversions are the primary source of water for the majority of respondents only in the Mountains (81%). Supplemental sources are available for 25 percent of those using direct diversions as their primary source, statewide.

The reliability of water supply is an important factor in many irrigation decisions. Whether or not a given water source is reliable is contingent upon the source of water, the application system, and the crop grown. To quantify reliability, we asked producers to estimate the number of years out of ten that the primary and supplemental water sources together provided a full water supply for the crops grown on the representative field. Once again, the results from this question varied by region.

Overall, 65 percent of respondents described their water supply as highly reliable, providing adequate water ten years out of ten. Regions with higher reliance on groundwater sources were found to have higher water reliability, while regions more reliant upon a ditch company have lower water reliability. In the Eastern Plains where reliability was the greatest, groundwater supplies 90 percent of the irrigation water with most producers applying the water with a center pivot. Conversely, in the Arkansas Valley where reliability was rated the lowest, 86 percent of irrigators used a ditch company as a primary water source and most water is applied using a gravity system.

The pump depth and well capacity are important parameters to the groundwater pumper. Pump lifts exceeded 100 feet for the majority of representative fields in the Eastern Plains (68%) and the Western Slope (80%) whereas they were less than 100 feet for the majority of those in other regions. Pumping yields were greatest for those in the

San Luis Valley, South Platte, and Eastern Plains (52%, 34%, and 24% over 1,000 gpm, respectively) while a large majority of wells in each of the other three regions produced less than 500 gpm.

Finally, producers using sprinkler systems on their representative field were asked about nozzle pressures. Nozzle pressure impacts water and energy conservation. Higher pressure requires more energy and generally leads to greater evaporation during application. On average, respondents cited nozzle pressures of 35 psi with the lowest pressures observed in the Eastern Plains and the Arkansas Valley. Much higher pressures were observed in the Mountains and the Western Slope. Use of lower pressure in the two eastern regions is expected because of sensitivity to high pumping costs and the increased need to conserve scarce water resources.

We included a question to assess concerns that irrigated producers have about the quality of the water used for crop production on the representative field (Table 14). Fifteen percent of producers affirmed concerns about their irrigation water quality with those in the South Platte (19%) and the Arkansas Valley (35%) indicating concern most frequently. The categories of impairment concerns are as diverse as the different regions of Colorado. The most common concern statewide and particularly in the Arkansas Valley and Western Slope region is salinity. These are legitimate concerns with high soluble salt content reported by several studies (Austin et al. 1997; Butler and von Guerard, 1996) in surface and ground water within these basins. Sediment, sewage, and nitrate contamination also have producers' interest in several basins. Other water quality issues ranged from heavy metals from mining to pesticides from other farms.

About 34 percent of all operators reported that there was no runoff from their representative field. About 80 percent of sprinkler operators claimed no runoff while only 12 percent of producers who surface irrigate reported none. Of all producers that reported runoff, 14 percent of irrigators reported runoff to on-farm collection systems, with the remainder going to surface drainage ways (43%) or other unspecified destinations (8%). Runoff to surface waterways was the destination for 59% of the surface irrigation water on a statewide basis.

Irrigation System on Representative Field

Type

Flood (32%) and center pivot (26%) systems comprise over half of the systems used by producers on their representative field. There are major differences between regions, however. While center pivots are most frequent in the Eastern Plains (79%) and San Luis Valley (50%), flood systems are most prevalent in the Mountains (82%), Western Slope (43%), and Arkansas Valley (41%) and second most important in the San Luis Valley (28%). Remaining producers on the Western Slope use primarily gated pipe or side roll sprinklers. Most non-flood Arkansas Valley producers use gated pipe or siphon tubes. The South Platte region revealed a variety of irrigation systems in use. Gravity systems were most prominent, with 36 percent of the respondents using siphon tubes, 20 percent using gated pipe, and 15 percent using flood. Center pivots were used by 25 percent of the respondents.

Age

Considerable variation was observed in the average age of the systems used. On average, the flood systems on the representative field were installed nearly 75 years ago. At less than half the age, the siphon tube system have been around for about 35 years. The average age of all other systems falls below 20 years at the regional level except for the small number of gated pipe systems found in the Eastern Plains (29 years).

Upgrades

Detailed questions were asked to determine which upgrades are implemented on representative field systems. The results are presented by irrigation system in the latter part of Table 15 because significant differences existed between system types. Nearly all center pivot users have upgraded their system in some manner with low pressure systems and drop nozzles catching on rapidly, but high technology systems like LEPA, corner catchers, and computer controllers are less common. A notable finding among side roll systems was the lack of upgrades. Forty-five percent of side roll systems have not been improved.

Among gravity systems, flood irrigation components are least frequently improved. Less than 40% of the flood systems in any of the three western regions have received an upgrade. Field leveling and lining ditches occurs frequently among flood systems in the eastern regions and for siphon tube systems across the state. Among gated pipe users, field leveling and surge valves were the most frequent upgrades. Surge valves prove especially popular in the more water-scarce Eastern Plains (50%) and Arkansas

Valley (32%). The percentage of producers using surge valves was surprising given that this technology has been promoted for less than 10 years in Colorado.

The feasibility and ease of upgrading certain systems and the technology available probably explains the contrasts seen between systems. Options available for upgrading systems such as center pivots are numerous, but practically the only way to upgrade a flood system is to change to a different system. The results in Table 15 show one tool that is not being often used is flow meters. The highest use is among producers with sprinkler systems, especially those in the San Luis Valley (32%). This finding is consistent with the low number of people reporting knowledge of how much water they applied to the representative field (Table 18). Flow meter cost may be a deterrent to adoption with little obvious return in yield increase or labor savings.

Many of the attributes describing the representative field vary more by the system installed than by region (Table 16). For example, typical field size is approximately 40 acres or less, except for center pivots that typically service a quarter section. Fields with siphon tube systems are leased more frequently than other systems (36%) while fields with side roll systems are seldom rented (6%). Center pivots are used on more coarse textured soils than other systems, while side roll systems are more often used on fine textured soils. Center pivot systems are used most frequently with groundwater as primary water source (79%) whereas side roll, gated pipe, and siphon tubes are primarily used with ditch company water (70, 80, and 86%, respectively). Flood systems are nearly evenly split on ditch versus direct diversion sources. Center pivots are associated with the most reliable water sources while side roll and flood systems are associated with the least reliable.

Center pivots are generally used with deeper wells than other systems and wells with moderate yield. Siphon tube and flood systems relying on groundwater generally use shallower wells with high yield. The greatest water quality concern for all systems except center pivots is salinity. Nitrate was cited as the major concern for center pivots.

Application Efficiency

When asked to estimate the field level irrigation application efficiency (Application Efficiency = Crop Water Use ÷ Water Applied) on their representative field, the majority of respondents (64%) indicated they knew system efficiency. Users of sprinkler systems generally claimed greater knowledge of efficiency than for gravity systems. As discussed later, this is difficult to reconcile with a much lower rate (28%) knowing how much water was applied to their representative field.

On one hand, producers indicated a high knowledge of system efficiency, but their estimates of surface efficiency indicate that their knowledge may be imperfect (Table 17). Producer application efficiency estimates tended to be much higher than values commonly reported from research, especially among surface irrigators. Sixty-six percent of producers using gated pipe to furrow irrigate their fields indicated they knew their system efficiency, estimating average efficiency at 72%. Northern Colorado Water Conservancy District (NCWCD) data suggests that efficiencies of less than 50% are most common for this kind of system. Producer estimates of sprinkler system application efficiency are theoretically attainable, but are also above what is typically measured in the field. Possible explanations are that producers did not understand the question, were not careful in answering the questions, or they tended to overestimate efficiency. This suggests that further study is needed to discover why producers are reporting such high values.

Management of the Representative Field

This section characterizes the management of the representative field and details several irrigation management decisions.

Amount of Water Applied

Only 28 percent of respondents indicated knowledge of the amount applied with the Eastern Plains being highest and the Mountains and Western Slope the least (Table 18). In general, only sprinkler systems and groundwater users claimed knowledge of irrigation water applied. Potato and barley growers in the San Luis Valley had the highest proportion of respondents knowing how much water was applied among commodity groups.

Knowledge of actual irrigation water applied and seasonal crop water use is essential to scientific water management and improving application efficiency. When asked how much water was applied on their representative field, producers indicated that they applied 19 inches on average with surprisingly little difference between crops (Table 19). Based on research about water requirements, it appears that producers are underestimating water application, perhaps explaining the high estimations of application efficiency reported previously in Table 17.

In an effort to reconcile reported irrigation application rates with accepted agronomic rates, the amount of water applied was summarized by average crop yield for some selected crops (Table 20). When comparing these values to data synthesized from the annual Irrigation Management Service reports by NCWCD, we find that the survey results are well below those of the published reports. It may be that producers need further education on how to estimate crop water needs and actual irrigation application, but again, further research is needed to determine why this difference exists.

The number of irrigation applications per season is presented in Table 21. These varied by region, application system, and crop. Overall, an average of eight irrigations per crop year was reported, with the Eastern Plains (13) and the San Luis Valley (11) well above the average and the Arkansas Valley (4) below average. Center pivot systems enable frequent irrigation application with minimal labor impact. Hay and pasture fields tend to be irrigated least frequently. Potato and barley producers in the San Luis Valley reported irrigating most frequently.

Recordkeeping

We found that only 16% of producers statewide indicated they kept records of water applied to their representative field (Table 22). Farmers in the San Luis Valley using sprinkler systems and growing potatoes and barley had a much higher likelihood of keeping records (62% and 47%, respectively) and tended to give more realistic answers on how much water they applied as well (Tables 17-21). Better record keeping systems may need to be developed to help producers track crops water needs and irrigation applications.

An important factor in any management decision is the cost of the inputs required. Irrigation decisions are no different. Table 23 reports the proportion of respondents that indicated that they purchased water for irrigating the representative field. Statewide, 21 percent of respondents paid for their water, with producers in the Arkansas Valley (35%) and Western Slope (38%) paying most frequently. Survey participants were asked for the amount paid for their water, but responses were generally unusable. This seemed to be tied to an inability to quantify the amount of water to which they were entitled.

The Irrigation Decision

Having characterized the representative field and its management in the last crop year, we turn our attention to understanding the irrigation application decision. The basic questions that we seek to answer are "how do you decide *when* to irrigate" and "how do you decide *how much* to apply?"

When to Apply

When asked the primary method used to determine when to irrigate their crops, 51 percent of producers indicated that "crop appearance" was the primary method used (Table 24). A "fixed number of days" between irrigations was the second most common method used to determine when to irrigate (29%). Irrigators receiving water from ditch companies reported using a "fixed number of days" method most often. The rule-based irrigation scheduling methods such as accumulated ET or available soil moisture were used most frequently by center pivot users and groundwater appropriators. Additionally, center pivot and groundwater users were the only groups to frequently use crop consultants to help schedule irrigation. It should be noted that many producers indicated they used more than one method to decide when to irrigate.

When sorted by crop only potato, barley, and wheat producers used rule-based scheduling methods with any frequency. They reported that consultants were working on more than 30% of the representative fields where potatoes or barley were grown. Irrigators frequently marked that they used "other" methods to determine when to irrigate, often specifying experience and tradition as the method.

Producers citing a fixed-day rule used an average interval of 12 days (Table 25). The longest intervals were associated with flood systems, surface water sources, and hay and pasture crops. These are all common in the Arkansas Valley which had the longest average interval of the regions. Shortest intervals were associated with center pivots and groundwater use. Of the crops with sufficient numbers of users citing a given number of days, corn was irrigated most frequently—on average at six days under this rule.

Over a quarter of all producers and as much as one half of some commodity producers cited using a soil moisture threshold as their decision rule for timing irrigation applications. Among all users of the soil moisture decision rule, the shovel or feel method was mentioned most frequently (38%) with the soil probe cited second most frequently (30%) (Table 26). A number of producers claimed to determine soil moisture through some visual means, but it was not clear how this was accomplished. One interpretation is that this is primarily determined by crop appearance with a "dash of experience" added.

Gypsum blocks or consultants are very seldom used. Gypsum blocks find some favor in the Eastern Plains and Arkansas Valley. The soil probe is the preferred method in these two regions as it is across all center pivots and gated pipe systems, groundwater sources, and bean and corn crops. The shovel method is preferred in the three western regions, across all flood, siphon tube, and non-pivot sprinkler systems, all surface water sources, and most crops.

An important aspect of using soil moisture thresholds is to identify how far the soil moisture profile is depleted. Users of soil moisture methods were asked to specify the level of available soil moisture that would trigger an irrigation event. Only one quarter of all producers using this method provided a quantified level. Not surprisingly, almost all producers using gypsum blocks knew their thresholds. Nearly half of all those using soil probes and nearly three-quarters of the probe users in the San Luis Valley cited a threshold. Those using the less sophisticated shovel and feel methods provided thresholds less than half as often. Few using the visual method provided a threshold.

