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Survey of Irrigation, Nutrient and Pesticide Management Practices in Colorado

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EXECUTIVE SUMMARY

Understanding currently used farming practices, information needs, management constraints, and water concerns of irrigating producers in Colorado is essential for conducting relevant research and outreach. To update our knowledge, we conducted a survey of irrigation, nutrient, and pest management practices adopted by producers. This survey was also intended as a five year follow-up to an irrigation management survey conducted in 1997. The survey was mailed in late 2001 to 3,268 irrigators identified through the Colorado Agricultural Statistics annual crop production survey. Approximately 40% of the surveys were returned with 37% being useable responses.

The survey instrument was divided into nine main sections. These nine sections include; General Farm Information, Irrigation System(s) on Whole Farm, Fertilizer Management on Whole Farm, Pest Management on Whole Farm, Representative Irrigated Field, 2001 Irrigation Management of the Representative Field, Water and Crop Management Decisions on Whole Farm, Water Concerns and Personal Information. Each respondent was asked a total of forty-two questions designed to provide detailed information about the specific topic of each section. A copy of the survey instrument is included in Appendix B.

The sample of Colorado irrigators that returned our survey represented a highly experienced group with an average of 30 years of irrigation experience. Our sample was also well educated, with 70% having some post-secondary education. The majority of respondents (65%) reported annual gross farm sales of less than $100,000 annually. Approximately 44% of respondents supplemented this farm income with off-farm employment. Although there was much regional variability, the average whole-farm size for the sample was 1,174 acres (median was 350 acres). The acreage sampled represented approximately 400,000 of the state's irrigated acres.

Surface water accounted for slightly over 70% of the irrigation water used by all respondents, with the balance coming from groundwater. However, many respondents rely on water from both surface and aquifer sources. Crops grown varied regionally, as would be expected in Colorado, but the most frequently irrigated crop statewide was alfalfa or some other type of hay, with corn second. The irrigation systems used also varied by region of the state and water source with siphon tubes and flood dominating the mountains and west slope and center pivots irrigating much of the High Plains. The majority of these systems had been upgraded with some improvement intended to improve their efficiency and or uniformity.

The reliability of water sources varied greatly by regions. However, only 46% of respondents described their water supply as highly reliable, providing adequate water ten years out of ten. The lowest reliability was reported by respondents from the Mountains and the Arkansas Valley. Ground water users tended to report higher water reliability, as expected. Likewise, water availability, drought and urban competition rated high as water concerns for producers both on their farm and in their county. We also found that 26% of respondents have concerns about the quality of their water for crop production, household, or livestock use. Irrigation water quality was the listed concern by over a third of these respondents as the most serious concern. Irrigators in the South Platte (31%) and the Arkansas Valley (58%) most frequently indicated concern with salinity. Other water quality concerns that rated high included weed seeds, sediment, and nitrate.

While results varied widely by region and farm demographic, overall we found many of the common nutrient and pest Best Management Practices are being used. For example, about half of all Colorado producers used soil test analysis to help determine their fertilizer rate, with the percentage reaching close to 80% in some regions. However, crediting of other nutrient sources such as past manure applications, legume crops, or irrigation water was mentioned less frequently. Among pest and pesticide management practices, field scouting was used by over half of the respondents (53%), with a higher adoption rate among farmers also reporting pesticide use. A majority of respondents also said they used integrated pest management (IPM) practices such as clean/pure seed, cultivation for weed control, and crop rotation. In contrast, use of other IPM practices such as biological controls and pest forecasting was not widely reported, as these practices have limited availability in Colorado.

Adoption of the irrigation water management practices of water application time and amount were also assessed. Respondents reported using experience and crop appearance more often than using accumulated crop water use (ET) or available soil moisture to time irrigations. These more precise techniques were selected by about a third of the respondents, but more frequently by ground water users who have more opportunity to control water delivery. Likewise, ground water users were about twice as likely to adjust water application amounts at each irrigation than surface water users. Still, “same amount each time” was chosen most frequently (48%) as the method to determine how much water should be applied among all respondents. The results also indicate that irrigation record keeping is not common, as only slightly over 40% of respondents reported they knew the amount of water applied to their representative field, and less than one-quarter of respondents indicated

keeping records of water application. Less than 10% reported accurate knowledge of how much water their crop used in the previous (2001) growing season.

The information sources growers use for management decisions was assessed. Respondents reported using institutional sources of information (Cooperative Extension, NRCS) less than crop input dealers or other private sources of information. Use of paid consultants for crop production advice varied widely by region, but was only used by 13% of respondents statewide. Besides information source, we also learned what factors may limit producers' decision making. Water availability, followed by equipment cost and management time, were the most frequently chosen factors that limit decisions. We also asked what information that CSU could provide to help irrigating crop producers in making water management decisions. The top two categories given by respondents could be categorized into irrigation system management and water crop water use

This survey report provides insight into how Colorado producers are managing their irrigation water, nutrients and pesticides. As these inputs become increasingly scarce and expensive, Colorado producers look to a variety of information sources, including their land grant university to help them improve their efficiency. This report provides information on the practices and areas of Colorado with research and extension needs and can be used to focus efforts to best serve Colorado producers.

All survey results are detailed by region within Appendix A. County level data is available by contacting the authors.

INTRODUCTION

Supplies of clean and abundant water have been a concern for humans as long as they have inhabited Colorado. A high percentage of Colorado's water is diverted for agricultural purposes and this sector is increasingly asked to conserve both the quality and quantity of this water for other uses. Improved irrigation, nutrient, and pesticide management practices to protect water resources are often referred to as Best Management Practices or "BMPs". For the most part, Colorado producers are encouraged to voluntarily adopt BMPs without state or federal mandates. Colorado State University Cooperative Extension and the Colorado Department of Agriculture developed and published many of these BMPs with significant input from producers, the USDA Natural Resources Conservation Service (NRCS), the agricultural industry, and others, in several agriculturally important watersheds throughout the state. The goal of these BMPs is to promote conservation and prevent degradation of water quality through voluntary adoption of BMPs by Colorado farmers.

Significant resources have been used to develop, encourage, and extend BMPs to producers for irrigated crop production. Until recently, there has been little quantified information on how many Colorado producers are using BMPs and where they are being used. Therefore, one objective of this work was to obtain quantifiable information about specific BMP's producers are using that maintain their productivity while protecting the environment. This information is necessary to conduct relevant educational programming, research and training in the areas and topics where it is most needed. The data is also helpful in documenting the progress that Colorado producers are making in protecting water quality and to identify where more effort is needed. This survey was also designed as a five-year follow-up to *Survey of Irrigation Management* conducted in 1997 (Frasier et al., 1999). Another objective was to assess whether growers have changed management practices in the five years since the first survey was conducted, to gain more detailed information than the first survey was able to acquire, and to explain questions brought up by the first survey. However, the primary purpose of this document is to report the latest survey results and few comparisons are made to the previous survey. These comparisons will be reserved for subsequent publications.

SURVEY DESIGN

The survey instrument was divided into nine main sections. These nine sections include; General Farm Information, Irrigation System(s) on Whole Farm, Fertilizer Management on Whole Farm, Pest Management on Whole Farm, Representative Irrigated Field, Irrigation Management of the Representative Field, Water and Crop Management Decisions on Whole Farm, Water Concerns, and Personal Information. Each respondent was asked a total of forty-two questions designed to provide detailed information about the specific topic of each section. A copy of the survey instrument is included in Appendix B.

The purpose of the first section, *General Farm Information*, was to gain general information about the respondents' farming operations. These questions included such topics as county location, total size of farm, major farm enterprises (crops and livestock), proportion of land irrigated, origin of irrigation water and well depth.

The second section, *Irrigation System(s) on Whole Farm*, consisted of a series of questions about the types of irrigation system used on the entire farming operation. The respondent was specifically asked the percentage of acres serviced by each specific irrigation system, the irrigation components they used, and the primary and secondary scheduling method(s) used to determine when to irrigate.

The third section, *Fertilizer Management on Whole Farm*, asked each survey respondent specific questions about their fertilizer management practices. The respondent was first asked about fertilizer management practices, then whether or not they use manure or effluent for fertilizer, and if so, how they determine the application rate. The respondent is then asked for possible reasons why they might reduce their nitrogen fertilizer, the percentage of their irrigated acreage that was soil tested in 2001 and all possible methods they used for nitrogen fertilizer application.

The fourth section, *Pest Management on Whole Farm*, asked two questions about the respondents' pest management practices. The first question asked the respondent to mark all of the pest management practices they routinely use. The second question asked each respondent how their pest management practices were carried out.

The fifth section of the survey, *Representative Irrigated Field Questions*, asked the survey respondent to focus their answers on "one irrigated field that is most representative of their irrigated farm acres." The respondent was then directed to describe the soil texture, the crops grown over the previous three years, the yield and the irrigated acreage on that

representative field. The respondent was then asked to describe the water source for that irrigated field, how many years out of ten they have had a full water supply, the irrigation application system used on the representative field and when that system was installed.

The sixth section of the survey instrument, *2001 Irrigation Management of the Representative Field*, deals with the same irrigated field that was described in the fifth section. The questions in this section focus on specific irrigation management techniques for that irrigated field. This section begins by asking what method the respondent uses to determine the amount of water to be applied at each application, how many applications were made throughout 2001, quantity of water applied during the 2001 growing season, whether or not the respondent knows the quantity of water used by the crop on the representative field and if they have changed any of their management practices on the representative field in the last five years.

The seventh section, *Water and Crop Management Decisions on Whole Farm*, requested more general information about management practices used on the entire farm. This section asked each respondent to list irrigation and production information sources, factors that limit irrigation and production decisions on their farm and what additional or new information from Colorado State University would be most helpful for making water management decisions.

The eighth section, *Water Concerns*, asks specific water management questions. This section asks whether or not the respondent has ever had their irrigation water analyzed, if they have any water quality concerns on their farm and general concerns about water on their farm or in their county.