While a producer may be able to manage a given crop on a given field very well without knowing the threshold in terms of percent of field capacity, there are some important implications for not being able to quantify the threshold. Much of our research literature and extension programming conveys crop management in such terms. Given the low reporting rates of thresholds, particularly among the less sophisticated methods that are used so frequently, perhaps some specific efforts should be directed at increasing the level of understanding of quantifying available soil moisture or translating such figures into terms that are more understandable.

A similar question arises among those citing the use of evapotranspiration (ET) thresholds. For those using the "checkbook method" of scheduling, they often trigger irrigations based on reaching some level of accumulated ET since the last irrigation or precipitation event. Unlike the soil moisture methods, an inability to quantify the ET threshold renders this method ineffective. While over a quarter of all respondents claimed to use accumulated ET thresholds, only 8 percent of those individuals provided a quantified threshold (Table 28). Only potato growers in the San Luis Valley who used ET scheduling provided a quantified threshold more than a quarter of the time (46%). Again, this suggests that some rethinking is likely needed regarding educational efforts targeted toward producers.

Amount to Apply

The second half of the irrigation decision is to determine how much water should be applied once the timing threshold has been met. Unfortunately, the survey contained a typographic error, listing one choice as "crop determines amount" rather than "crop consultant determines amount" as intended. Interestingly, for all regions, water sources, crops, and irrigation categories except sideroll, respondents indicated that the "crop determines amount" of irrigation water to apply as the most commonly used method (Table 29). We can infer from this that producers consider crop growth stage and accumulated ET when making an application decision. It is also possible that they were equating "crop determines amount" with the idea that crop appearance indicates how much water is needed. Only in the case of side roll sprinkler systems did producers more commonly indicate they "always apply the same amount." Producers infrequently indicated that they use ET and soil water depletion in determining how much water to apply, although replenishment of soil moisture was indicated by nearly a third of those in the Eastern Plains, all center pivots, all groundwater users, and all potato growers. Other methods such as experience and tradition were cited frequently, particularly in alfalfa, hay, small grains, and under flood irrigation systems. Most commonly, producers only used one method to determine how much water to apply.

We infer the effectiveness of the quantified decision rules (soil moisture and accumulated ET) by the indication of specific thresholds (Table 30). The majority of producers specifying either of these methods also provided the threshold for the quantity of water to be applied. Fifty-eight percent of those indicating that they made quantity decisions to replenish soil moisture specified a threshold. Higher portions of those in the Eastern Plains and San Luis Valley, center pivot and gated pipe users, and potato and wheat growers reported thresholds. On average, users of this method attempt to return the soil profile to 87 percent of available soil water capacity. Of those replenishing accumulated ET, 63 percent specified a threshold. On average they attempt to replenish 93 percent of accumulated ET. In the Eastern Plains where 72 percent provided a threshold, they attempt to replace 109 percent of ET.

Why Methods Were Selected

Respondents were asked to provide the rationale for selecting both the timing and quantity thresholds. Responses to this open-ended question were classified into the twelve categories heading Table 31. Experience or tradition (25%) and water availability (21%) were the two reasons cited most frequently by all respondents for selecting the chosen timing rule. Water availability was the primary factor in the Arkansas Valley and the Mountains, for all flood and non-pivot sprinklers, all direct diversions, and all hay crops. On the other hand, water availability was not a major factor for those on the

Easter Plains, groundwater appropriators, center pivot systems, or barley and potato producers.

The reasons for selecting the method for determining the amount to apply, shown in Table 32, were similar to those for timing. Experience or tradition was the primary reason for every category except the Arkansas Valley, where producers cited water availability as most important.

Changes in Management

The last question on the representative field asked whether management had changed in the last five years and, if so, what had changed. About 27 percent of all producers reported changing management in the last five years, with 40 percent changing in the Eastern Plains, but only 18 percent indicating a change in the Mountains. Among the irrigation systems, center pivot, side roll, and gated pipe users reported the most changes. Flood changed least frequently. Ground water sources showed the most change. No strong patterns emerged from the crop summaries with the exception of beans, corn, and wheat on the Eastern Plains that indicated fairly high rates of change.

When characterizing the nature of the changes, it was found that nearly half of the changes involved the water application system (Table 34). Water management, fertilizer management, crop management, and tillage were the categories best classifying the other changes indicated. Improving water use efficiency was the most frequent reason given for the management change (Table 35).

Irrigation Decision Factors and Information Sources

A primary goal for the survey effort was to discover the relative importance of various factors influencing irrigation decisions for producers in Colorado. Section 4 of the survey was designed to evaluate the trade-offs that producers perceive would result from using different application systems. A more meaningful evaluation of this data requires the use of advanced statistical techniques that will be reported in subsequent publications. However, ratings of factors in the decision process and the quality of information available are summarized here.

Importance of Factors on Irrigation Decisions

Producers were asked to rate the relative importance of selected factors in their irrigation management decisions including system reliability, water availability, and yield impact were the most important factors identified (Table 36). Cropping flexibility and water laws were the least important factors. However, only cropping flexibility rated on average as less than "important". Apparently all of the issues selected weigh heavily in most irrigators' decisions. When ranking the averages, major differences did not appear across region or other summary attributes (detailed summaries presented in Appendix Tables B5 and B6, respectively), although the rating for cropping flexibility is understandably less in the Mountains and West Slope and for hay and pasture.

Quality of Information

We also asked respondents to rate the quality of information received from selected sources for irrigation and crop production decisions (Table 37). Consultants, soil testing laboratories, and chemical dealers garnered the highest ratings for quality of information provided, with an average rating between “Good” and “Very Good”. Cooperative Extension and neighbors were next with an average “Good” rating. NRCS and water management districts followed closely with slightly less than a “Good” rating. Popular press received the lowest average rating of just better than “Fair”. The majority of respondents had an opinion on each of the sources. Only consultants, water management districts, and popular press earned ratings from less than three-quarters of the respondents. As with the decision factors, major differences in rating of information quality did not appear across region or other summary attributes (see Appendix Tables B7 and B8, respectively).

Opinion of CSU Water Management Activities

Finally, respondents were asked to rate CSU research and extension activities in water management (Table 38). The average ratings for both technical research and extension/education activities are “Good” to “Very Good”. No significant rating differences were observed among the different regions. The striking result, however, is the number of respondents who have not directly used the services that are available.

Only half and slightly over half of producers have used CSU’s technical research and extension, respectively. Irrigators in the Eastern Plains and Arkansas Valley appear to make the greatest use of both of these resources while those in the Mountains use them the least. One caveat that should be raised is that producers may receive information from another source that is based on CSU activities. As such, while the responses here provide an indication of direct use by producers, they do not capture information that is transferred by less direct means.

When examining the ratings of CSU’s work in water management provided by cross sections of respondents, some subtle differences appear (Table 39). The average rating for each subgroup falls in the range of “Good” to “Very Good”. When evaluated by application system, those with “other sprinkler” systems provide the highest ratings for both research and extension, while those with sideroll systems provide the lowest. Those diverting water directly from a stream or river gave the lowest rating among all water sources. Finally, among growers of different commodities, barley, bean, and wheat producers rated CSU work highest while those with pasture gave the lowest ratings.

Table 3. Personal Characteristics of Respondents

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Average Years of Irrigation Experience	32	25	29	32	31	33	31
Education Level (%)							
High School	33	28	27	30	28	32	31
Some College	27	24	35	29	23	25	26
Vocational/Tech Degree	10	8	9	6	7	6	8
Bachelors Degree	22	32	25	25	27	24	25
Graduate Degree	9	8	3	11	15	13	10
Gross Farm Sales (%)							
Under $50,000	24	9	34	38	46	54	34
$50,000 - $99,000	25	16	29	17	32	23	23
$100,000 - $249,000	23	25	19	22	17	16	20
$250,000 - $499,000	14	30	12	10	5	5	12
$500,000 - $1,000,000	8	12	3	7	1	1	5
Over $1,000,000	7	9	4	6	0	1	4
Off-Farm Job (%)	32	20	36	31	45	38	34
Percent of Income from Farm (respondents with off-farm employment)	42	49	40	35	44	35	40
Percent of Income from Farm (all respondents)	82	91	80	81	76	76	81

Table 4. General Characteristics of Entire Farm

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Farm Size[a] (acres)							
Average	890	2555	2326	800	2883	3015	2009
Median	400	1600	398	585	850	263	480
Avg. Cropped Area (acres)	548	1345	415	495	382	174	529
Avg. Irrigated Area (acres)	429	719	332	495	306	161	387
Irrigated Area Rented (%)	39	36	30	17	16	23	29
Water Source (average %)							
Groundwater	34	92	12	37	1	1	28
Surface Water	66	8	88	63	99	99	72
Water Source (% of respondents)							
All Surface Water	43	5	68	37	97	98	59
<33% GW, >67% SW	19	2	22	18	2	1	10
"Half'n'half"[b]	12	4	3	17	<1	<1	6
>67% GW, <33% SW	7	1	1	15	<1	<1	4
All Ground Water	18	89	7	13	1	<1	20

[a] Includes all irrigated and dry cropland, pasture, and rangeland.
[b] Between 33% and 67% surface water with the balance from groundwater.

Table 5. Irrigation Systems Used on Entire Farm

System	Region: South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Percent of Irrigated Area Served						
Gated Pipe	13	9	21	1	3	19	11
Siphon Tubes	27	1	23	7	<1	9	12
Flood	10	1	48	33	91	45	27
Other Gravity System	2	0	1	1	1	8	2
Center Pivot	46	89	7	58	1	4	46
Other Sprinkler	1	1	0	<1	2	15	2
Other Irrigation System	<1	<1	<1	<1	1	2	<1
	Percent of Respondents Using System[a]						
Gated Pipe	45	30	55	6	11	44	36
Siphon Tubes	58	3	47	29	2	16	29
Flood	45	8	61	65	90	61	52
Other Gravity System	8	0	4	3	3	15	7
Center Pivot	35	81	6	51	8	4	30
Other Sprinkler	6	8	1	1	14	27	12
Other Irrigation System	2	1	1	1	4	4	2
	Average Percent of Irrigated Area Served if Using System						
Gated Pipe	37	44	40	25	44	50	42
Siphon Tubes	55	48	53	41	19	46	51
Flood	46	77	73	68	91	75	69
Other Gravity System	35	--	47	22	38	46	41
Center Pivot	70	91	53	82	38	43	78
Other Sprinkler	39	60	47	5	40	54	50
Other Irrigation System	45	5	100	10	55	42	45

[a] Percentages do not add to 100 because many respondents use more than one type of system on their farm.

Table 6. Crops Grown on Entire Farm

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Proportion of Respondents Growing Each Crop (%)						
Alfalfa or Other Hay	72	38	88	80	97	89	77
Corn for Grain or Silage	72	77	53	--	1	18	42
Wheat	35	68	33	22	2	14	29
Beans	28	25	8	--	--	9	15
Barley	9	1	2	24	1	3	6
Potatoes	2	1	--	23	1	0	3
Other Crops	37	30	44	15	1	21	26
Pasture	17	7	18	31	22	40	24
	Average Acreage of Respondents Growing Each Crop						
Alfalfa or Other Hay	128	135	196	243	375	135	185
Corn for Grain or Silage	306	695	128	--	69	78	359
Wheat	326	834	231	233	238	71	442
Beans	99	225	71	--	--	76	123
Barley	79	110	145	411	25	46	220
Potatoes	224	520	--	420	30	8	376
Other Crops	157	336	160	250	33	61	171
Pasture	559	1467	780	411	1345	341	570
	Average Proportion Irrigated for Respondents Growing Each Crop (%)						
Alfalfa or Other Hay	93	91	95	93	89	93	93
Corn for Grain or Silage	95	91	98	--	100	97	95
Wheat	54	27	85	97	67	84	56
Beans	94	96	100	--	--	100	96
Barley	87	100	75	99	0	89	91
Potatoes	100	100	--	100	100	100	100
Other Crops	92	45	90	97	100	94	85
Pasture	42	25	55	67	47	63	56

"--" indicates that no respondents reported growing crop in region.

Table 7. Livestock Grown on Entire Farm

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Proportion of Respondents Raising Each Class of Livestock (%)						
Livestock of Any Type	57	59	70	59	91	77	68
Beef Cows	41	46	62	53	83	70	57
Fat Cattle	5	9	4	--	2	1	3
Stocker Cattle	12	13	7	3	10	5	9
Dairy	2	2	1	--	--	0	1
Sheep	2	1	2	9	4	8	4
Swine	3	2	2	1	--	0	1
	Average Number of Animals for Respondents Growing Each Type						
Beef Cows	139	177	147	135	187	129	148
Fat Cattle	1649	1010	1205	--	413	817	1230
Stocker Cattle	273	403	679	173	421	674	406
Dairy	489	326	35	--	--	1048	452
Sheep	824	1000	334	124	773	875	667
Swine	158	100	15	20	--	15	111
	Distribution of Total Livestock Numbers (%)						
None	43	41	30	41	9	23	32
1 to 50 head	21	11	21	17	23	25	21
51 to 100 head	12	8	22	17	16	21	16
100 to 250 head	10	18	14	14	27	17	16
Greater than 250 head	14	21	13	11	24	15	16

"--" indicates that no respondents reported growing livestock class in region.