The ninth section, *Personal Information*, requested that the respondents provide selected demographic information about themselves. This included their years of irrigation experience, education level, annual gross farm sales and whether or not the respondent has another job off the farm.

An advisory committee consisting of research and extension representatives from major irrigation-related disciplines at Colorado State University was consulted throughout the design of the survey instrument. Additionally, a preliminary draft of the survey was tested on a group of nine irrigating producers who reviewed it for language and difficulty and to determine the completion time.

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 3,268 addresses distributed across the state as shown in Table 1. Appendix Tables A31 and A32 detail this distribution at the county level. The surveys were mailed on November 30, 2001.

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
	---------- Number of Farms ----------							
S. Platte	151	221	172	177	107	38	30	896
E. Plains	1	17	38	59	118	85	50	368
Ark	30	47	69	48	47	19	23	283
SLV	30	91	116	127	110	27	12	513
Mts	33	78	66	64	80	39	29	389
W. Slope	128	232	173	116	87	38	45	819
Colorado	373	686	634	591	549	246	189	3,268

[a] Includes all irrigated and dry cropland, pasture, and rangeland.
S. Platte = South Platte
E. Plains = Eastern Plains
Ark = Arkansas Valley
SLV = San Luis Valley
Mts = Mountains
W. Slope = W. Slope

Compared to the 1997 survey (Frasier et al., 1999) fewer (189) surveys were mailed in 2001 to largest farms (>2,500 acres); more (373) to smallest (<100 acres). However, the percentage of mailed surveys by farm size compares well to irrigated farm size categories reported by the 1997 Census of Agriculture Farm and Ranch Irrigation Survey (USDA-NASS, 1999) as shown in Figure 1. The only major difference is that we did not mail surveys to farmers with less than 40 acres of total cropland, as does NASS.

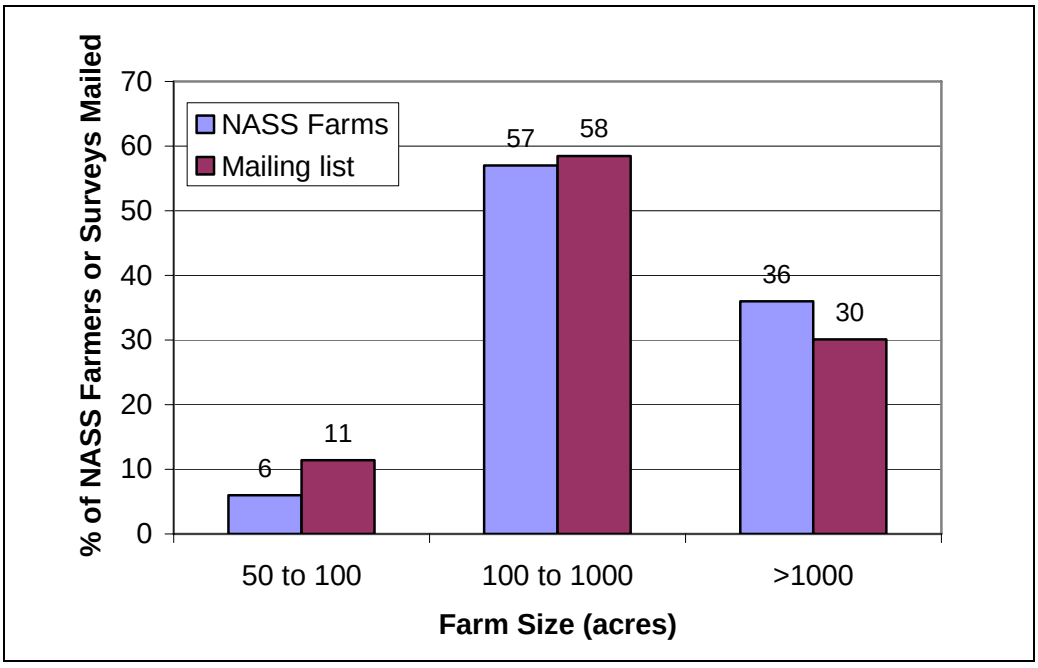


Figure 1. Comparison of Colorado farm size as reported by NASS to survey mailing list farm size.

As suggested 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 we were unable to mail follow-up surveys.

SURVEY RESPONSE

Over the following 13 months, 1,2271 usable responses were returned. This represented 37% of the total surveys mailed. Survey responses were received as early as December 4, 2001 and as late as December 15, 2003. If adjusted for undeliverable surveys and non-usable (incomplete) returns, the overall response rate was 40%. This was a slightly lower response, but a similar pattern in response rate among farm sizes as compared to 1997.

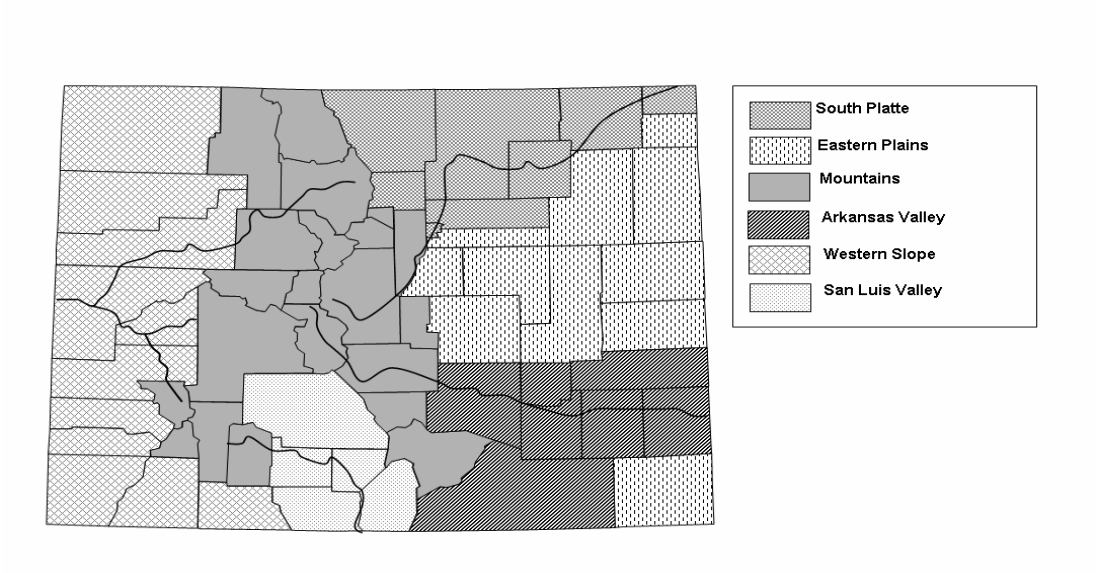


Figure 2. Regional grouping of survey responses by county given.

To control for the diversity of irrigation and cropping practices in Colorado, survey responses were grouped into six geographic regions: the South Platte, the Eastern Plains, the Arkansas Valley, the San Luis Valley, the Mountains, and the Western Slope (Figure 2). These regions were selected based on known differences in cropping practices, water sources 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 High Plains (Ogallala) aquifer. The Arkansas Valley is characterized by use of the Arkansas River as the primary source for irrigation. Note that Baca County, while contiguous with the Arkansas Valley region, was categorized in the High Plains because the High Plains (Ogallala) aquifer is the primary water source. The San Luis Valley region obtains water primarily from the Rio Grande River and the Valley's unconfined aquifer. The Western Slope gets water primarily from rivers and streams, 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.

Table 2. Percentage of usable surveys returned by region and farm size.

Region	Farm Size[a] (acres)							
	Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	All Farms
	---------- % ----------							
S. Platte	34	48	24	29	32	45	37	35
E. Plains	**	59	24	39	31	25	20	31
Ark	47	49	46	33	32	21	30	40
SLV	47	32	28	31	31	22	8	32
Mts	33	38	47	33	48	44	28	42
W. Slope	58	44	46	36	26	39	18	43
Colorado	45	44	36	32	33	33	24	37

[a] Includes all irrigated and dry cropland, pasture, and rangeland.
** Five respondents or fewer in category

Response rate across the six regions was relatively similar. The highest response rates were for the Mountain and Western Slope regions, which had response rates of 42 and 43%, respectively. The lowest response rates were for the Eastern Plains and San Luis Valley regions, which respectively had 31 and 32% response rates. In looking at the response rate with regard to the farm size categories, the response rate decreases with increasing farm size (Table 2). For example, the overall response rate for farms smaller than 100 acres was 45% and response rate for farms over 5000 acres was 23%.

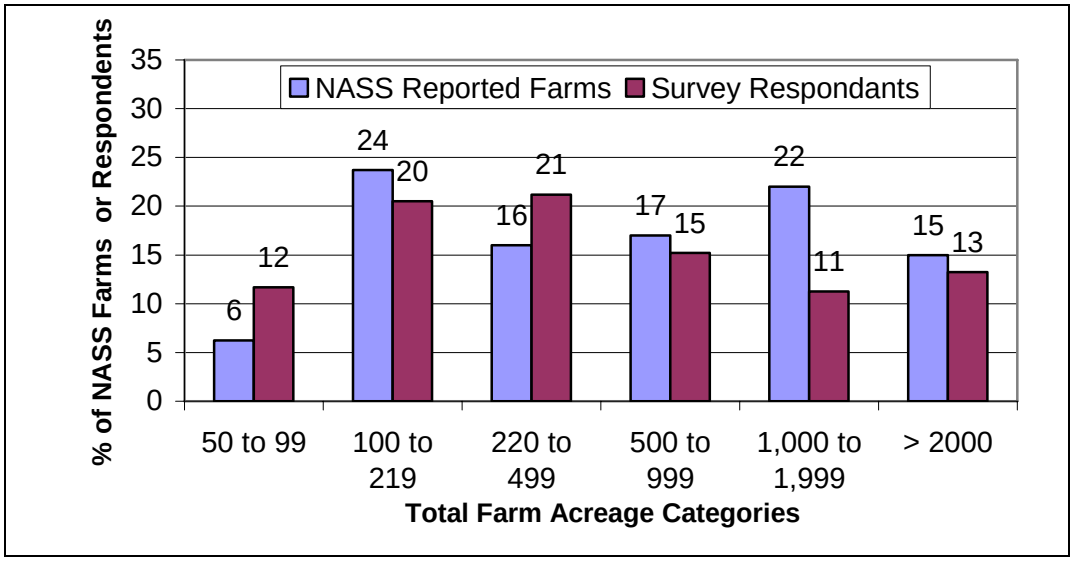


Figure 3. Respondent's farm acreage compared to NASS farm size.