Table 8. Frequency of Best Management Practice (BMP) Implementation Anywhere on Farm

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Percent of Respondents Using						
Irrigation Upgrades							
Surge Valves	8	13	11	2	2	8	8
Flow Meters	14	19	8	18	3	7	12
Flume or Wier	50	4	53	42	69	70	50
Drop Nozzles	28	60	6	43	5	2	23
LEPA	1	15	2	2	1	0	3
Low Pressure	28	64	7	40	11	13	27
Lined Ditches	45	3	55	9	7	16	25
None of these used	13	10	11	24	25	17	16
Fertilizer Practices							
Soil Test Analysis	82	90	59	56	44	49	66
% Sampled in 1996	53	82	24	52	23	29	50
Manure Credit	43	19	30	26	18	18	27
Plant Tissue Analysis	10	12	4	22	2	8	10
Yield Goal	71	67	60	51	36	43	56
Legume Credit	26	11	32	20	6	12	18
Irrigation Water Analysis	10	10	1	19	7	2	7
Past Experience	77	67	77	67	55	74	71
Consultant	33	45	16	28	5	9	23
None of these used	2	4	11	18	30	9	10
Pesticide Practices							
Field Scouting	81	81	70	59	29	50	64
Pesticides	84	80	74	49	17	50	63
Resistant Varieties	34	35	36	19	8	26	28
Crop Rotation	70	64	77	52	6	40	53
Tillage	63	63	61	49	8	35	48
Biological Controls	9	13	7	4	7	15	10
Pest Forecasting	15	25	13	18	1	6	13
None of these used	4	4	6	23	62	15	15
Pest Management							
Keep Pesticide Records	56	54	33	30	10	25	38
Use Crop Consultants	60	66	35	44	9	18	41
Use Economic Thresholds	51	65	45	30	6	18	37
Use Band or Spot Applic.	51	41	16	15	16	24	32
None of these used	10	11	29	42	72	47	31

Table 9. Frequency of Nutrient Crediting Practices on Whole Farm

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Percent of Respondents Using						
Water Credit							
Using Groundwater	15	10	0	28	**	**	14
No Groundwater	4	0	1	4	7	2	3
Manure Credit							
Manure Use Indicated	78	86	75	**	33	57	69
No Manure Use Indicated	38	16	26	24	16	16	24
Own Livestock (>10 hd)	54	28	31	41	16	21	32
No Livestock	31	8	26	7	33	7	19
Legume Credit							
Grow Alfalfa	34	25	34	19	15	16	27
No Alfalfa	17	5	27	20	4	10	12
Grow Beans	37	22	60	**	**	33	34
No Beans	22	8	29	20	6	10	15
Beans, No Alfalfa	30	16	**	**	**	28	26
All others	25	10	31	20	6	11	17

** Five respondents or fewer in category

Table 10. Adoption of Pest Control and Pesticide Best Management Practices (BMPs)

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Pest Management Practices	Use Among Respondents Using Pesticides (% using)						
Field Scouting	86	86	80	87	83	61	80
Resistant Varieties	38	39	42	31	17	35	37
Crop Rotation	76	70	85	72	13	53	69
Tillage	70	70	73	69	13	45	63
Biological Controls	9	15	6	3	17	20	12
Pest Forecasting	18	28	14	32	4	12	19
None Of These Used	0	0	0	0	0	0	0
Pesticide Management							
Keep Pesticide Records	63	62	39	54	36	41	54
Use Crop Consultants	67	73	39	72	32	30	57
Use Economic Thresholds	58	74	52	56	32	32	54
Use Band Or Spot Applic.	57	48	14	24	55	34	43
None Of These Used	3	3	20	9	5	19	9
Pest Management Practices	Use Among Respondents Not Using Pesticides (% using)						
Field Scouting	56	61	43	32	18	39	37
Resistant Varieties	16	19	20	8	5	16	13
Crop Rotation	39	42	57	33	5	26	27
Tillage	28	33	30	29	6	26	23
Biological Controls	8	6	10	4	5	10	7
Pest Forecasting	2	11	10	4	0	1	3
None Of These Used	23	19	23	44	75	30	40
Pesticide Management							
Keep Pesticide Records	24	22	14	7	5	8	11
Use Crop Consultants	27	42	21	17	5	6	14
Use Economic Thresholds	19	33	21	6	1	4	9
Use Band Or Spot Applic.	24	14	21	6	9	14	13
None Of These Used	46	42	57	75	85	75	70

Table 11. Pest and Fertilizer Best Management Practices (BMPs) by Cropping Diversity

	Number of Crops Grown on Farm			
	1	2 to 3	4 or more	All Farms
	Percent of Respondents Using			
Fertilizer Practices				
Soil Test Analysis	47	70	77	66
% Sampled in 1996	37	53	51	50
Manure Credit	19	26	38	27
Plant Tissue Analysis	4	9	17	10
Yield Goal	35	60	71	56
Legume Credit	6	16	35	18
Irrigation Water Analysis	5	7	11	7
Past Experience	57	72	84	71
Consultant	9	27	31	23
None of these used	21	6	4	10
Pesticide Practices				
Field Scouting	37	70	82	64
Pesticides	32	68	85	63
Resistant Varieties	11	30	41	28
Crop Rotation	14	58	86	53
Tillage	17	52	74	48
Biological Controls	10	10	12	10
Pest Forecasting	4	13	22	13
None of these used	36	10	3	15
Pest Management				
Keep Pesticide Records	13	41	60	38
Use Crop Consultants	16	46	58	41
Use Economic Thresholds	13	40	58	37
Use Band or Spot Applic.	24	30	44	32
None of these used	56	28	12	31

Table 12. General Characteristics of Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Field Size (acres)							
Average	58	127	37	98	81	36	67
Median	40	126	29	105	40	24	40
Rented or Leased (% yes)	33	35	24	12	10	14	23
For Those Using Gravity Systems:							
Length of Row (% of respondents)							
< 500 feet	4	6	11	11	22	25	13
500 - 1,000 feet	21	14	21	22	29	37	26
1,000 - 1500 feet	52	50	59	56	22	33	45
1,500 - 2,000 feet	7	11	4	4	4	3	5
> 2,000 feet	17	19	6	7	23	3	11
Average Length (feet)	1,424	1,484	1,216	1,211	1,492	920	1,234
Field Slope (% of respondents)							
0 - 1 %	29	32	20	41	24	18	25
1 - 3 %	41	41	47	41	43	44	43
3 - 5 %	13	9	20	10	11	21	16
> 5 %	17	18	13	7	22	17	17
Soil Texture (% of respondents)							
Sandy	7	12	3	13	10	3	7
Sandy to Loamy	35	31	21	36	28	14	27
Loamy	26	37	29	30	33	26	29
Clayey to Loamy	23	15	32	15	17	30	23
Clayey	9	5	15	7	12	27	14

Table 13. Characteristics of Water Source for Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Primary Water Source (%)							
Groundwater Well	33	90	5	38	1	1	27
% supplemented	20	2	0	39	0	50	14
Ditch Company	69	3	86	55	20	80	57
% supplemented	45	33	33	43	15	23	34
Direct Diversion	4	7	11	17	81	21	19
% supplemented	21	8	17	38	22	29	25
Water Reliability[a] (%)							
(years out of 10)							
10	74	82	46	63	59	54	65
9	7	4	6	9	7	10	7
8	7	4	14	8	13	13	9
7	5	2	14	6	4	7	6
6	2	2	2	4	7	4	3
5	1	1	9	4	4	3	3
Fewer than 5	4	5	10	7	6	9	6
For Those Pumping Ground Water:							
Depth to Water (%)							
0 - 25 feet	21	5	31	44	50	20	21
25 - 100 feet	61	27	53	42	17	0	44
100 - 200 feet	12	37	6	9	17	60	21
> 200 feet	6	31	9	5	17	20	15
Well Pumping Capacity (%)							
0 - 500 gpm	14	18	59	1	75	75	17
500 - 1000 gpm	52	59	26	47	25	25	51
1000 - 1500 gpm	25	18	11	27	0	0	21
> 1500 gpm	9	6	4	25	0	0	10
For Those with Sprinkler Systems:							
Nozzle Pressure (%)							
0 - 15 psi	10	29	40	3	8	0	14
15 - 30 psi	42	42	40	39	31	15	36
30 - 45 psi	34	16	20	53	38	35	31
> 45 psi	13	13	0	5	23	50	19
Average (psi)	33	28	21	34	44	51	35

[a] Number of years out of 10 that the water source provides a full water supply for the crop grown on the representative field.

Table 14. Water Quality Characteristics for Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
				Percent of Respondents			
Respondents Concerned About Water Quality for Crop Crop Production	19	11	35	12	5	12	15
Problems Cited When Water Quality is a Concern							
Salts	22	8	68	6	17	42	31
Sediment	16	12	8	6	33	13	13
Sewage	12	16	0	6	0	13	10
Nitrate	15	12	0	17	0	0	9
General Pollution	6	20	5	17	17	2	8
Chem/Fert Residue	5	16	8	11	0	2	7
Weedseed	9	0	0	0	0	13	6
Pesticides	1	0	0	0	0	4	1
Heavy Metals	2	0	0	6	0	0	1
Urban Storm Water	0	0	0	6	0	0	0
Algae	1	0	0	0	0	0	0
Other Concerns	11	16	11	28	33	9	13
Destination of Surface Runoff of Water Applied							
On-Farm Reuse	10	9	18	10	18	22	14
Surface Drainage Ways	47	15	55	26	51	53	43
Other Destination	8	4	8	8	15	9	8
No Runoff from Field	37	74	12	54	14	18	34

Table 15. Irrigation Application System Used on Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Respondents Using System (%)						
Center Pivot Sprinkler	25	79	3	50	5	2	26
Side Roll Sprinkler	2	3	0	0	5	16	6
Other Sprinkler	1	3	2	1	2	5	2
Gated Pipe or Tube	20	9	26	3	5	25	17
Siphon Tubes	36	2	28	13	1	9	17
Flood	15	5	41	34	82	43	32
	Average Age of System (Years)						
Center Pivot Sprinkler	12	16	**	14	8	9	14
Side Roll Sprinkler	13	**	**	**	11	9	10
Other Sprinkler	**	**	**	**	**	8	14
Gated Pipe or Tube	11	29	12	**	18	8	11
Siphon Tubes	38	**	38	38	**	21	35
Flood	57	87	72	75	81	71	74
All Systems	25	21	39	31	66	31	32
	Systems Upgraded (%)						
Center Pivot							
Low Pressure Sprinklers	74	71	**	75	83	25	72
Drop Nozzles	82	70	**	75	83	25	74
LEPA	5	14	**	1	0	0	8
Corner Catcher	3	0	**	10	0	0	3
Computer Controller	5	4	**	16	0	0	7
Flow Meter	14	11	**	32	0	25	16
Field Leveling	5	11	**	19	33	38	12
Lined Ditches	2	0	**	6	0	0	2
Other Upgrade	4	5	**	3	0	0	4
None of the Above	2	4	**	4	17	38	5
Side Roll							
Low Pressure Sprinklers	29	**	**	**	0	30	23
Computer Controller	0	**	**	**	0	3	2
Flow meter	0	**	**	**	29	5	9
Field Leveling	29	**	**	**	0	14	13
Lined Ditches	0	**	**	**	0	3	2
Other Upgrade	0	**	**	**	0	16	14
None of the Above	57	**	**	**	71	38	45

(continued)

Table 15. Continued

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Systems Upgraded (%)						
Gated Pipe							
Surge Valves	15	50	32	**	25	17	22
Computer Controller	0	0	4	**	0	4	2
Flow meter	6	6	8	**	0	7	6
Field Leveling	40	50	32	**	50	52	45
Lined Ditches	15	0	4	**	25	12	11
Other Upgrade	10	6	20	**	0	16	13
None of the Above	34	25	28	**	25	28	30
Siphon Tubes							
Flow meter	4	**	0	0	**	0	2
Field Leveling	51	**	59	44	**	40	50
Lined Ditches	56	**	59	0	**	50	50
Other Upgrade	3	**	3	6	**	7	4
None of the Above	22	**	16	50	**	27	25
Flood							
Flow Meter	4	11	2	0	1	1	2
Field Leveling	46	44	51	18	19	23	28
Lined Ditches	15	22	22	0	6	8	9
Other Upgrade	4	0	7	10	16	9	10
None of the Above	43	33	39	70	64	61	57
All Systems							
Surge Valves	4	6	9	1	1	4	4
Low Pressure Sprinklers	21	56	4	40	4	8	22
Drop Nozzles	22	55	3	39	4	1	20
LEPA	1	12	0	1	0	0	2
Corner Catcher	1	1	0	6	0	0	1
Computer Controller	1	3	2	8	0	2	2
Flow Meter	7	11	3	17	2	4	7
Field Leveling	36	16	48	24	20	30	29
Lined Ditches	26	1	28	5	6	12	15
Other Upgrade	5	6	10	5	13	12	8
None of the Above	22	11	27	32	60	44	32