Characteristics of the survey respondents suggest that we obtained a representative sample of Colorado irrigators. For example, Figure 3 shows the percentage of survey respondents as compared to farm acreage categories as reported by NASS. This survey had fewer respondents in the 1,000 to 1,999 and more respondents in the 50 to 99 acreage size classes, but the others sizes categories were similar. Likewise, the average irrigated acres of different total farm class compared well to those NASS reported (Figure 4).

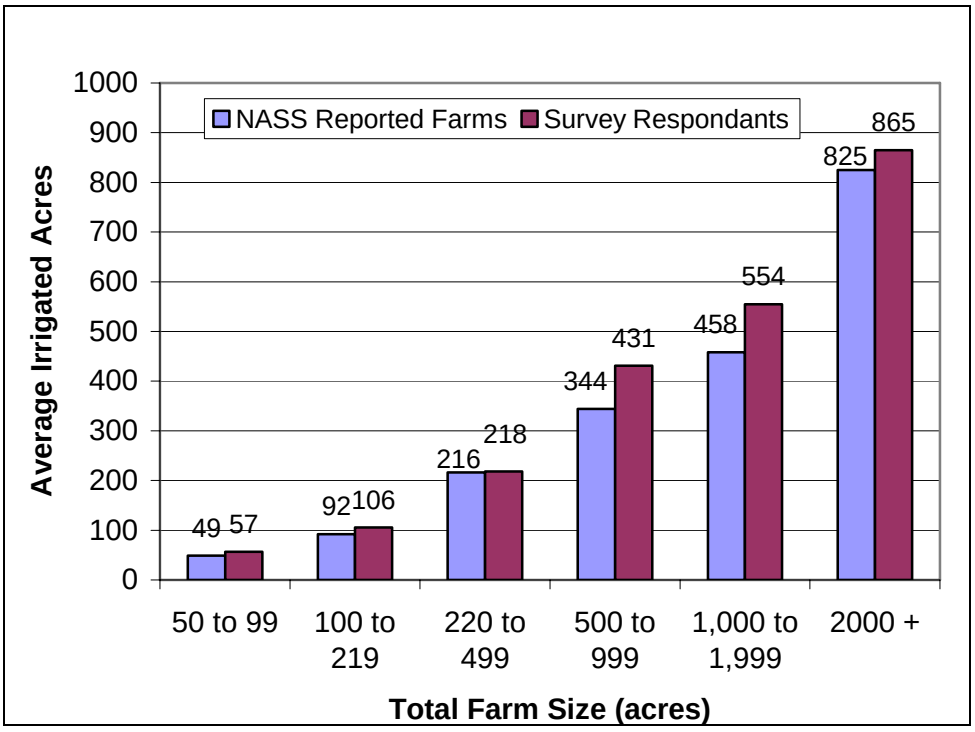


Figure 4. Comparison between NASS reported and survey respondents with regard to average irrigated acres within farm sizes.

SURVEY RESULTS

Many results in this publication are presented as the average percent of respondents using a particular practice or having a particular characteristic. These averages are the simple arithmetic mean of the percentage and are not weighted by the size of the group categorized. In general, if a question did not have a sufficient number of respondents (typically < 5) to accurately compare, the result is not provided and the table is footnoted as such.

Respondent Characteristics

Survey Question
How many years of irrigation experience do you have? _____ years

Although the questions pertaining to the respondents' personal characteristics were asked at the end of the survey, evaluation of these results first can give insight into why respondents take different actions in managing their enterprises (Table A1). The survey results show that Colorado irrigators are highly experienced, with an average of 30 years of irrigation experience. All regions were similar in this regard except the Eastern Plains, which was slightly lower at 25 years. Major development of irrigation in this region did not occur until the 1970s. This does not provide the opportunity for producers to have 40 to 50 years of experience, as observed in the other regions.

Survey Question
Check ☑ your highest level of education.

❍ High School
❍ Some college
❍ Technical/Vocational Degree
❍ Bachelors degree
❍ Graduate or Professional degree

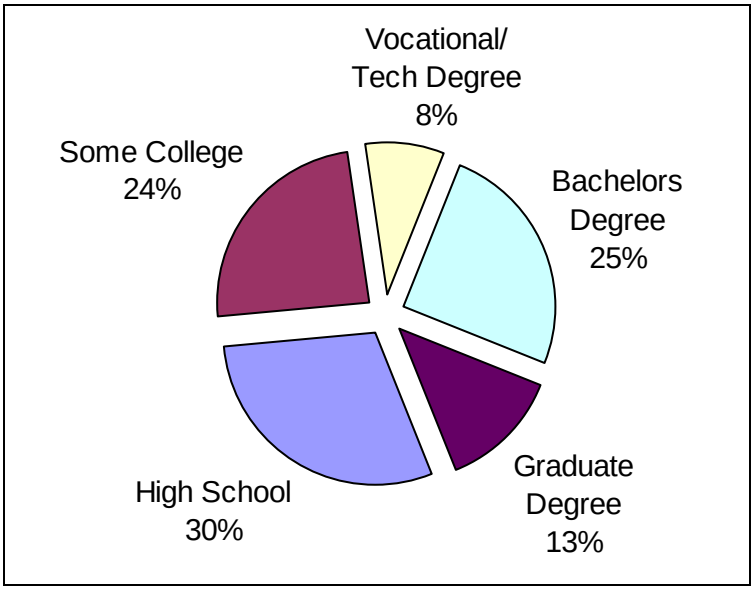


Figure 6. Education level of respondents.

Statewide, producers' educational experiences were divided by similar percentages among those with a high school background, those with some college or vocational degree, and those holding a college degree (Fig. 6). Seventy percent of the respondents had some post-secondary education. As expected, differences were found among regions. For example, the Arkansas Valley had the lowest proportion of graduate degrees (8%), but an almost equal proportion with a high school education and some college (34 and 30% respectively). At 31%, the Eastern Plains had the highest proportion of those with a bachelor's degree, while the Mountains had the most producers with post-graduate degrees at 18% (Table A1).

Survey Question
Check Ø your estimated annual gross farm sales.

❍ less than $50,000	❍ $250,000 - $499,000
❍ $50,000 - $99,000	❍ $500,000 - $1,000,000
❍ $100,000 - $249,000	❍ over $1,000,000

Figure 5 and Table A1 provide the respondents' gross farm sale distribution. For the entire state, 44% grossed less than $50,000 annually, while only 3% grossed over $1,000,000. Collectively, 46% of the respondents grossed between $50,000 and $250,000 while 19% grossed between $250,000 and $1,000,000. Regional differences in gross sales between regions are obvious. On the Eastern Plains 64% of the producers had annual sales exceeding $100,000, compared to one-quarter of those responding from the Mountains and Western Slope.

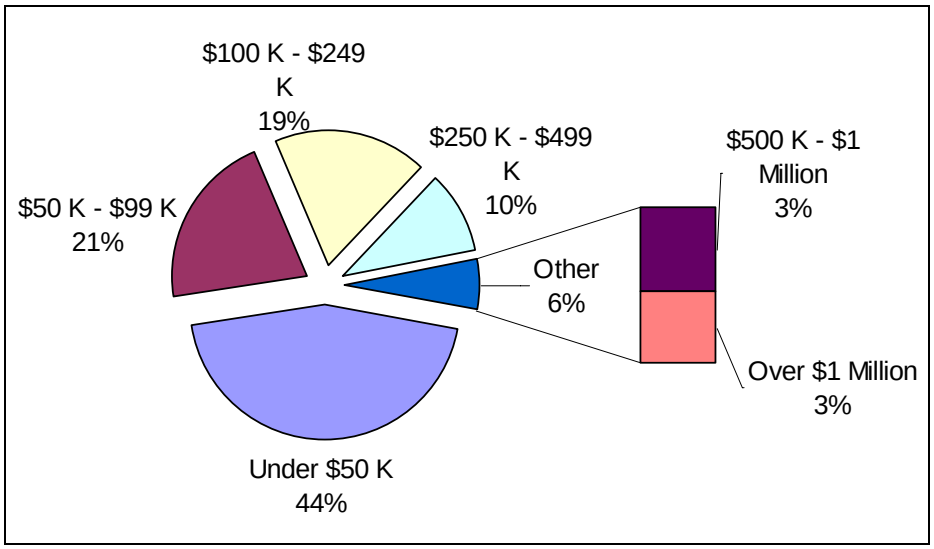


Figure 5. Gross farm sales of respondents.

Survey Question
Do you have another job off the farm?
Yes No
What percentage of your net income comes from farming? _____%

Trends in off-farm employment follow a related pattern. Statewide averages show that 44% 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. For irrigators with a job off the farm, 31% of their income was derived from the farm, ranging from 21% in the San Luis Valley to 43% in the Eastern Plains.

One notable difference in the respondents' personal characteristics in this survey's from 1997 survey's respondents (Frasier, et al 1997) was the 10% increase in respondents that reported having an off-farm job. This is consistent with a 10% increase in responding farms that reported gross farm sales under $50,000 from 1997 suggesting the 2001-2002 survey had a higher proportion of small farm respondents. Additionally, the percent of income reported from the farm by all respondents (regardless of off-farm job status), decreased substantially from 81 to 49% from 1997 suggesting a general downturn in the farm economy between the two surveys or possibly differences between the populations sampled.

Farm Resources

Land

As expected, farm resources differ greatly by region (Table 3). The average farm size for the state was 1,174 acres, ranging from 812 acres in the San Luis Valley to 2,698 acres on the Eastern Plains. The inclusion of a few very large operations in the sample pulls these averages up so the median farm size (350 acres) is also included to characterize the typical operation. Significant variation exists in the average cropped area across regions. According to USDA-NASS (1999) there were approximately 2,942,230 irrigated acres in Colorado in 1998 on 13,430 farms. Our 1,272 usable returned surveys represented 412,963 irrigated acres. Thus, our survey results represent approximately 12.9% of the state's irrigated acreage and 9.5% of the irrigating farmers.

Survey Question
What is the total size of your farm? _____ acres

Statewide, producers leased or rented an average of 14% of their irrigated acres. This was significantly lower than the 1997 survey where respondents reported renting 29% 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.

Survey Question
What portion of your irrigated acres are rented or leased from someone else?
_____ % OR _____ acres

Table 3. General characteristics of entire farm.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
Farm Size[a] (acres)							
Average	847	2698	1280	812	1345	1014	1174
Median	245	1200	350	511	535	240	350
Cropped Area (acres)							
Average	565	1107	736	481	374	178	476
Median	167	731	230	285	139	100	160
Irrigated Area (acres)							
Average	314	530	471	539	291	171	325
Median	150	303	211	320	130	112	150
Irrigated Area Rented (%)	20	21	15	9	10	11	14
Water Source[b] (average %)							
Groundwater	25	90	16	42	1	1	22
Surface Water	73	7	82	57	97	95	73

[a] Includes all irrigated and dry cropland, pasture, and rangeland.
[b] Percentages to not add to 100 because of actual responses given

Water Resources

Survey Question
Approximately what percentage of irrigation water used on your farm comes from the following sources? (allocations should total 100 percent)
Groundwater well _____%
Surface water _____%

As expected, water sources had the greatest variation across regions. Similar to 1997, surface water accounted for 73% of the irrigation water used by all respondents with the balance coming from groundwater (Table 3). Surface water sources supplied nearly all of the irrigation water in the Mountains and Western Slope regions. The Arkansas and S. Platte Valleys are also surface water dominated, but groundwater sources are important, accounting for up to a quarter of the water supply. However, groundwater is relied upon for 42% of the supply in the San Luis Valley. In contrast to the other regions, farmers on the Eastern Plains obtained 90% of their irrigation water from a groundwater source.

Survey Question
What is the depth to water in your farmstead well? _____ft
❍ No well exists.

We also asked respondents to tell us about their water supply for their farmstead. This question was included to learn how many producers relied upon ground water for their farm and household water supply and the vulnerability of this supply to surface contamination. As shown in Figure 7, reliance upon ground water for farmstead uses varies considerably across the state, with respondents in the Eastern Plains (97%) and the San Luis Valley (86%) most reliant on ground water. Because a few very deep wells skewed the well depth average, we report median values in Figure 7. Except for the Eastern Plains, the median well depth for all regions was less than 100 feet. The San Luis and Arkansas Valleys have the most shallow and likely vulnerable water supplies with median well depths 40 feet or less.

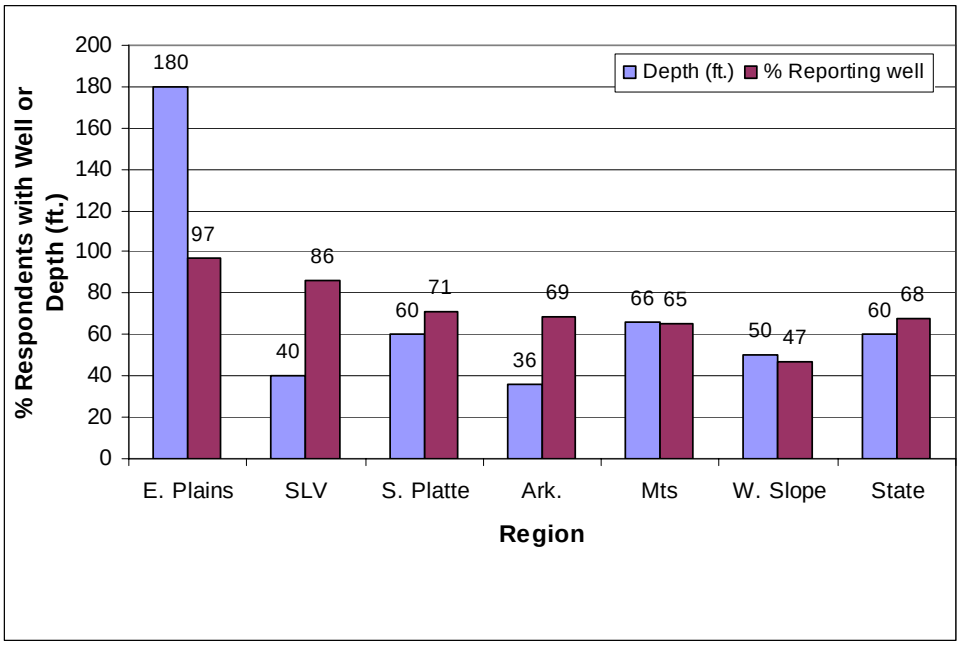


Figure 7. Respondents' farmstead well frequency and median depth.

Farm Products

Crops

Producers in Colorado grow a diverse set of crops and livestock, but we grouped survey responses into broad crop categories (alfalfa or other hay, barley, beans, corn for silage or grain, pasture, potatoes, wheat, and other crops) to facilitate summarization. The Other Crops category included sugar beets, grain and forage sorghum, various vegetables, onions, fruit crops, sunflowers, melons, and millet. While often important locally, they did not constitute enough acreage to report individually statewide. Because of the importance of potatoes in the San Luis Valley, we chose to report it individually. Readers interested in results of a particular Other Crop are encouraged to contact the authors of this report.

Survey Question
List your ***major*** farm enterprises:

Crop	Number of Acres*	Percent Irrigated

Livestock Type	Peak # of Head

*Total number of dryland and irrigated acres.

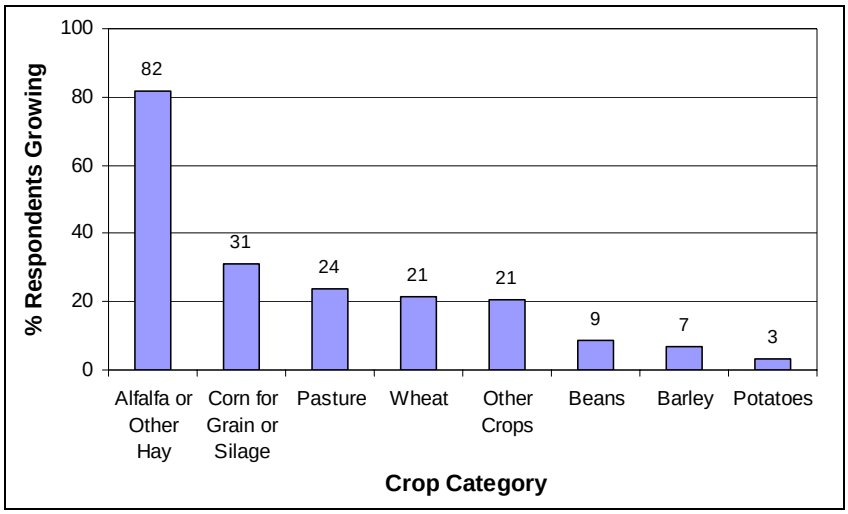


Figure 8. Percent of respondents that report growing crop types, averaged across regions.

Alfalfa or other hay is the most common crop, grown by 82% of survey respondents (Fig. 8). Within each region farmers chose to grow hay more frequently than any other crop, except for the Eastern Plains where corn and wheat are the dominant crops (Table A2). The selection of non-hay crops varies across region. Corn and wheat are dominant crops among the three eastern regions with Other Crops also being important in the South Platte. Potatoes, barley, and wheat are the major crops grown in the San Luis Valley. Producers in the Eastern Plains and the Arkansas Valley 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. The percentage of respondents growing alfalfa or other hay substantially increased from 1997 (77 to 82%), whereas all other crops decreased or did not change. Corn and beans had the largest decreases at 11 and 6%, respectively. These changes may reflect the increase in smaller farms responding to this survey.

On a statewide basis, wheat is the largest cropping enterprise with an average of 379 acres of wheat production per farm. Potatoes and corn are next with 346 and 296 acres, respectively. Examination of Table A2, however, reveals that the average per-farm-acreage of each crop grown varies widely from region to region and from crop to crop. On average, more than 80% 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 and San Luis Valley. This provides an indication that, similar to 1997, the sample represents individuals who are active in irrigation enterprises, not merely irrigating a few acres.

Livestock

Similar to 1997, the majority of respondents in this survey have some livestock on the farm (65% statewide) (Table A3). However, 70% of the respondents had less than 100 head or none. Sixty percent of the respondents raised beef cattle, (beef cows, fat cattle, stocker cattle), the largest livestock category. The next largest group of livestock category, horses, represents a considerable change from 1997 when there were not enough respondents to report them separately.

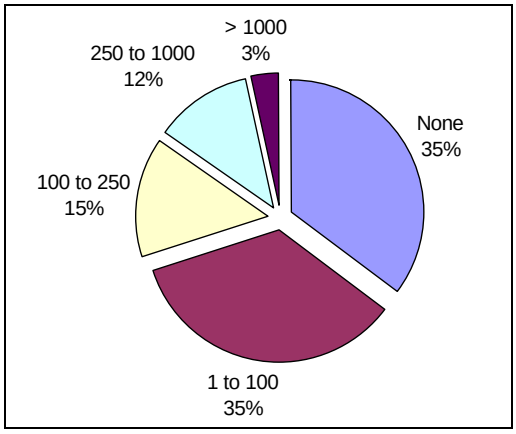


Figure 9. Percent of respondents reporting total livestock size categories.