** Five respondents or fewer in category

Table 16. Characteristics of Representative Field by Irrigation System

	System						
	Center Pivot	Side Roll	Other Sprinkler	Gated Pipe	Siphon Tubes	Flood	All Systems
Field Size (acres)							
Average	126	43	34	37	38	58	67
Median	130	35	25	28	31	34	40
Rented or Leased (% yes)	28	6	14	21	36	16	23
Soil Texture (% of respondents)							
Sandy	14	0	7	3	2	8	7
Sandy to Loamy	41	22	21	26	26	19	27
Loamy	28	13	38	25	33	31	29
Clayey to Loamy	13	37	10	31	27	23	23
Clayey	4	28	24	15	12	18	14
Primary Water Source (%)							
Groundwater Well	79	13	21	15	16	2	27
% supplemented	11	11	0	19	36	14	14
Ditch Company	21	70	48	80	86	58	57
% supplemented	45	16	36	27	49	29	34
Direct Diversion	5	21	38	8	2	43	19
% supplemented	29	27	18	38	25	22	25
Water Reliability[a] (%)							
(years out of 10)							
10	82	55	57	70	74	47	65
9	4	11	7	6	11	8	7
8	4	8	14	13	5	14	9
7	3	9	7	4	5	9	6
6	2	3	0	2	1	5	3
5	1	6	7	2	0	6	3
Fewer than 5	4	8	7	3	3	11	6

(continued)

Table 16. Continued

	Center Pivot	Side Roll	Other Sprinkler	Gated Pipe	Siphon Tubes	Flood	All Systems
	System						
	Percent of Respondents						
Well Depth to Water							
0 - 25 feet	16	18	13	20	30	32	21
25 - 100 feet	33	55	75	54	62	57	44
100 - 200 feet	31	18	13	7	7	0	21
> 200 feet	20	9	0	20	1	11	15
Well Pumping Capacity							
0 - 500 gpm	13	58	50	24	14	29	17
500 - 1000 gpm	58	33	38	51	45	17	51
1000 - 1500 gpm	21	8	13	22	28	13	21
> 1500 gpm	9	0	0	2	13	42	10
Water Quality is an Issue	10	13	22	23	21	13	15
Frequency of Problem Cited							
Salts	14	30	33	33	34	40	31
Sediment	5	20	33	17	14	13	13
Sewage	12	0	0	11	12	8	10
Nitrates	19	0	17	4	14	2	9
General Pollution	7	10	0	7	7	11	8
Chem/Fert Residue	14	0	0	6	5	6	7
Weedseed	5	30	0	13	2	2	6
Pesticides	2	0	0	2	0	2	1
Heavy Metals	2	0	0	0	3	0	1
Urban Storm Water	0	0	0	0	2	0	0
Algae	2	0	0	0	0	0	0
Other Concerns	19	10	17	7	8	17	12
System Upgrades							
Surge Valves	--	--	--	22	--	--	4
Low Pressure Sprinklers	72	23	33	--	--	--	22
Drop Nozzles	74	--	--	--	--	--	20
LEPA	8	--	--	--	--	--	2
Corner Catcher	3	--	--	--	--	--	1
Computer Controller	7	2	4	2	--	--	2
Flow Meter	16	9	15	6	2	2	7
Field Leveling	12	13	19	45	50	28	29
Lined Ditches	2	2	0	11	50	9	15
Other Upgrade	4	14	15	13	4	10	8
None of the Above	5	45	33	30	25	57	32

-- Indicates upgrade not appropriate for system type.

Table 17. Irrigation Application Efficiency on Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Respondents Knowing Application Efficiency[a] (%)							
Center Pivot Sprinkler	78	73	**	70	67	88	74
Side Roll Sprinkler	63	**	**	**	67	86	79
Other Sprinkler	**	**	**	**	**	69	60
Gated Pipe or Tube	65	67	62	**	29	73	66
Siphon Tubes	59	**	75	29	**	55	59
Flood	49	89	56	59	50	55	54
Average Estimate of Application Efficiency (%)							
Center Pivot Sprinkler	85	82	**	81	**	64	82
Side Roll Sprinkler	**	**	**	**	**	80	78
Other Sprinkler	**	**	**	**	**	84	83
Gated Pipe or Tube	70	81	73	**	**	74	72
Siphon Tubes	74	**	68	**	**	74	72
Flood	76	64	65	58	66	64	66

** Five respondents or fewer in category

[a] Respondents were asked to specify the irrigation application efficiency for the representative field. The definition was provided as follows: Application Efficiency = (Crop Water Use / Water Applied) x 100%.

Table 18. Respondents Knowing Amount of Water Applied to Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Percent of Respondents						
All Categories	36	38	25	30	17	17	28
By Application System							
Center Pivot	57	38	**	50	33	57	46
Sideroll	75	**	**	**	33	59	57
Other Sprinkler	**	**	**	**	**	27	32
Gated Pipe	31	31	31	**	14	5	21
Siphon Tubes	27	**	20	6	**	11	23
Flood	21	44	23	13	14	7	14
By Water Source							
Groundwater	39	36	17	54	**	**	40
Ditch Company	35	50	23	17	17	20	25
Direct Diversion	14	45	11	11	17	9	15
By 1996 Crop							
Alfalfa & Hay	30	32	16	16	16	18	20
Barley	**	**	**	57	**	**	50
Beans	30	29	**	**	**	0	20
Corn (grain & silage)	36	42	36	**	**	16	37
Pasture	**	**	**	**	**	0	9
Potatoes	**	**	**	68	**	**	62
Wheat	44	27	**	**	**	50	38
Other Crops	48	**	25	17	**	16	31

** Five respondents or fewer in category

Table 19. Average Reported Water Applied for Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Inches Applied						
All Categories	19	16	21	20	20	20	19
By Application System							
Center Pivot	18	16	**	20	**	**	17
Sideroll	11	**	**	**	**	22	20
Other Sprinkler	**	**	**	**	**	**	11
Gated Pipe	21	**	27	**	**	**	21
Siphon Tubes	20	**	**	**	**	**	20
Flood	21	**	14	**	23	21	20
By Water Source							
Groundwater	17	15	**	20	**	**	17
Ditch Company	20	**	23	24	**	20	20
Direct Diversion	**	**	**	**	22	13	19
By 1996 Crop							
Alfalfa & Hay	18	17	17	22	19	19	19
Barley	**	**	**	18	**	**	18
Beans	16	**	**	**	**	**	14
Corn (grain & silage)	20	16	23	**	**	**	19
Pasture	**	**	**	**	**	**	**
Potatoes	**	**	**	20	**	**	20
Wheat	9	**	**	**	**	**	11
Other Crops	23	**	**	**	**	**	23

** Five respondents or fewer in category

Table 20. Average Reported Water Applied for Selected Crops on Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Inches Applied						
Alfalfa							
Less than 2 ton	**	**	**	**	**	18	16
2 - 4 ton	17	18	21	**	16	17	17
Greater than 4 ton	19	**	16	25	**	23	20
Corn							
Less than 150 bu	18	15	**	**	**	**	19
150 - 180 bu	22	14	28	**	**	**	19
Greater than 180 bu	21	20	21	**	**	**	20
Barley							
Less than 100 bu	**	**	**	**	**	**	9
100 - 140 bu	**	**	**	21	**	**	22
Greater than 140 bu	**	**	**	19	**	**	19
Potatoes							
Less than 400 cwt	**	**	**	20	**	**	20
Greater than 400 cwt	**	**	**	20	**	**	20

** Three respondents or fewer in category

Table 21. Average Number of Irrigations Applied to Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Number of Applications						
All Categories	8	13	4	11	6	7	8
By Application System							
Center Pivot	15	15	**	23	**	12	16
Sideroll	3	**	**	**	8	7	6
Other Sprinkler	**	**	**	**	**	6	6
Gated Pipe	5	5	6	**	7	6	6
Siphon Tubes	7	**	5	4	**	9	7
Flood	5	4	3	3	6	7	5
By Water Source							
Groundwater	11	13	**	22	**	**	13
Ditch Company	7	**	4	7	6	7	7
Direct Diversion	4	11	5	3	6	4	5
By 1996 Crop							
Alfalfa & Hay	5	12	4	7	7	7	6
Barley	**	**	**	20	**	**	15
Beans	7	**	**	**	**	8	7
Corn (grain & silage)	9	12	6	**	**	7	10
Pasture	**	**	**	**	**	8	5
Potatoes	**	**	**	23	**	**	23
Wheat	8	7	**	**	**	6	9
Other Crops	8	**	7	**	**	7	10

** Five respondents or fewer in category

Table 22. Respondents Keeping Records of Water Applied to Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Percent of Respondents						
All Categories	16	19	15	25	12	12	16
By Application System							
Center Pivot	27	17	**	41	14	25	26
Sideroll	13	**	**	**	0	26	23
Other Sprinkler	**	**	**	**	**	19	21
Gated Pipe	14	25	14	**	14	10	13
Siphon Tubes	12	**	10	0	**	13	11
Flood	11	11	17	13	14	7	11
By Water Source							
Groundwater	19	19	17	43	**	**	23
Ditch Company	15	17	13	12	4	12	13
Direct Diversion	14	27	10	17	16	13	15
By 1996 Crop							
Alfalfa & Hay	12	28	19	10	13	11	13
Barley	**	**	**	47	**	**	33
Beans	19	29	**	**	**	15	19
Corn (grain & silage)	17	17	12	**	**	5	16
Pasture	**	**	**	**	**	0	13
Potatoes	**	**	**	62	**	**	57
Wheat	22	10	**	**	**	33	21
Other Crops	22	**	0	17	**	26	22

** Five respondents or fewer in category

Table 23. Respondents Purchasing Water Applied to Representative Field

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Percent of Respondents						
All Categories	19	6	35	16	6	38	21
By Application System							
Center Pivot	13	4	**	10	0	63	10
Sideroll	25	**	**	**	14	44	37
Other Sprinkler	**	**	**	**	**	33	24
Gated Pipe	27	6	34	**	0	45	33
Siphon Tubes	18	**	55	24	**	60	29
Flood	21	11	24	18	4	26	18
By Water Source							
Groundwater	2	5	33	6	**	**	4
Ditch Company	27	33	39	24	8	46	34
Direct Diversion	0	0	0	11	5	6	5
By 1996 Crop							
Alfalfa & Hay	24	17	27	19	3	32	22
Barley	**	**	**	10	**	**	21
Beans	14	0	**	**	**	85	34
Corn (grain & silage)	19	4	37	**	**	55	17
Pasture	**	**	**	**	**	33	29
Potatoes	**	**	**	0	**	**	0
Wheat	6	0	**	**	**	50	16
Other Crops	15	**	50	**	**	47	27

** Five respondents or fewer in category

Table 24. Decision Rule Used to Determine When to Apply Irrigation Water

	Decision Rule					
	Fixed Number of Days	Accum. ET Threshold[a]	Soil Moisture Threshold[a]	Crop Appearance	Consultant Determines	Other
	Respondents Citing Rule (%)					
All Categories	29	26	27	51	10	20
By Region						
South Platte	39	24	25	54	12	15
Eastern Plains	20	37	37	33	32	14
Arkansas Valley	19	21	27	63	10	31
San Luis Valley	17	32	31	51	14	20
Mountains	29	18	19	51	0	28
Western Slope	31	24	25	55	0	21
By Application System						
Center Pivot	23	41	41	40	29	11
Sideroll	43	22	22	46	1	20
Other Sprinkler	14	21	24	55	3	31
Gated Pipe	30	26	29	59	8	17
Siphon Tubes	46	21	21	58	6	20
Flood	23	18	19	54	2	27
By Water Source						
Groundwater	24	37	39	41	29	10
Ditch Company	33	23	24	58	4	20
Direct Diversion	25	18	19	48	0	34
By 1996 Crop						
Alfalfa & Hay	26	19	21	56	2	26
Barley	10	48	45	52	31	7
Beans	33	31	33	52	14	12
Corn (grain & silage)	35	31	32	44	22	13
Pasture	29	17	13	58	0	38
Potatoes	22	57	52	39	30	9
Wheat	16	45	48	45	20	23
Other Crops	37	32	33	58	8	8

** Percentages do not necessarily sum to 100 percent because many producers cited more than one rule.

[a] Most respondents indicating the use of accumulated ET thresholds also indicated the use of a soil moisture threshold. The simple correlation coefficient between these two rules was 0.937.