The percent of respondents with horses decreased with increasing farm size, suggesting that the higher number of horse owners in this survey resulted from a greater percentage of smaller farms. Twenty-seven percent of the respondents were medium sized operations (100 to 1000 head), but only 3% had more than the 1,000 head of livestock (Fig. 9). Depending up on the type of livestock, few respondents would be classified as confined animal feeding operations (CAFOs) based upon animal numbers. One livestock category that was not well represented by the survey was dairy, with only six total respondents reporting dairy cattle.

Irrigation Systems and Components

Survey Question
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	%	Sprinkler:	center pivot	%
	siphon tubes	%		sideroll	%
	ditch and check	%		other sprinkler	%
	lay flat/collapsible pipe	%	Drip tube (surface or buried)		%
	other gravity	%	Other		%

Statewide, more respondents reported using ditch and check and gated pipe irrigation systems than any other system (Table A4). Center pivots were the third most frequently used system, but account for 74% of systems used on the Eastern Plains and 56% in the San Luis Valley. Center pivots irrigated 38% of the acreage reported by our respondents. Thirty eight

percent of USDA/NASS, 1999 estimates for irrigated acreage in Colorado would be approximately 1.1 million acres under center pivots. This compares closely to 1.2 million acres of center pivot irrigation mapped by Bauder et al., 2004. Among all respondents, center pivots dominated sprinkler usage except on the Western Slope where side roll systems are prevalent. Siphon tubes were the dominant gravity system in the South Platte. While the first section of Table A4 shows that respondents' may use more than one irrigation system on their farm, the second section demonstrates that one system often dominates within a region. For example, 78% of a respondent's acreage is served by center pivots in the East Plains and 70% by ditch and check in the Mountains. However, the other regions of the state showed producers often deal with more types of systems in their operations. Finally, Figure 10 shows that center pivots covered the largest percentage of acreage that was surveyed.

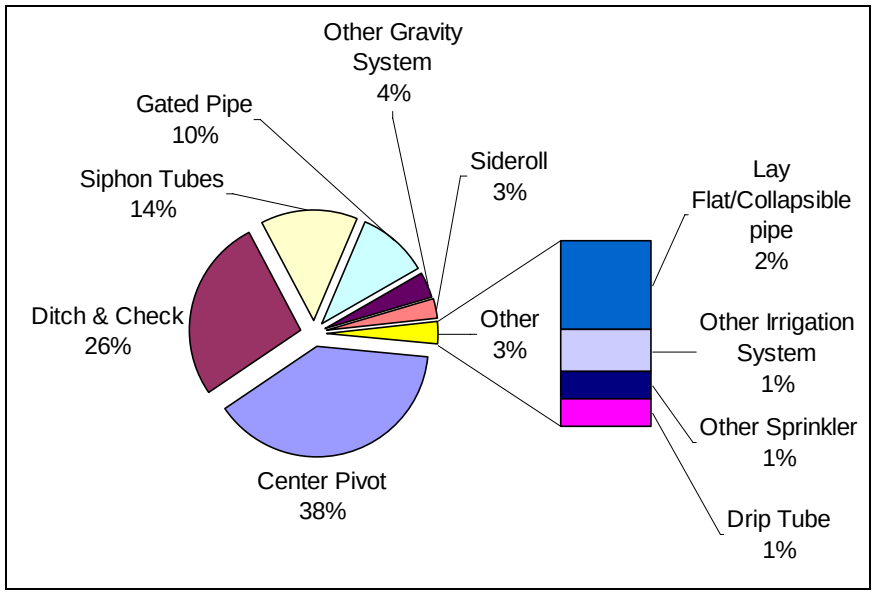


Figure 10. Percent of acreage covered by respondents' irrigation systems.

Survey Question
Check ☑ ***all*** irrigation components used on your farm:

❍ Surge valves	❍ Polyacryamides (PAM)	❍ Drop nozzles
❍ Field leveling	❍ Flow meters	❍ Low pressure nozzles (<25 psi)
❍ Lined ditches	❍ Computerized panel	❍ None of these used
❍ Flume or weir	❍ LEPA	❍ Other

Table 4. Irrigation system upgrade implementation anywhere on respondent's farm.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
	---------- % of Respondents Using ----------						
Irrigation Upgrades							
[a]Field Leveling	51	48	58	48	17	42	44
[a]Lined Ditches	49	8	50	10	9	17	28
[a]Polyacrylamide	18	0	18	0	1	7	9
[a]Surge Valves	6	24	11	2	2	10	7
[b]Drop Nozzles	81	78	77	91	57	40	80
[b]Low Pressure (<25 psi)	57	75	38	54	43	40	59
[b]Computerized panel	6	17	2	18	2	2	7
[b]LEPA	7	23	31	4	0	0	11
[c]Flume or Wier	39	38	40	29	50	45	37
[d]Flow Meters	24	63	37	21	50	9	25
Other	4	6	4	5	13	10	7
None of these used	16	7	16	14	31	21	18

[a] percent of respondents using surface irrigation
[b] percent of respondents using center pivot irrigation
[c] percent of respondents using surface water
[d] percent of respondents using ground water

Table 4 documents the irrigation components and systems upgrades used by respondents. Many of these are intended to increase the irrigation uniformity and/or efficiency of a particular system. Field leveling and lined ditches are the most popular system upgrades for surface irrigation systems. Installation of these improvements has been cost-shared by the Natural Resource Conservation Service (NRCS) and their benefits are readily apparent to producers. Interestingly, the adoption of surge valves is not expanding in many areas of the state. Their use has been heavily promoted in the South Platte and Arkansas River basins, but the highest adoption rate is in the Eastern Plains. Among center pivot irrigators, drop nozzles and low pressure systems are popular, but LEPA (low energy precision application) is not. Over 50% of respondents had some type of water measurement (flume, weir, or flow meter) available somewhere on their farm. The highest reported use was flow meters in the Eastern Plains region. Finally, although the use of polyacrylamide (PAM) is only as high as 18% in the Arkansas and S. Platte regions, this is a relatively high adoption rate for a product that has been available for less than 10 years.

Irrigation Management

Survey Question
Check ❍ the ***primary*** and ***secondary*** scheduling method(s) that you use to determine when to irrigate on your farm:

Primary	Secondary		Primary	Secondary	
❍	❍	Fixed number of days	❍	❍	Paid crop consultant
❍	❍	Ditch schedule	❍	❍	Atmometer (ET gage)
❍	❍	Soil probe	❍	❍	Gypsum blocks
❍	❍	Tensiometers	❍	❍	Computer program
❍	❍	Weather station ET	❍	❍	Experience
❍	❍	Crop appearance	❍	❍	Other

Table 5 provides the irrigation scheduling methods used by respondents to determine when to irrigate. Respondents were allowed to choose from both primary and secondary methods, because results from the 1997 survey indicated that producers use a combination of methodologies to determine when to irrigate. As found in 1997, Experience and Crop Appearance were the top methods selected. These methods are complementary, because experience is necessary to schedule irrigations using crop appearance. The next two methods, Fixed number of days and Ditch schedule, were used more often by nearly half of surface water users, but only 10% of ground water users (Fig. 11). Experience, Crop Appearance, Fixed number of days, and Ditch scheduling are all important, but are not reliable for maximizing field level efficiency.

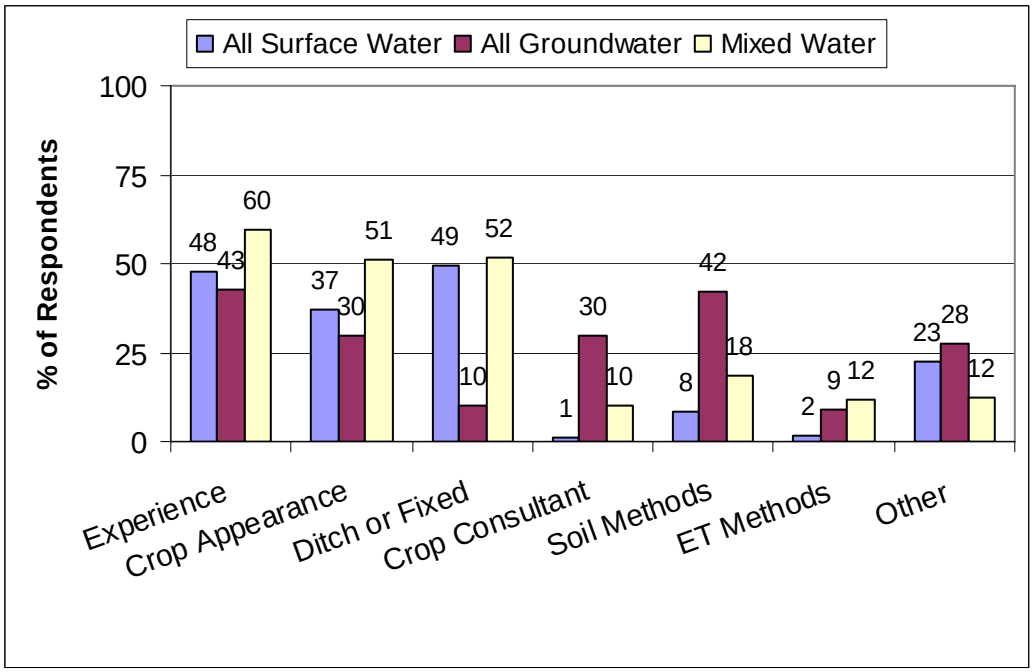


Figure 11. Irrigation scheduling methods used by respondents.