Table 25. Average Number of Days Between Applications for Fixed Day Users

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Average Number of Days						
All Categories	9	11	19	12	14	15	12
By Application System							
Center Pivot	5	6	**	3	**	**	6
Sideroll	**	**	**	**	**	13	13
Other Sprinkler	**	**	**	**	**	**	**
Gated Pipe	13	**	**	**	**	18	15
Siphon Tubes	8	**	15	**	**	8	9
Flood	18	**	25	22	15	16	18
By Water Source							
Groundwater	7	7	**	**	**	**	7
Ditch Company	10	**	16	15	18	15	13
Direct Diversion	**	**	**	**	10	13	15
By 1996 Crop							
Alfalfa & Hay	17	**	26	14	14	16	16
Barley	**	**	**	**	**	**	**
Beans	9	**	**	**	**	**	8
Corn (grain & silage)	8	6	**	**	**	13	8
Pasture	**	**	**	**	**	**	15
Potatoes	**	**	**	**	**	**	**
Wheat	**	**	**	**	**	**	11
Other Crops	7	**	**	**	**	14	9

** Five respondents or fewer in category

Table 26. Method Used to Determine Soil Moisture for Timing of Irrigation Applications

	Method					
	Soil Probe	Gypsum Blocks	Shovel/ Feel	Visual	Consultant	Not Specified
	Soil Moisture Users Citing Method (%)					
All Categories	30	3	38	17	2	11
By Region						
South Platte	28	1	33	17	4	17
Eastern Plains	52	8	18	17	3	3
Arkansas Valley	53	7	27	10	0	3
San Luis Valley	16	2	64	7	0	11
Mountains	8	0	42	17	0	33
Western Slope	19	0	51	26	0	5
By Application System						
Center Pivot	39	5	36	11	2	7
Sideroll	27	0	60	7	0	7
Other Sprinkler	29	0	71	0	0	0
Gated Pipe	33	5	31	21	3	7
Siphon Tubes	26	0	40	19	2	13
Flood	15	0	39	25	0	21
By Water Source						
Groundwater	42	4	29	15	3	7
Ditch Company	25	2	46	15	1	11
Direct Diversion	13	0	42	21	0	24
By 1996 Crop						
Alfalfa & Hay	21	1	46	18	0	14
Barley	15	0	69	8	0	8
Beans	43	0	29	29	0	0
Corn (grain & silage)	43	5	21	17	4	9
Pasture	33	0	33	33	0	0
Potatoes	33	0	67	0	0	0
Wheat	33	0	57	5	0	5
Other Crops	21	6	39	18	3	12

Table 27. Soil Moisture Method Users Reporting Percent Moisture Threshold

	Method					
	Soil Probe	Gypsum Blocks	Shovel/ Feel	Visual	Consultant	All Methods
	Method Users Reporting a Threshold (%)					
All Categories	46	89	22	3	17	26
By Region						
South Platte	48	**	19	6	**	24
Eastern Plains	50	**	33	9	**	42
Arkansas Valley	44	**	25	**	**	40
San Luis Valley	71	**	28	**	**	29
Mountains	**	**	10	**	**	4
Western Slope	27	**	20	0	**	15

** Five respondents or fewer in category

Table 28. Use of Evapotranspiration (ET) Thresholds in Determining When to Irrigate

	Respondents Using ET Criterion (%)	ET Users Citing Threshold (%)
All Categories	26	8
By Region		
South Platte	24	3
Eastern Plains	37	9
Arkansas Valley	21	8
San Luis Valley	32	22
Mountains	18	4
Western Slope	24	6
By Application System		
Center Pivot	41	14
Sideroll	22	20
Other Sprinkler	21	0
Gated Pipe	26	4
Siphon Tubes	21	2
Flood	18	4
By Water Source		
Groundwater	37	14
Ditch Company	23	4
Direct Diversion	18	3
By 1996 Crop		
Alfalfa & Hay	19	6
Barley	48	7
Beans	31	0
Corn (grain & silage)	31	6
Pasture	17	25
Potatoes	57	46
Wheat	45	25
Other Crops	32	3

Table 29. Decision Rule Used to Determine How Much Water to Apply When Irrigating

	Decision Rule				
	Same Amount Each Time	Replenish Accumulated ET	Replenish Soil Moisture	Crop Determines	Other
	Respondents Citing Rule (%)				
All Categories	31	4	13	48	19
By Region					
South Platte	35	4	10	53	15
Eastern Plains	21	6	32	46	12
Arkansas Valley	21	4	14	54	20
San Luis Valley	18	11	18	50	21
Mountains	37	2	4	39	26
Western Slope	37	1	7	45	23
By Application System					
Center Pivot	16	11	30	52	12
Sideroll	55	1	4	43	18
Other Sprinkler	37	0	0	48	22
Gated Pipe	31	3	10	48	20
Siphon Tubes	36	3	8	52	16
Flood	35	1	6	44	27
By Water Source					
Groundwater	23	9	27	49	10
Ditch Company	33	2	7	51	21
Direct Diversion	33	2	7	38	29
By 1996 Crop					
Alfalfa & Hay	35	1	5	47	25
Barley	3	17	17	59	21
Beans	28	3	18	55	10
Corn (grain & silage)	30	7	23	47	12
Pasture	38	4	13	42	21
Potatoes	5	32	36	45	9
Wheat	23	10	28	40	20
Other Crops	27	1	12	59	15

** Percentages do not necessarily sum to 100 percent because many producers cited more than one reason.

Table 30. Use of Quantified Rules in Determining How Much Water to Apply

	Soil Moisture Replenishment		Accumulated ET Replenishment	
	Users Specifying a Threshold (%)	Portion of Avail. Soil Water Capacity Filled (%)	Users Specifying a Threshold (%)	Portion of Accumulated ET Replenished (%)
All Categories	58	87	63	93
By Region				
South Platte	46	87	62	83
Eastern Plains	80	86	72	109
Arkansas Valley	50	87	**	**
San Luis Valley	67	87	54	94
Mountains	**	**	**	**
Western Slope	50	86	**	**
By Application System				
Center Pivot	61	86	68	100
Sideroll	**	**	**	**
Other Sprinkler	**	**	**	**
Gated Pipe	83	86	70	**
Siphon Tubes	50	85	53	**
Flood	0	97	**	**
By Water Source				
Groundwater	60	86	68	98
Ditch Company	60	86	66	84
Direct Diversion	33	**	**	**
By 1996 Crop				
Alfalfa & Hay	43	94	46	**
Barley	**	**	**	**
Beans	0	**	**	**
Corn (grain & silage)	64	86	67	98
Pasture	**	**	**	**
Potatoes	86	94	75	99
Wheat	75	73	**	**
Other Crops	0	78	**	**

** Five respondents or fewer in category

Table 31. Reasons Cited for Selecting Method for Determining When to Irrigate

	Reason Cited											
	Experience/ Tradition	Water Availability	Crop Needs	Soil Properties	Labor	Consultant	Weather/ Climate	Harvest Intervals	Most Accurate	Conserve Water	Sprinkler Capacity	Other
	Respondents Citing Reason (%)											
All Categories	25	21	13	12	7	6	6	4	2	2	1	2
By Region												
South Platte	26	20	13	10	8	5	7	4	2	3	1	2
Eastern Plains	17	9	13	13	8	21	7	2	4	2	0	3
Arkansas Valley	16	23	18	13	5	4	4	8	2	0	0	5
San Luis Valley	29	14	10	13	7	10	6	3	5	1	1	2
Mountains	23	30	16	9	4	0	9	1	1	3	1	3
Western Slope	29	27	11	14	7	0	4	4	2	0	2	1
By Application System												
Center Pivot	24	6	13	14	9	18	5	1	4	3	0	3
Sideroll	19	30	11	13	2	2	5	8	2	2	8	0
Other Sprinkler	13	30	23	13	3	0	10	7	0	0	0	0
Gated Pipe	32	21	11	10	6	5	5	4	3	1	1	2
Siphon Tubes	26	24	12	12	8	2	8	2	1	3	0	0
Flood	22	30	14	10	7	0	6	5	1	1	1	3
By Water Source												
Groundwater	21	9	13	14	7	16	7	2	4	3	1	2
Ditch Company	28	23	13	12	7	2	5	4	2	1	1	2
Direct Diversion	20	32	13	7	8	1	9	3	2	1	2	2
By 1996 Crop												
Alfalfa & Hay	25	26	13	11	6	1	6	7	2	0	1	2
Barley	41	3	3	17	7	21	3	0	3	0	0	0
Beans	37	17	20	7	2	0	12	0	0	5	0	0
Corn (grain & silage)	22	16	11	13	9	15	5	1	3	2	0	3
Pasture	23	27	8	8	4	0	12	4	0	8	4	4
Potatoes	15	4	30	15	0	11	7	0	11	0	0	7
Wheat	16	14	22	22	11	8	3	0	5	0	0	0
Other Crops	29	17	10	12	8	4	8	0	1	6	3	2

Table 32. Reasons Cited for Selecting Method for Determining Amount to Irrigate

	Reason Cited										
	Experience/ Tradition	Water Availability	Crop Needs	Soil Properties	Get Water Across Field	Application Efficiency	Weather/ Climate	Consultant	Labor Restrictions	Reliable/ Accurate	Other
	Respondents Citing Reason (%)										
All Categories	25	18	16	10	9	7	7	4	3	0	1
By Region											
South Platte	25	16	20	7	8	9	7	4	3	0	1
Eastern Plains	20	7	20	14	3	11	9	14	2	0	2
Arkansas Valley	23	28	13	11	14	4	6	1	0	0	0
San Luis Valley	25	16	17	15	6	6	6	4	4	0	3
Mountains	25	27	10	8	11	11	8	0	1	0	1
Western Slope	29	22	13	9	13	3	7	0	5	0	1
By Application System											
Center Pivot	20	5	21	17	1	8	10	12	3	0	3
Sideroll	20	27	11	11	13	2	13	0	4	0	0
Other Sprinkler	33	21	17	4	17	4	4	0	0	0	0
Gated Pipe	31	22	16	7	8	9	3	1	3	0	1
Siphon Tubes	23	19	18	8	12	8	7	1	3	0	1
Flood	28	26	12	6	14	5	5	0	2	0	1
By Water Source											
Groundwater	22	8	20	14	2	10	7	12	3	0	2
Ditch Company	27	21	15	8	13	5	6	1	3	0	1
Direct Diversion	23	24	12	10	10	9	10	0	2	0	1
By 1996 Crop											
Alfalfa & Hay	27	24	13	8	12	5	7	0	2	0	1
Barley	22	7	19	15	0	4	11	7	7	0	7
Beans		8	38	3	0	11	5	8	3	0	3
Corn (grain & silage)	24	12	17	13	6	10	7	8	3	0	1
Pasture	15	15	5	10	30	10	15	0	0	0	0
Potatoes	30	5	35	20	0	0	0	5	5	0	0
Wheat	9	15	18	6	12	18	0	9	6	0	6
Other Crops	25	17	16	13	10	3	9	4	4	0	0

Table 33. Respondents Reporting Change in Management in Last Five Years

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Percent of Respondents						
All Categories	27	40	23	21	18	27	27
By Application System							
Center Pivot	38	46	**	23	0	13	38
Sideroll	50	**	**	**	29	41	40
Other Sprinkler	**	**	**	**	**	38	27
Gated Pipe	30	27	30	**	57	42	35
Siphon Tubes	21	**	23	11	**	17	20
Flood	18	11	12	21	16	17	16
By Water Source							
Groundwater	31	41	50	23	**	**	35
Ditch Company	25	50	17	19	17	29	25
Direct Diversion	**	0	40	19	18	23	20
By 1996 Crop							
Alfalfa & Hay	27	33	18	15	18	27	23
Barley	**	**	**	33	**	**	33
Beans	26	57	**	**	**	31	33
Corn (grain & silage)	26	40	32	**	**	15	31
Pasture	**	**	**	**	**	0	26
Potatoes	**	**	**	24	**	**	22
Wheat	27	50	**	**	**	17	32
Other Crops	27	**	13	17	**	44	31

** Five respondents or fewer in category

Table 34. Management Changes Implemented on Farms

	Aspect of Management Modified					
	Water System	Water Mgt.	Fertilizer Mgt.	Crop Mgt.	Tillage	Other
	Percent of Respondents					
All Categories	12	4	3	4	3	2
By Region						
South Platte	10	4	4	3	5	2
Eastern Plains	18	3	6	8	9	<1
Arkansas Valley	11	3	0	6	2	<1
San Luis Valley	9	4	<1	4	1	4
Mountains	10	2	<1	2	0	2
Western Slope	14	5	3	4	<1	2
By Application System						
Center Pivot	18	3	6	7	8	2
Sideroll	22	4	3	9	1	0
Other Sprinkler	10	7	0	10	0	3
Gated Pipe	20	6	2	4	<1	<1
Siphon Tubes	6	4	1	2	6	1
Flood	6	2	2	3	<1	3
By Water Source						
Groundwater	14	4	6	7	7	2
Ditch Company	12	4	2	3	3	2
Direct Diversion	9	2	<1	4	0	4
By 1996 Crop						
Alfalfa & Hay	11	4	2	4	<1	2
Barley		0	3	13	3	3
Beans	10	5	8	5	10	5
Corn (grain & silage)	13	2	5	4	7	1
Pasture	13	4	0	4	0	0
Potatoes	4	13	0	4	4	4
Wheat	18	3	0	5	8	0
Other Crops	11	9	2	4	3	1

Table 35. Reason Cited for Management Changes Implemented on Farms

	Reason for Management Modification				
	Soil Properties	Water Use Efficiency	Crop Production	Labor	No Reason Cited
	Percent of Respondents with Changed Management				
All Categories	8	22	15	7	59
By Region					
South Platte	7	21	15	1	62
Eastern Plains	10	23	22	6	57
Arkansas Valley	4	24	4	8	60
San Luis Valley	3	24	17	7	52
Mountains	4	30	13	4	61
Western Slope	9	20	12	13	60
By Application System					
Center Pivot	8	21	19	5	59
Sideroll	4	19	15	11	59
Other Sprinkler	13	25	25	0	38
Gated Pipe	8	25	15	10	56
Siphon Tubes	10	19	10	2	64
Flood	5	26	10	6	61
By Water Source					
Groundwater	7	21	24	5	57
Ditch Company	9	24	10	7	59
Direct Diversion	5	26	18	8	56
By 1996 Crop					
Alfalfa & Hay	2	22	14	8	61
Barley		20	20	0	60
Beans	15	15	23	8	62
Corn (grain & silage)	8	21	15	4	61
Pasture	17	33	33	0	33
Potatoes	0	40	60	20	0
Wheat	17	25	17	0	58
Other Crops	17	27	10	13	53

** Percentages do not necessarily sum to 100 percent because many producers cited more than one reason.

Table 36. Respondent Rating of Importance of Factors in Irrigation Decisions

Factor	Rating: Very Important (1)	Important (2)	Slightly Important (3)	Not Important (4)	Average Rating
	--------------------Percent of Respondents--------------------				
System reliability	67	29	3	2	1.4
Water availability	69	24	5	2	1.4
Yield impact	65	32	3	1	1.4
Familiarity with system	58	35	5	2	1.5
Timing of labor required	51	40	7	3	1.6
Difficulty to operate/manage	41	44	10	4	1.8
Soil type	39	46	13	2	1.8
Water laws	43	32	15	10	1.9
Cropping flexibility	31	41	16	11	2.1

Table 37. Respondent Rating of Quality of Information Received from Sources

Source	Excellent (1)	Very Good (2)	Good (3)	Fair (4)	Poor (5)	No Opinion	Average Rating[a]
	Rating						
	---------------------Percent of Respondents---------------------						
Consultant	10	19	16	9	4	42	2.6
Soil Testing Lab	10	27	27	11	4	22	2.6
Chemical Dealer	11	26	29	12	4	18	2.7
Cooperative Extension	6	20	30	15	7	21	3.0
Neighbors	5	17	38	17	6	16	3.0
NRCS	5	15	28	19	10	23	3.2
Water Mgt District	5	14	22	14	12	32	3.2
Popular Press	0	4	19	25	17	33	3.8

[a] Average of respondents with a stated opinion of given information source.

Table 38. Respondent Rating of CSU's Work in Water Management

	Rating						
	Excellent (1)	Very Good (2)	Good (3)	Fair (4)	Poor (5)	Have Not Used	Average Rating[a]
	---------------------Percent of Respondents---------------------						
Technical Research							
All Categories	6	21	17	4	1	50	2.5
South Platte	8	20	18	5	1	48	2.4
Eastern Plains	6	29	23	5	2	36	2.5
Arkansas Valley	6	23	22	4	2	44	2.5
San Luis Valley	4	21	15	4	2	53	2.5
Mountains	4	13	12	3	2	65	2.6
Western Slope	6	19	15	4	1	55	2.4
Extension/Education							
All Categories	6	19	22	7	3	43	2.7
South Platte	5	18	24	8	1	43	2.7
Eastern Plains	6	24	27	5	3	35	2.6
Arkansas Valley	6	23	24	6	7	35	2.8
San Luis Valley	5	23	16	7	2	47	2.6
Mountains	8	13	17	3	3	56	2.6
Western Slope	6	19	21	7	3	45	2.7

[a] Average of those rating CSU water management activities.

Table 39. Average Rating of CSU's Work in Water Management[a]

	CSU Source	
	Technical Research	Extension/ Education
All Categories	2.5	2.7
By Application System		
Center Pivot	2.5	2.6
Sideroll	2.7	2.9
Other Sprinkler	2.0	2.0
Gated Pipe	2.4	2.6
Siphon Tubes	2.4	2.7
Flood	2.6	2.8
By Water Source		
Groundwater	2.5	2.6
Ditch Company	2.4	2.7
Direct Diversion	2.6	2.8
By 1996 Crop		
Alfalfa & Hay	2.5	2.7
Barley	2.1	2.1
Beans	2.2	2.5
Corn (grain & silage)	2.5	2.7
Pasture	3.0	3.1
Potatoes	2.8	2.7
Wheat	2.2	2.5
Other Crops	2.6	2.8

[a] Average rating of those rating CSU water management activities.
(1 = Excellent, 2 = Very Good, 3 = Good, 4 = Fair, 5 = Poor.)

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APPENDIX A

The Survey Instrument

Survey of Irrigation Management in Colorado

Sponsored by:

- The Water Center at Colorado State University
- Colorado State University Cooperative Extension
- Colorado State University Agricultural Experiment Station
- Colorado Department of Agriculture

Dear Survey Respondent:

Thank you for taking time out of your busy schedule to complete this survey. It should take about 20 minutes to complete.

Please attempt to answer every question in the survey. However, if you cannot or do not wish to answer a particular question, please skip it and proceed through the remainder of the questionnaire.

When you have completed the survey, please return it in the envelope provided. No stamp is required as postage has been prepaid.

Your response is anonymous. This questionnaire is not marked in any way that would allow us to identify who you are.

If you have any questions or comments regarding this survey, please don't hesitate to call us collect.

Thank you!

Marshall Frasier
(970) 491-6071

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(970) 491-6201

SECTION 1: **General Farm Information**

1. In what county is your farm located? [ ]

2. What is the total size of your farm? [ ] acres

3. List your major farm enterprises:

Crop	Number of Acres	Percent Irrigated

Livestock type	Number of Head

4. What portion of your irrigated acres are rented or leased from someone else? [ ] % OR [ ] acres

5. Approximately what percentage of irrigation water used on your farm comes from the following sources? (allocations should total 100 percent)

   Groundwater well [ ] %
   Surface water [ ] %

6. Approximately what percentage of the irrigated acres on your farm are serviced by each of the following types of irrigation systems? (should total 100 percent)

   Gravity:
   - gated pipe [ ] %
   - siphon tubes [ ] %
   - flood [ ] %
   - other gravity [ ] %

   Sprinkler:
   - center pivot [ ] %
   - other sprinkler [ ] %

   Other System [ ] %

7. Check ✓ all irrigation components used on your farm.

   ❍ Surge valves ❍ Flow meters ❍ Flume or weir for measurement
   ❍ Drop nozzles ❍ LEPA ❍ Low pressure sprinklers
   ❍ Lined ditches ❍ None of these used

8. Check ✓ all techniques that you use in determining fertilizer application rates.

❍ Soil test analysis ❍ Manure credit ❍ Plant tissue analysis
❍ Crop yield goal ❍ Legume credit ❍ Irrigation water analysis
❍ Past experience ❍ Consultant ❍ None of these used

9. IF YOU SOIL TEST:

What percent of your ***irrigated*** acreage was sampled in 1996? [%]

10. Check ✓ all pest management practices that you routinely use.
(Include all weed, insect, and disease controls)

❍ Field scouting ❍ Pesticides ❍ Resistant varieties
❍ Crop rotation ❍ Tillage ❍ Biological controls
❍ Pest forecasting ❍ None of these used

11. With respect to your pest management program do you... (check all that apply)

❍ Keep pest and pesticide records
❍ Use crop consultants for pest scouting and management advice
❍ Use economic thresholds to determine pesticide application timing
❍ Use banding or spot application as opposed to broadcast application
❍ None of these used

SECTION 2: **Describe a Representative Irrigated Field**

The following questions target a specific field that you farm. Select the ONE irrigated field that is ***most*** representative of your farm. Please answer all questions in Sections 2, 3, and 4 thinking only about this ***representative field***.

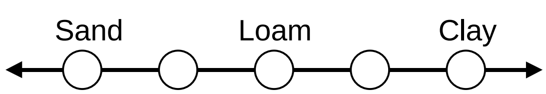
1. What is the size of this ***representative field***? [acres]

2. Is this ***representative field*** rented or leased?

❍ Yes

❍ No

3. Check ✓ the circle that best characterizes the predominant soil texture ***of the representative field***.



4. What crops have been grown over the last three years ***on the representative field***?

	1996	1995	1994
Crop			
Yield / acre			

5. Check ✓ the source(s) of the irrigation water used ***on the representative field***.

	Groundwater well	Ditch company	Individual surface diversion
Primary	❍	❍	❍
Supplemental	❍	❍	❍

6. IF YOU CHECKED GROUNDWATER WELL ABOVE:

What is the depth to water? [feet] Pumping capacity? [gpm]

7. Check ✓ the number of years out of 10 that the primary and supplemental water sources *together* are able to provide a full water supply for the crops grown ***on the representative field***.

0 ❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5 ❍ 6 ❍ 7 ❍ 8 ❍ 9 ❍ 10 ❍

8. Are there any concerns about the quality of your water for crop production?

❍ No ☞ Skip to number 9 on the next page.

❍ Yes

Please briefly describe these water quality concerns:

9. Check ✓ the irrigation application system used ***on the representative field***.

❍ Center pivot ❍ Gated pipe
❍ Siphon tubes ❍ Flood
❍ Other (specify)____

10. How long ago was this system installed? [____ years]

11. Check ✓ all irrigation upgrades used on the system identified ***for this field***.

❍ Surge valves ❍ Flow meters ❍ Low pressure sprinklers
❍ LEPA ❍ Drop nozzles ❍ Computer controller
❍ Field leveling ❍ Lined ditches ❍ Corner catcher
❍ None apply ❍ Other (specify)_________________________

12. IF THIS IS A GRAVITY SYSTEM:

What is the average row length of this field? [____ mile] OR [____ feet]

What is the approximate slope of this field? [____ %]

13. IF THIS IS A SPRINKLER SYSTEM:

What is the pressure at the nozzle? [____ psi]

14. Check ✓ the destination of runoff from ***this field***.

❍ On-farm collection for reuse ❍ Surface drainage ways
❍ There is no runoff ❍ Other _________________________

15. Check ✓ your best estimate of the system's average field application efficiency for 1996. (*Application Efficiency = Crop Water Use ÷ Water Applied)*

20% ◯ ○ 40% ◯ ○ 60% ◯ ○ 80% ◯ ○ 100% ◯ Don't Know ◯

SECTION 3: **1996 Management of the Representative Field**

Please answer all questions in this section thinking only about your 1996 management of the crop and irrigation system on the ***representative field*** identified in Section 2.

1. Do you know how much water was applied to the ***representative field*** in 1996?
   - ❍ No
   - ❍ Yes ☞ How much irrigation water was applied? [ ] inches

2. How many irrigation applications were made to the ***representative field*** throughout 1996? [ ] applications

3. How many pounds of nitrogen were applied to ***this field*** in 1996?

Preplant Fertilizer	Sidedress Fertilizer	Fertigation	Manure
lb N/ac	lb N/ac	lb N/ac	lb N/ac

4. Did you keep written or computerized records of water applied throughout the season? ❍ YES ❍ NO

5. Did you purchase or lease water applied to the ***representative field*** in 1996?
   - ❍ No
   - ❍ Yes ☞ How much did you pay for the water?

   [ ] $/ac ft OR [ ] $/ac in OR [ ] $/ac

6. Check ✓ the ONE primary method that you used in 1996 to decide **WHEN** to irrigate.
   - ❍ Fixed number of days between irrigations ☞ How many days? [ ] days
   - ❍ Accumulated evapotranspiration (ET) ☞ How much ET? [ ] inches
   - ❍ Available soil moisture ☞ How determined? [ ]
     ☞ What percent available moisture? [ ] %
   - ❍ Crop appearance
   - ❍ Crop consultant determines schedule
   - ❍ Other (specify)____

7. Explain **WHY** you used the method identified previously to determine **WHEN** to irrigate.

8. Check ✓ the ONE primary method used in 1996 to decide **HOW MUCH** water to apply for each irrigation application.

- ❍ Always apply the same amount each time
- ❍ Replenish accumulated ET since last irrigation ☞ What portion? [%]
- ❍ Replenish soil profile to a given level ☞ What level? [% avail water cap]
- ❍ Crop determines the quantity applied
- ❍ Other (specify)____

9. Please explain **WHY** you used this method to determine **HOW MUCH** to apply.

10. Have you changed any management practices on this field in the last five years?
❍ Yes ❍ No ☞ Skip to Section 4 on the next page.

List the specific practices that you changed and why.

SECTION 4: **Technology Comparison**

Please rate each of ***three*** different gravity or sprinkler irrigation systems as if they could be used on your ***representative field***.