Regional differences in scheduling methods reflect the differences in water sources and systems found throughout Colorado. Irrigating by ditch schedule dominates in surface water basins while using weather station ET is more popular in the San Luis Valley. Scheduling according to soil moisture using a probe or gypsum blocks is more frequently used in Eastern Plains and San Luis Valley where consultants have promoted these methods. The Mountains and Western Slope regions have the least "sophisticated" irrigation scheduling methods, reflecting perhaps the reliance on direct diversions and ditch schedules. Irrigators in areas more reliant on ground water (Eastern Plains and San Luis Valley) tend to utilize more advanced scheduling techniques and advice from crop consultants.

Table 5. Irrigation scheduling methods used anywhere on farm.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
	---------- % of Respondents Using ----------						
Primary Method							
Experience	52	47	42	53	48	49	50
Crop Appearance	49	25	35	38	26	42	39
Ditch Schedule	29	4	60	25	26	15	24
Fixed # Day	19	7	9	10	22	30	19
Soil Probe	9	32	9	17	2	6	11
Crop Consultant	6	34	8	11	0	0	7
Weather Station ET	2	2	3	12	0	1	3
Tensiometer	1	0	0	6	0	0	1
Gypsum Block	1	6	0	1	0	0	1
Atmometer	1	0	0	1	1	0	0
Computer Program	0	0	0	1	0	0	0
Other	4	1	5	4	4	5	4
Secondary Method							
Experience	19	26	21	14	23	24	21
Crop Appearance	22	35	27	21	26	26	25
Ditch Schedule	19	2	9	14	8	10	12
Fixed # Day	23	12	10	22	9	15	16
Soil Probe	9	7	10	13	3	7	8
Crop Consultant	5	11	6	8	0	1	4
Weather Station ET	16	19	7	26	3	7	12
Tensiometer	4	1	2	8	0	1	3
Gypsum Block	3	2	1	1	0	0	1
Atmometer	2	0	1	1	0	1	1
Computer Program	2	0	0	4	1	0	1
Other	3	3	3	3	6	4	4

Among soil moisture based scheduling methods, using a soil probe is more popular than instrumentation such as gypsum blocks or tensiometers. Gypsum blocks only see significant use (6%) in the Eastern Plains and tensiometers (6%) only see significant use in the San Luis Valley. This result reflects the difficulty in obtaining adoption of irrigation scheduling methods. Gypsum blocks have been promoted and supported by the Y-W Soil Conservation District in Eastern Colorado and thus the slightly higher adoption rate is to be expected. However, tensiometers have been heavily promoted in the S. Platte by the Northern Colorado Water Conservancy District for almost a decade, yet their adoption is not much higher than any other region. Outside of the San Luis Valley, few respondents reported using ET-based (evapotranspiration) irrigation scheduling methods such as weather stations, atmometers and computer programs. This doesn't mean these methods are ineffective; rather they haven't been adopted in many areas. Additionally, these methods receive good local support in the San Luis Valley by Cooperative Extension, private consultants, the Agricultural Experiment Station, and NRCS.

Appendix Tables A5 and A6 report irrigation scheduling methods adopted by respondents according to irrigation system and water source. Growers with sprinkler systems tend to use more sophisticated scheduling and in general, the more sophisticated the irrigation system the more sophisticated the scheduling method. Additionally, respondents using ground water as their primary water source are more likely to schedule by soil or ET-based methods (Fig. 11). This result is not surprising given these users typically have more incentive to schedule closer to crop need because of pumping costs and have the ability to determine when to irrigate that surface water users may not always have.

Nutrient Management

Survey Question
With respect to your nutrient (fertilizer) management do you ..***(check Ø all that apply)***

❍ Keep written records	❍ Use variable rate application (VRT)
❍ Establish crop yield goals	❍ Use soil test analysis to determine fertilizer rate
❍ Take plant tissue samples	❍ Use dealer rep for fertilizer recommendation
❍ Use paid crop consultant	❍ None of these used
❍ Deep soil test	❍ Other

Table 6 provides general adoption rates for nutrient management practices across all responding farms. Statewide, soil test analysis was the number one practice selected, used by roughly half of the producers. Regional differences among adoption rates reflect their cropping diversity, fertilization practices, and respondent characteristics. For example, plant tissue analysis has higher adoption in areas where fertigation is most prevalent and dealer representatives are used more often for fertility advice in all basins except the Eastern Plains. Almost half of the producers in the Eastern Plains rely on paid consultants for nutrient management advice, more than any other region. Statewide, less than half of the respondents said they keep written fertility records.

Table 6. Nutrient management methods used anywhere on farm.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
		---------- % of Respondents Using ----------					
Soil test analysis	64	78	45	54	23	36	49
Keep written records	48	50	33	40	27	40	41
Dealer representative	50	31	34	38	25	41	40
Establish yield goals	48	60	44	39	21	30	39
Deep soil test	21	40	11	21	5	9	16
Paid crop consultants	11	48	15	23	0	1	12
Variable rate application	7	11	7	6	5	9	8
Plant tissue samples	6	10	4	18	2	4	7
Other	2	4	6	4	9	8	6
None used	11	7	14	31	44	20	20

Survey Question
If you soil test, approximately what percent of your ***irrigated*** acreage was soil sampled in:
2001 _____% last 3 years _____%

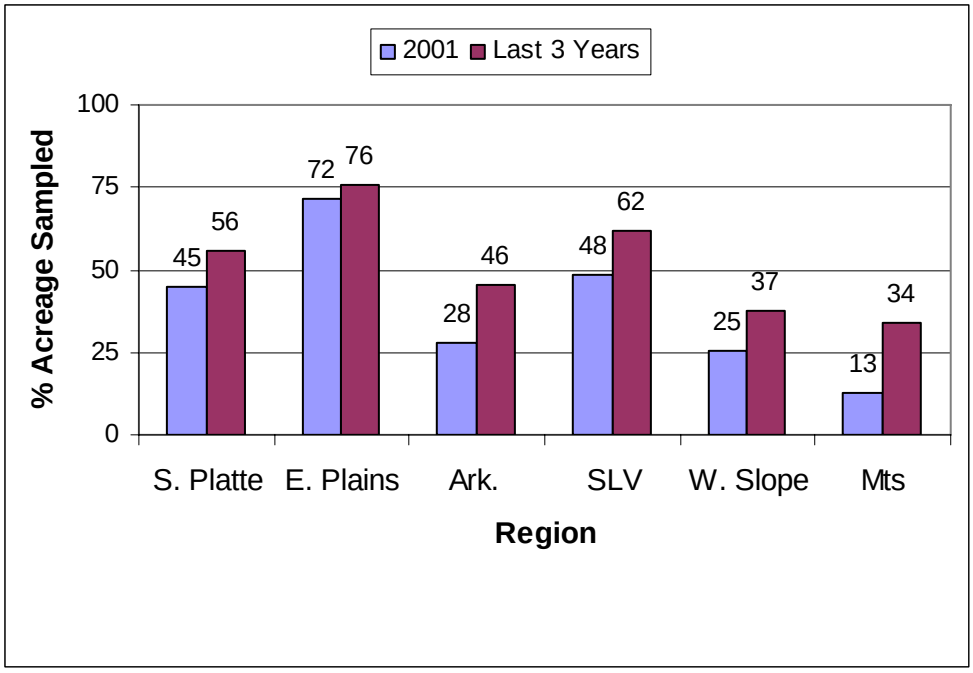


Figure 12. Percent of respondent's irrigated acreage soil sampled.

Respondents from the Eastern Plains and the San Luis Valley reported sampling a higher percentage of their irrigated acreage than other regions (Fig. 12). Cropping patterns explain much of the differences between acreage sampled (Tables A7 and A8). Approximately 13% of the respondents reported that they did not apply any commercial nitrogen fertilizers. Table A9 shows that adoption rates for nutrient management practices where higher among respondents that also reported using commercial nitrogen fertilizer. Among producers using nitrogen fertilizer, BMP adoption is significantly higher than the general survey population or those using manure only. When respondents used N fertilizer, only those from the Eastern Plains were more likely to use a paid crop consultant for advice than a dealer representative.

Survey Question
Do you use livestock manure or effluent for fertilizer? ❍ Yes ❍ No

If yes, how do you determine your application rate? ***(check ☑ all that apply)***

❍ Soil test analysis	❍ Manure nutrient table values	❍ Use paid crop consultant
❍ Manure analysis	❍ Same amount each time	❍ None of these are used
❍ Spreader capacity	❍ Use all manure from pens	❍ Other

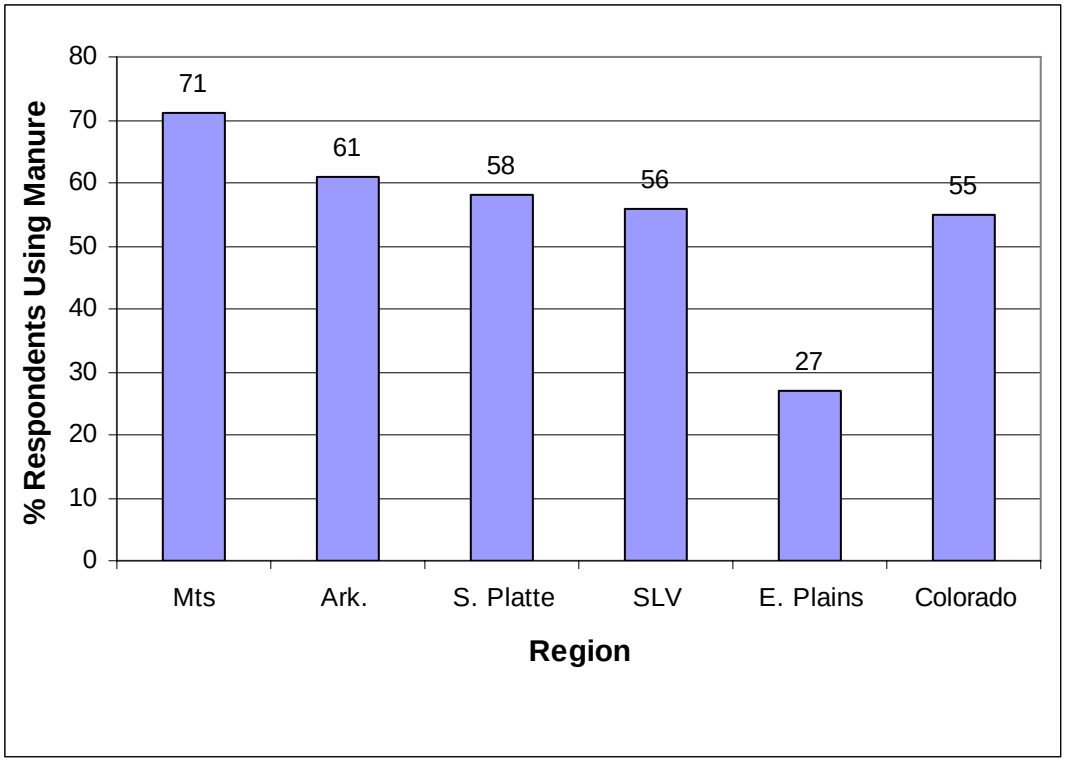


Figure 13. Manure use among respondents by region.