Rate ***EITHER*** the 3 gravity or 3 sprinkler systems

1 = Very Low ⟷ ***5 = Very High***

Rate each of the three systems for…	**Gravity Systems**: Siphon Tubes	**Gravity Systems**: Gated Pipe	**Gravity Systems**: Gated Pipe w/ Surge	**Sprinkler Systems**: Standard Center Pivot	**Sprinkler Systems**: Low PSI Pivot w/ Drop Nozzle	**Sprinkler Systems**: Computer Controlled Pivot
1. Your familiarity with each						
2. Competition with other farm and non-farm activities for your time						
3. Difficulty to operate and manage						
4. Reliability in consistently delivering water to crop						
5. Overall desirability *(consider **all** factors important to you)*						
Please estimate the 10-year average per-acre yield that you think would be produced under each system. (Indicate for crop grown on the ***representative field*** in 1996)						

Specify units (e.g. bushels, ton)____________________

SECTION 5: **Water Management Decisions**

1. Rate each of the following for how they affect your irrigation management decisions.

	Very Important	Important	Slightly Important	Not Important
Familiarity with system	○	○	○	○
Timing of labor required	○	○	○	○
Difficulty to operate/manage	○	○	○	○
System reliability	○	○	○	○
Yield impact	○	○	○	○
Soil type	○	○	○	○
Water availability	○	○	○	○
Cropping flexibility	○	○	○	○
Water laws	○	○	○	○

2. Check ⊘ the circle that best indicates the quality of information provided by each of the following for your crop production and irrigation management decisions.

Very

		No				
	Excellent	Good	Good	Fair	Poor	Opinion
Chemical dealer/applicator	○	○	○	○	○	○
Consultant	○	○	○	○	○	○
Cooperative Extension	○	○	○	○	○	○
Neighbors	○	○	○	○	○	○
NRCS (formerly SCS)	○	○	○	○	○	○
Popular Press	○	○	○	○	○	○
Soil testing lab	○	○	○	○	○	○
Water management district	○	○	○	○	○	○
Other________________	○	○	○	○	○	○

3. We are interested in whether CSU's work on water management meets your needs. Please rate CSU's job on the following:

	Excellent	Very Good	Good	Fair	Poor	Have Not Used It
Technical research:	○	○	○	○	○	○
Extension/Education:	○	○	○	○	○	○

SECTION 6: **Personal Information**

1. How many years of irrigation experience do you have? [years]

2. Check ✓ your highest level of education.
   - ❍ High School
   - ❍ Some college
   - ❍ Technical/Vocational Degree
   - ❍ Bachelors degree
   - ❍ Graduate or Professional degree

3. Check ✓ your annual gross farm sales.
   - ❍ less than $50,000
   - ❍ $50,000 - $99,000
   - ❍ $100,000 - $249,000
   - ❍ $250,000 - $499,000
   - ❍ $500,000 - $1,000,000
   - ❍ over $1,000,000

4. Do you have another job off the farm?
   - ❍ No
   - ❍ Yes ☞ What percentage of your net income comes from farming? [%]

THANK YOU very much for taking the time to answer this questionnaire. Please return the completed survey in the enclosed postage-paid envelope. Feel free to use the space below to give us any comments you may have.

APPENDIX B

Tables of Supporting Details

Table B1. Number of Surveys Mailed by County and Farm Size[a]

	Farm Size (acres)							
Region/County	Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
Colorado	236	638	565	590	619	343	290	3,281
South Platte	93	237	205	190	139	65	39	968
Adams	2	4	9	8	10	6	5	44
Boulder	10	19	11	9	6	2	1	58
Larimer	18	25	21	16	11	7	5	103
Logan	3	14	12	17	20	14	6	86
Morgan	12	42	51	47	36	12	5	205
Sedgwick	1	0	3	4	5	7	6	26
Weld	47	133	98	89	51	17	11	446
Eastern Plains	1	17	35	69	194	130	82	528
Arapahoe	0	1	0	1	2	2	0	6
Baca	0	2	4	11	19	16	9	61
Cheyenne	0	0	0	1	7	2	8	18
Douglas	0	2	4	3	5	1	1	16
El Paso	1	2	2	4	13	4	4	30
Elbert	0	0	1	0	6	1	5	13
Kit Carson	0	1	4	13	35	32	17	102
Phillips	0	1	6	15	39	23	4	88
Washington	0	4	3	4	10	12	6	39
Yuma	0	4	11	17	58	37	28	155
Arkansas Valley	23	56	51	66	43	23	43	305
Bent	2	5	8	8	6	2	10	41
Crowley	1	4	5	6	0	1	2	19
Kiowa	0	0	0	0	1	2	2	5
Las Animas	3	9	7	10	8	4	9	50
Otero	7	17	16	14	10	1	3	68
Prowers	3	12	10	17	16	10	13	81
Pueblo	7	9	5	11	2	3	4	41
San Luis Valley	20	62	68	89	70	20	8	337
Alamosa	4	19	17	16	19	2	1	78
Conejos	9	16	19	18	16	7	2	87
Costilla	3	9	5	12	5	3	1	38
Rio Grande	3	15	24	25	19	4	2	92
Saguache	1	3	3	18	11	4	2	42

(continued)

Table B1 continued.

Region/County	Farm Size (acres) Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
Mountains	17	46	38	51	64	62	57	335
Chaffee	7	9	6	4	4	5	2	37
Custer	0	4	3	8	4	3	4	26
Eagle	0	2	3	4	3	2	3	17
Fremont	0	7	1	6	2	4	3	23
Grand	2	3	2	2	8	9	3	29
Gunnison	0	0	3	4	4	3	1	15
Hinsdale	0	1	0	1	0	0	0	2
Huerfano	0	1	3	2	3	9	5	23
Jackson	0	0	0	3	10	7	17	37
Lake	0	1	0	0	0	0	0	1
Mineral	0	0	0	0	0	1	0	1
Ouray	3	1	2	0	2	3	6	17
Park	0	0	0	2	4	3	2	11
Pitkin	1	5	5	2	3	2	0	18
Routt	4	12	10	12	15	11	5	69
Summit	0	0	0	1	2	0	2	5
Teller	0	0	0	0	0	0	4	4
Western Slope	82	220	168	125	109	43	61	808
Archuleta	1	3	2	5	5	1	2	19
Delta	17	44	28	10	13	1	4	117
Dolores	0	1	2	6	3	1	1	14
Garfield	3	14	15	15	16	9	7	79
La Plata	14	41	24	27	18	4	3	131
Mesa	24	29	30	11	11	6	8	119
Moffat	0	2	8	3	5	4	12	34
Montezuma	5	31	21	25	17	1	4	104
Montrose	16	46	32	16	12	10	5	137
Rio Blanco	2	5	5	6	8	5	12	43
San Miguel	0	4	1	1	1	1	3	11
Colorado	236	638	565	590	619	343	290	3,281

[a] County and farm size identified from National Agricultural Statistics Service (NASS) database prior to mailing.

Table B2. Number of Usable Responses by County and Farm Size[a]

Region/County	Farm Size (acres) Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
Colorado	131	301	235	245	243	107	57	1,319
South Platte	48	92	83	73	60	21	9	386
Adams	0	2	4	3	4	3	0	16
Boulder	5	8	1	3	2	0	0	19
Larimer	8	13	9	3	6	1	3	43
Logan	1	4	7	5	10	6	1	34
Morgan	7	16	15	18	14	2	0	72
Sedgwick	0	0	1	1	3	5	3	13
Weld	27	49	46	40	21	4	2	189
Eastern Plains	1	11	12	33	71	41	14	183
Arapahoe	0	0	1	1	2	0	0	4
Baca	0	3	2	4	4	5	1	19
Cheyenne	0	0	0	0	4	0	0	4
Douglas	0	1	0	2	2	1	0	6
El Paso	1	2	0	3	6	0	0	12
Elbert	0	0	0	1	1	1	2	5
Kit Carson	0	0	1	5	14	9	1	30
Phillips	0	1	3	5	9	3	1	22
Washington	0	2	1	3	4	4	2	16
Yuma	0	2	4	9	25	18	7	65
Arkansas Valley	15	30	24	26	15	4	7	121
Bent	2	1	5	4	4	0	1	17
Crowley	0	5	1	1	2	0	0	9
Kiowa	0	1	0	0	0	1	0	2
Las Animas	2	6	2	5	1	0	3	19
Otero	6	7	6	4	1	0	0	24
Prowers	1	5	4	10	5	3	2	30
Pueblo	4	5	6	2	2	0	1	20
San Luis Valley	9	32	24	38	36	6	0	145
Alamosa	3	6	9	7	11	0	0	36
Conejos	2	8	6	10	6	1	0	33
Costilla	3	5	1	8	2	1	0	20
Rio Grande	1	11	6	7	7	2	0	34
Saguache	0	2	2	6	10	2	0	22

(continued)

Table B2 continued.

Region/County	Farm Size (acres) Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
Mountains	8	24	18	24	28	22	19	143
Chaffee	2	6	3	1	0	1	0	13
Custer	0	1	1	1	1	3	1	8
Eagle	1	1	0	3	0	1	3	9
Fremont	1	2	2	1	2	0	1	9
Grand	1	1	1	2	4	3	1	13
Gunnison	0	0	2	3	3	0	1	9
Hinsdale	0	1	0	1	0	0	0	2
Huerfano	0	3	1	0	2	4	1	11
Jackson	0	0	0	0	3	4	7	14
Lake	0	1	0	0	0	0	0	1
Mineral	0	0	0	0	0	1	0	1
Ouray	0	1	2	0	1	1	1	6
Park	0	0	0	2	1	0	1	4
Pitkin	0	0	3	2	1	0	0	6
Routt	2	7	3	8	7	3	2	32
Summit	0	0	0	0	2	0	0	2
Teller	1	0	0	0	1	1	0	3
Western Slope	50	112	74	51	33	13	8	341
Archuleta	1	1	1	2	2	0	0	7
Delta	11	23	10	4	3	1	0	52
Dolores	0	1	0	1	1	0	0	3
Garfield	2	7	3	8	6	4	1	31
La Plata	8	23	18	11	6	0	1	67
Mesa	13	16	7	5	1	2	1	45
Moffat	0	2	3	2	2	2	4	15
Montezuma	5	11	11	9	4	0	0	40
Montrose	8	19	16	8	4	2	0	57
Rio Blanco	2	8	3	1	4	1	1	20
San Miguel	0	1	2	0	0	1	0	4
Colorado	131	301	235	245	243	107	57	1,319

[a] County and farm size determined from survey replies.

Table B3. Percentage of Surveys Returned by County and Farm Size[a]

	Farm Size (acres)							
Region/County	Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
Colorado	56	47	42	42	39	31	20	40
South Platte	52	39	40	38	43	32	23	40
Adams	0	50	44	38	40	50	0	36
Boulder	50	42	9	33	33	0	0	33
Larimer	44	52	43	19	55	14	60	42
Logan	33	29	58	29	50	43	17	40
Morgan	58	38	29	38	39	17	0	35
Sedgwick	0	-	33	25	60	71	50	50
Weld	57	37	47	45	41	24	18	42
Eastern Plains	100	65	34	48	37	32	17	35
Arapahoe	-	0	-	100	100	0	-	67
Baca	-	150	50	36	21	31	11	31
Cheyenne	-	-	-	0	57	0	0	22
Douglas	-	50	0	67	40	100	0	38
El Paso	100	100	0	75	46	0	0	40
Elbert	-	-	0	-	17	100	40	38
Kit Carson	-	0	25	38	40	28	6	29
Phillips	-	100	50	33	23	13	25	25
Washington	-	50	33	75	40	33	33	41
Yuma	-	50	36	53	43	49	25	42
Arkansas Valley	65	54	47	39	35	17	16	40
Bent	100	20	63	50	67	0	10	41
Crowley	0	125	20	17	-	0	0	47
Kiowa	-	-	-	-	0	50	0	40
Las Animas	67	67	29	50	13	0	33	38
Otero	86	41	38	29	10	0	0	35
Prowers	33	42	40	59	31	30	15	37
Pueblo	57	56	120	18	100	0	25	49
San Luis Valley	45	52	35	43	51	30	0	43
Alamosa	75	32	53	44	58	0	0	46
Conejos	22	50	32	56	38	14	0	38
Costilla	100	56	20	67	40	33	0	53
Rio Grande	33	73	25	28	37	50	0	37
Saguache	0	67	67	33	91	50	0	52

(continued)

Table B3 continued.

Region/County	Farm Size (acres) Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
Mountains	47	52	47	47	44	35	33	43
Chaffee	29	67	50	25	0	20	0	35
Custer	-	25	33	13	25	100	25	31
Eagle	-	50	0	75	0	50	100	53
Fremont	-	29	200	17	100	0	33	39
Grand	50	33	50	100	50	33	33	45
Gunnison	-	-	67	75	75	0	100	60
Hinsdale	-	100	-	100	-	-	-	100
Huerfano	-	300	33	0	67	44	20	48
Jackson	-	-	-	0	30	57	41	38
Lake	-	100	-	-	-	-	-	100
Mineral	-	-	-	-	-	100	-	100
Ouray	0	100	100	-	50	33	17	35
Park	-	-	-	100	25	0	50	36
Pitkin	0	0	60	100	33	0	-	33
Routt	50	58	30	67	47	27	40	46
Summit	-	-	-	0	100	-	0	40
Teller	-	-	-	-	-	-	0	75
Western Slope	61	51	44	41	30	30	13	42
Archuleta	100	33	50	40	40	0	0	37
Delta	65	52	36	40	23	100	0	44
Dolores	-	100	0	17	33	0	0	21
Garfield	67	50	20	53	38	44	14	39
La Plata	57	56	75	41	33	0	33	51
Mesa	54	55	23	45	9	33	13	38
Moffat	-	100	38	67	40	50	33	44
Montezuma	100	35	52	36	24	0	0	38
Montrose	50	41	50	50	33	20	0	42
Rio Blanco	100	160	60	17	50	20	8	47
San Miguel	-	25	200	0	0	100	0	36
Colorado	56	47	42	42	39	31	20	40

[a] Farm size and county reported by some respondents did not match NASS records, causing response rates to be overstated for some categories (particularly those indicating greater than 100% response) and understated for others. Anonymity of respondents prevents reconciliation of these differences. Pooling across county and farm size should diminish the effect of these errors.

Table B4. Count Distribution of Usable Responses for Representative Field Attributes

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
All Categories	386	183	121	145	143	341	1,319
By Application System							
Center Pivot	97	143	4	69	7	8	328
Sideroll	8	5	-	-	7	51	71
Other Sprinkler	3	5	2	1	3	16	30
Gated Pipe	77	16	30	4	7	81	215
Siphon Tubes	139	3	32	18	1	31	224
Flood	58	9	47	47	113	141	415
No system reported	4	2	6	6	5	13	36
By Water Source							
Groundwater	122	161	6	55	1	2	347
Ditch Company	246	6	96	67	27	263	705
Direct Diversion	7	11	10	19	104	62	213
No source reported	11	5	9	4	11	14	54
By 1996 Crop							
Alfalfa & Hay	97	29	59	80	121	243	629
Barley	5	-	1	21	-	4	31
Beans	22	7	1	-	-	13	43
Corn (grain & silage)	178	127	33	-	2	20	360
Pasture	4	1	3	5	5	6	24
Potatoes	2	-	-	21	-	-	23
Wheat	18	11	4	5	1	6	45
Other Crops	46	5	9	6	-	35	101
No crop reported	14	3	11	7	14	14	63

Table B5. Regional Ratings of Importance of Factors in Irrigation Decisions

	Rating				
	Very Important (1)	Important (2)	Slightly Important (3)	Not Important (4)	Average Rating
	--------------------Percent of Respondents--------------------				
South Platte					
System reliability	70	26	3	1	1.3
Water availability	68	26	4	1	1.4
Yield impact	66	32	2	1	1.4
Familiarity with system	58	36	4	2	1.5
Timing of labor required	56	37	6	1	1.5
Difficulty to operate/manag	42	42	14	2	1.7
Soil type	42	47	11	1	1.7
Water laws	40	32	20	8	2.0
Cropping flexibility	38	42	15	5	1.9
Eastern Plains					
System reliability	74	26	1	0	1.3
Water availability	62	32	4	2	1.5
Yield impact	72	26	1	1	1.3
Familiarity with system	53	43	3	1	1.5
Timing of labor required	49	43	7	1	1.6
Difficulty to operate/manag	41	50	8	2	1.7
Soil type	42	48	9	1	1.7
Water laws	43	37	15	5	1.8
Cropping flexibility	36	45	14	5	1.9
Arkansas Valley					
System reliability	65	33	2	0	1.4
Water availability	78	19	2	1	1.3
Yield impact	63	34	2	1	1.4
Familiarity with system	54	40	6	0	1.5
Timing of labor required	56	37	4	3	1.5
Difficulty to operate/manag	49	37	10	4	1.7
Soil type	35	48	16	1	1.8
Water laws	53	22	12	14	1.9
Cropping flexibility	34	46	15	5	1.9

(continued)

Table B5. Continued

	Rating				
	Very Important (1)	Important (2)	Slightly Important (3)	Not Important (4)	Average Rating
	--------------------Percent of Respondents--------------------				
San Luis Valley					
System reliability	63	27	4	6	1.5
Water availability	80	19	1	1	1.2
Yield impact	67	28	3	2	1.4
Familiarity with system	62	30	4	5	1.5
Timing of labor required	39	43	7	11	1.9
Difficulty to operate/manag	37	45	8	10	1.9
Soil type	42	48	8	2	1.7
Water laws	52	29	12	6	1.7
Cropping flexibility	37	40	13	11	2.0
Mountains					
System reliability	57	35	5	3	1.5
Water availability	67	23	4	6	1.5
Yield impact	59	34	6	1	1.5
Familiarity with system	66	29	3	2	1.4
Timing of labor required	46	44	8	3	1.7
Difficulty to operate/manag	35	44	12	9	1.9
Soil type	37	37	23	3	1.9
Water laws	55	31	4	10	1.7
Cropping flexibility	13	29	15	42	2.9
Western Slope					
System reliability	66	30	2	2	1.4
Water availability	67	23	9	1	1.4
Yield impact	61	36	3	0	1.4
Familiarity with system	59	33	6	2	1.5
Timing of labor required	51	40	7	2	1.6
Difficulty to operate/manag	42	46	8	3	1.7
Soil type	35	46	16	3	1.9
Water laws	36	33	15	16	2.1
Cropping flexibility	23	42	22	13	2.2

Table B6. Average Rating of Importance of Factors in Irrigation Decisions[a]

	Decision Factor								
	System reliability	Water availability	Yield impact	Familiarity with system	Timing of labor required	Difficulty to operate/ manage	Soil type	Water laws	Cropping flexibility
All Categories	1.4	1.4	1.4	1.5	1.6	1.8	1.8	1.9	2.1
By Application System									
Center Pivot	1.2	1.4	1.2	1.5	1.6	1.7	1.6	1.9	1.8
Sideroll	1.3	1.5	1.4	1.6	1.5	1.9	1.8	2.1	2.2
Other Sprinkler	1.4	1.5	1.5	1.4	1.7	1.8	1.9	2.0	2.5
Gated Pipe	1.4	1.5	1.4	1.6	1.5	1.7	1.9	2.2	2.1
Siphon Tubes	1.4	1.3	1.4	1.5	1.5	1.8	1.7	1.9	1.8
Flood	1.5	1.3	1.5	1.5	1.7	1.9	1.9	1.8	2.5
By Water Source									
Groundwater	1.3	1.4	1.2	1.5	1.6	1.7	1.7	1.8	1.8
Ditch Company	1.4	1.4	1.4	1.5	1.6	1.7	1.8	2.1	2.0
Direct Diversion	1.6	1.3	1.5	1.5	1.7	1.9	2.0	1.7	2.8
By 1996 Crop									
Alfalfa & Hay	1.5	1.4	1.5	1.5	1.7	1.8	1.9	1.9	2.4
Barley	1.3	1.3	1.3	1.3	1.6	1.6	1.6	1.7	1.6
Beans	1.3	1.4	1.3	1.5	1.5	1.6	1.8	1.9	1.8
Corn (grain & silage)	1.3	1.4	1.3	1.5	1.5	1.7	1.6	1.9	1.8
Pasture	1.5	1.4	1.6	1.6	1.7	2.0	1.8	1.9	2.4
Potatoes	1.3	1.4	1.1	1.6	1.7	1.7	1.2	2.0	1.7
Wheat	1.2	1.4	1.3	1.5	1.6	1.8	1.8	1.9	1.6
Other Crops	1.3	1.5	1.4	1.5	1.6	1.8	1.8	2.1	1.9

[a] 1 = Very Important, 2 = Important, 3 = Slightly Important, 4 = Not Important

Table B7. Regional Rating of Quality of Information Received from Sources

	Rating						
	Excellent (1)	Very Good (2)	Good (3)	Fair (4)	Poor (5)	No Opinion	Average Rating[a]
	---Percent of Respondents---						
South Platte							
Consultant	13	22	18	8	2	37	2.4
Soil Testing Lab	10	33	28	12	2	15	2.6
Chemical Dealer	15	33	32	9	2	7	2.5
Cooperative Extension	4	16	32	18	7	23	3.1
Neighbors	4	16	38	19	5	18	3.1
NRCS	4	13	26	22	9	26	3.3
Water Mgt District	6	18	27	14	9	26	3.0
Popular Press	0	5	20	29	16	29	3.8
Eastern Plains							
Consultant	21	34	16	8	1	20	2.2
Soil Testing Lab	17	34	32	8	2	7	2.4
Chemical Dealer	12	33	30	12	2	10	2.5
Cooperative Extension	6	25	33	15	5	16	2.8
Neighbors	4	11	40	24	5	16	3.2
NRCS	3	12	31	22	13	19	3.4
Water Mgt District	3	22	25	19	11	20	3.2
Popular Press	0	6	28	26	17	22	3.7
Other	17	13	4	4	0	63	1.9
Arkansas Valley							
Consultant	6	17	28	7	3	39	2.8
Soil Testing Lab	6	33	22	16	4	19	2.7
Chemical Dealer	10	29	33	9	6	13	2.7
Cooperative Extension	6	28	23	11	11	21	2.9
Neighbors	8	23	32	22	5	11	2.9
NRCS	3	19	33	20	9	16	3.2
Water Mgt District	4	5	19	28	17	26	3.7
Popular Press	1	8	25	26	12	29	3.6

(continued)

Table B7. Continued

	Rating						
	Excellent (1)	Very Good (2)	Good (3)	Fair (4)	Poor (5)	No Opinion	Average Rating[a]
	---------------------Percent of Respondents---------------------						
San Luis Valley							
Consultant	10	26	14	17	2	31	2.6
Soil Testing Lab	13	24	24	11	3	25	2.6
Chemical Dealer	8	18	32	13	5	25	2.9
Cooperative Extension	7	27	28	14	7	18	2.8
Neighbors	6	14	44	17	6	13	3.0
NRCS	4	16	18	22	12	28	3.3
Water Mgt District	4	13	23	17	13	32	3.3
Popular Press	0	1	19	27	21	32	4.0
Mountains							
Consultant	6	7	7	6	5	70	2.9
Soil Testing Lab	7	21	21	10	3	38	2.7
Chemical Dealer	5	13	21	13	5	41	3.0
Cooperative Extension	9	15	30	7	7	32	2.8
Neighbors	7	22	32	11	4	23	2.8
NRCS	8	15	31	10	4	32	2.8
Water Mgt District	6	8	15	7	9	56	3.1
Popular Press	0	5	9	18	15	53	3.9
Western Slope							
Consultant	5	8	14	10	9	54	3.2
Soil Testing Lab	6	15	27	11	8	32	3.0
Chemical Dealer	8	19	24	18	7	24	2.9
Cooperative Extension	7	18	31	15	9	20	3.0
Neighbors	6	19	38	13	8	15	3.0
NRCS	8	18	29	16	11	18	3.1
Water Mgt District	6	11	19	9	15	40	3.3
Popular Press	1	3	16	21	19	40	3.9

[a] Average of respondents with a stated opinion of given information source.

Table B8. Average Rating of Quality of Information from Various Sources[a]

	Information Source							
	Consultant	Soil Testing Lab	Chemical Dealer	Cooperative Extension	Neighbors	NRCS	Water Mgt District	Popular Press
All Categories	2.6	2.6	2.7	3.0	3.0	3.2	3.2	3.8
By Application System								
Center Pivot	2.3	2.4	2.5	2.9	3.1	3.4	3.2	3.8
Sideroll	3.4	2.9	3.1	3.1	3.2	3.2	3.5	3.8
Other Sprinkler	2.7	2.6	3.0	2.8	2.8	2.9	2.9	3.8
Gated Pipe	2.8	2.8	2.7	3.0	3.2	3.1	3.3	3.8
Siphon Tubes	2.6	2.8	2.5	3.0	2.9	3.3	3.0	3.8
Flood	3.0	2.7	2.9	3.0	2.8	2.9	3.3	3.8
By Water Source								
Groundwater	2.2	2.4	2.5	2.8	3.2	3.3	3.2	3.8
Ditch Company	2.8	2.7	2.7	3.0	2.9	3.1	3.2	3.8
Direct Diversion	3.1	2.8	3.0	2.9	3.0	3.0	3.4	4.0
By 1996 Crop								
Alfalfa & Hay	3.0	2.7	2.9	2.9	2.9	3.1	3.3	3.8
Barley	2.1	2.4	2.2	2.7	3.2	3.1	3.1	3.9
Beans	2.5	2.9	2.2	3.1	3.3	3.2	3.0	3.7
Corn (grain & silage)	2.3	2.5	2.5	3.0	3.1	3.3	3.1	3.7
Pasture	3.6	2.5	3.1	3.4	2.6	3.1	3.3	4.3
Potatoes	2.0	2.6	2.6	2.6	3.1	3.5	3.4	4.1
Wheat	2.6	2.7	2.5	2.8	3.2	3.1	3.2	4.1
Other Crops	2.6	2.7	2.7	3.1	3.2	3.4	3.1	4.0

[a] Average rating of respondents with a stated opinion of the given information source. (1 = Excellent, 2 = Very Good, 3 = Good, 4 = Fair, 5 = Poor)