Livestock feeding is extremely important to many areas of Colorado and manure is a valuable byproduct of this industry that should be used as a plant nutrient source. Figure 13 shows that slightly greater than half of respondents used manure, which is consistent with livestock ownership on irrigated farms. Respondents indicated that manure spreader capacity and use of all manure from pens were the most common methods used to determine application rates. The Eastern Plains region had the highest use of soil and manure testing to determine application rates. Surprisingly, manure analysis is used at slightly higher rate than manure nutrient table values, although both are used by less than 10% of the respondents in all areas besides the Eastern Plains, where 34% of the respondents used manure analysis. Consultants are used less frequently for manure application rate determination than with fertilizer or pest decisions.

Table 7. Determination of manure application rates.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
	---------- % of Respondents Using ----------						
Application Rate Determination							
Use All Manure From Pens	43	41	28	62	53	55	49
Spreader Capacity	31	21	28	27	18	23	26
Soil Test Analysis	32	45	23	11	3	8	17
Same Amount Each Time	13	7	10	10	10	7	10
Manure Analysis	17	34	8	5	1	1	8
Manure Nutrient Table Values	13	3	8	5	1	1	6
Use Paid Consultant	8	14	5	6	0	0	4
Other	9	14	10	8	17	14	12
None of These Used	5	7	15	13	21	17	13

Survey Question

Do you reduce your N fertilizer or manure rate for any of the following?

	Approximate reduction?
❍ Previous manure application	lbs N/ton
❍ Previous legume crop	lbs N/acre
❍ Irrigation water nitrate	lbs N/acre

❍ Consultant determines

❍ None of these used

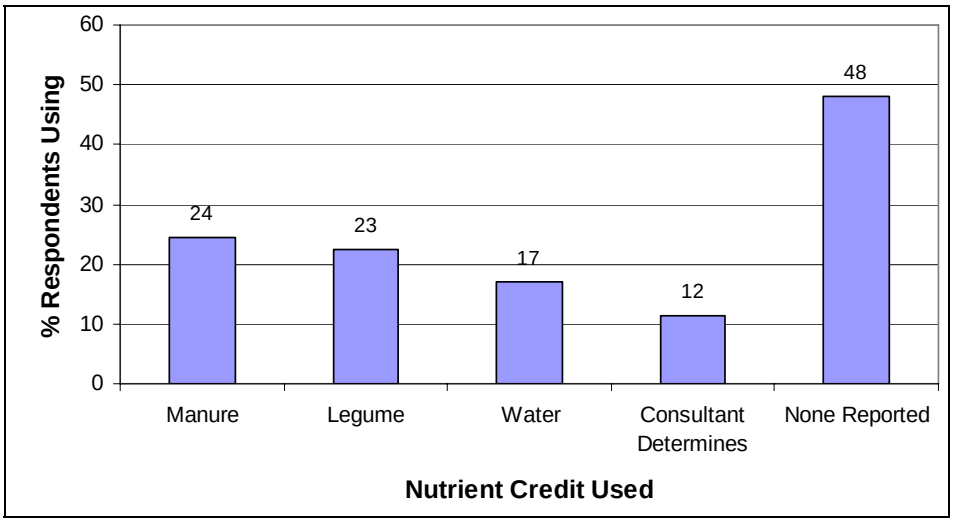


Figure 14. Nutrient credits used by respondents. Manure, legume, and water credits are calculated as the percent of respondents who use manure, grow alfalfa and have only groundwater, respectively.

Sound nutrient management also requires considering nutrients from other sources. Figure 14 reports nutrient credits used by respondents towards fertilizer and manure application rates. Of those reporting they applied manure, only 24% statewide indicated using a manure credit. However, this ranged from 40% in the S. Platte, to 9% in the mountains (Table A10). The amount of nitrogen credited per ton of manure applied reported by the respondents is higher than recommended values (Waskom and Davis, 1999) at 24 pounds per ton. The low number of respondents reporting the use of a manure credit but not owning livestock suggests that most of the respondents did not import manure from other operations.

Legume crops, especially alfalfa can also provide a valuable source of nitrogen for subsequent crops. The percentage of respondents using a legume credit, excluding the Mountains and West Slope was approximately 30%. The amount of nitrogen growers reported crediting to subsequent crops is within published values, but adoption of this practice is low. However, many of the alfalfa growers in this survey did not grow other crops and therefore would not necessarily need to consider a nitrogen credit.

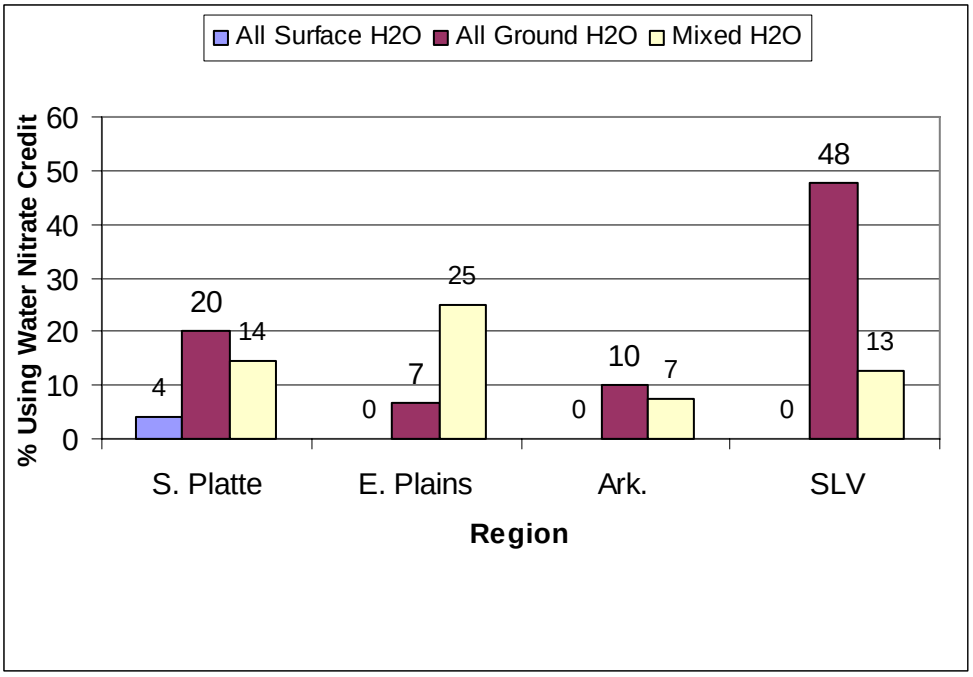


Figure 15. Percent of respondents using an irrigation water nitrate credit.

Many areas of the state have irrigation water that contains enough nitrogen (usually as nitrate) to significantly benefit crop production and a fertilizer or manure rate can be reduced accordingly. High nitrate irrigation water is usually ground water, and therefore a

water nitrogen credit was used more frequently by respondents where ground water supplied all of their irrigation water. The adoption of this practice is highest in the San Luis Valley, with nearly half of the respondents there reporting using a water credit (Fig. 15). The S. Platte was second with 20% of ground water users using water credits. Both of these regions have areas with high nitrate in the ground water. The use of this practice in these areas is encouraging because many resources have been used to build awareness of the nitrate problem by Cooperative Extension, the NRCS and other public entities in these areas about the practice of water nitrate crediting.

Survey Question
Check ***all*** the methods that you use to apply N fertilizer:

❍ Fall preplant	❍ Sidedress	❍ Do not apply commercial N fertilizer
❍ Spring preplant	❍ Fertigate	❍ None of these application methods
❍ Planting (starter)	❍ Topdress	❍ Other

Table 8. Methods used to apply nitrogen fertilizer.

	Region						
Methods To Apply Nitrogen	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
		% of Respondents Using					
Spring preplant	46	55	52	47	12	34	40
Topdress	33	45	41	32	36	48	39
Planting (starter)	24	63	26	21	2	13	22
Sidedress	30	42	44	10	1	12	21
Fall Preplant	18	28	27	8	6	7	14
Fertigate	13	41	13	25	1	3	13
Do Not Apply Comm. Fert.	11	5	8	21	19	11	13
Other	2	5	1	7	9	5	5
None of These Methods	8	4	6	18	25	11	12

The timing and method of fertilizer application are also important management practices that increase fertilizer efficiency and protect water resources. Thus, producers were asked to indicate nitrogen fertilizer application methods. Table 8 shows that spring pre-plant applications were the most common method followed by topdress and at planting. In-season applications such as sidedress, fertigate, and planting were highest in Eastern Plains and Arkansas Valley. As expected, producers in regions where center pivots are common more frequently utilize fertigation (application during irrigation). Appling nitrogen fertilizer in the fall is generally not considered a BMP for spring crops due to increase potential for leaching, runoff and other loses. However, this practice was used by almost 30% of respondents in the

Eastern Plains and Arkansas Valley, although some of this application was likely to winter wheat. Table A11 provides the response to this question queried by the crop grown on the representative field. Respondents were least likely to apply N on hay and pasture. In-season applications were highest for respondents growing corn, other crops and potatoes on the representative field. A significant proportion (13%) of the respondents indicated that they do not apply commercial nitrogen fertilizer. These respondents were mostly from the San Luis Valley and the Mountains and were usually alfalfa growers. Mountain meadows with grass clover mix will see clover decline when nitrogen is applied and therefore it is probably a best practice not to apply.

Pest and Pesticide Management

Survey Question
Check ***all*** pest management practices that you routinely use:
(Include all weed, insect, and disease controls)

❍ Residue management	❍ Biological controls
❍ Clean/pure seed	❍ Adjust planting/harvest dates
❍ Fungicides	❍ Biotech crops(GM)
❍ Resistant varieties	❍ Mulching
❍ Sanitation practices	❍ Herbicides
❍ Pest forecasting	❍ Hand hoeing/rogueing
❍ Crop rotation	❍ Cultivation
❍ Field scouting	❍ None of these used
❍ Insecticides	❍ Other _____

Controlling crop pests (weeds, insects, diseases, etc.) represents a significant percentage of input costs for many Colorado crops. Pesticides (herbicides, fungicides, insecticides) are a frequently used tool for pest control, but a wide variety of other practices (Table 9) can be used, some in combination with pesticides, to manage pests. Many of these practices are included in the concept of Integrated Pest Management (IPM) that is promoted over a chemical only approach to pest control. Among pesticides, herbicides (weed control chemicals) were the most frequently used chemical and used by over 88% of the growers who reported using any pesticide (Table 9). Fungicides were used far less frequently statewide and most often in San Luis Valley, an area with a large acreage of potatoes (Fig 16). Likewise, growers in the San Luis Valley also reported using sanitation practices at a higher rate.

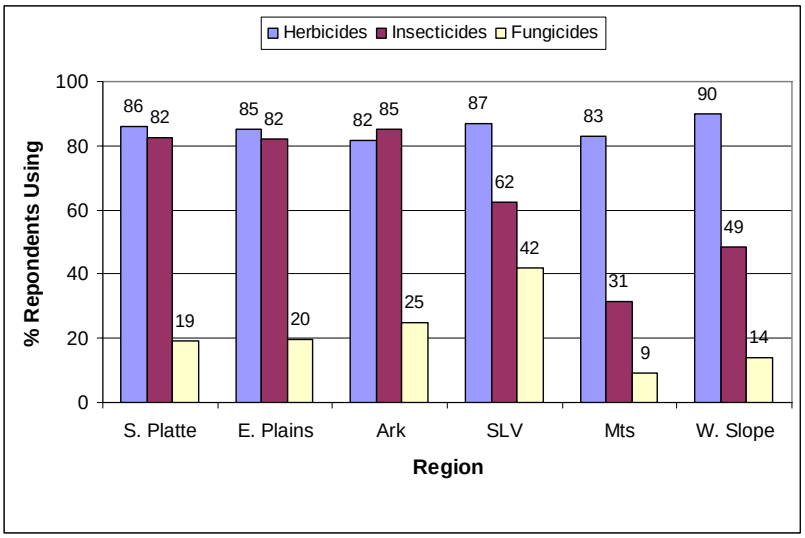


Figure 16. Type of pesticides used by respondents.

Table 9. Adoption of pest control and pesticide best management practices (BMPs) by respondents using pesticides.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
Pest Management Practices	---Use Among Respondents Using Any Pesticide (% using)---						
Herbicides	86	85	82	87	83	90	88
Insecticides	82	82	85	62	31	49	68
Clean / Pure Seed	63	74	69	69	23	56	68
Cultivation	70	75	75	55	13	43	68
Field Scouting	60	74	58	65	27	42	53
Crop Rotation	58	71	74	68	5	38	59
Resistant Varieties	40	57	62	39	11	31	38
Residue Management	34	51	32	35	5	16	32
Fungicides	19	20	25	42	9	14	15
Sanitation Practices	17	15	11	38	3	13	26
Adjust Planting / Harvest	16	25	16	18	3	14	21
Mulching	19	10	12	12	2	6	18
Biotech Crops (GM)	8	36	32	0	0	4	12
Pest Forecasting	14	14	9	22	0	6	12
Hand Hoeing Rogueing	14	14	9	22	0	6	12
Biological Controls	7	13	10	11	5	12	12
Other	2	0	2	3	3	3	3
None of These Used	0	0	0	0	0	0	0
Pesticide Management							
Keep Pesticide Records	55	50	42	44	17	27	41
Economic Thresholds	46	54	50	44	8	21	37
Dealer Representative	55	29	39	47	6	25	37
Banding / Spot App.	36	33	17	15	38	31	30
Keep Pest Records	34	34	25	37	16	18	28
Paid Crop Consultants	18	51	20	35	5	7	20
Other	3	0	9	4	5	8	21
None of These Used	9	3	8	16	34	28	16

Field scouting, a baseline IPM practice, was used by 53% of the respondents using pesticides, but adoption varied significantly by region and by primary crop grown (Table 9). As with fertilizer, paid crop consultants are used less frequently than dealer representatives for pest scouting and advice, except in the Eastern Plains. A higher percentage of respondents with potatoes or 'other crops' as primary crop reported using paid consultants for pest scouting and management advice (Fig. 17).

Survey Question
With respect to your pest management program do you… (check ***all*** that apply)

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

All pest management practices in both questions were used at a much higher percentage by growers using pesticides than those who did not. For non-pesticide users, 'None used' was the most frequent response (Table A13). The only management practice with a higher adoption rate by non-pesticide users responding to the survey was biological controls in the S. Platte, but not in other regions. This result is somewhat surprising given that many of the practices listed are alternative management practices that can be used to control pests without pesticides. Adoption of IPM practices was low in the Mountains, but this rate reflects lack of overall pest pressure and low chemical use compared to other regions.

Genetically modified crops or 'biotech crops' (i.e. Bt corn, RoundUp® Ready) have become new pest management tools, primarily for corn growers in Colorado. Although they are used by a much higher percentage of growers in some other states, only a small minority of Colorado growers reported using Biotech crops for pest control. Respondents in the Eastern Plains and Arkansas Valley used biotech crops more frequently than other regions.

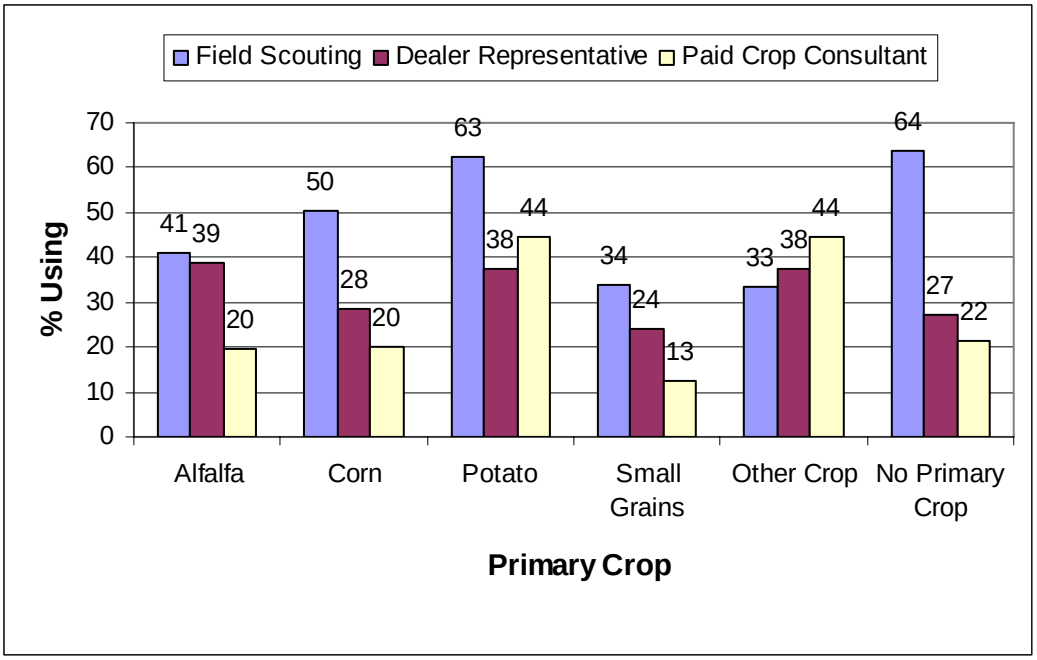


Figure 17. Percent of respondents using pest scouting and/or outside pest advice.

Pest and pesticide record keeping is another IPM practice that helps growers track pest outbreaks, reduce pesticide resistance by rotating chemical families, prevent crop damage from carry-over, and reduce liability from misapplied pesticides. Pesticide recordkeeping is also required by law for those using restricted use pesticides. However, only 41% of pesticide users statewide reported keeping pesticide records and fewer still (28%) kept pest records. As expected, respondents using pesticides were more likely to keep pest records than those that do not use pesticides.

Questions about the Representative Field

Colorado farms are quite diverse and it is difficult to obtain information on specific management decisions across the entire farm. Field specific characteristics influence management decisions and many Colorado farms have fields that vary considerably in water source, irrigation system, soil type and other characteristics. Therefore, each respondent was asked to identify a specific field on their farm that they believed was representative of their farm. The questions in this section of the survey were specific to that identified field. To provide a context for interpreting the management on the representative field, we asked respondents to describe several characteristics of what they believe is a field representative of their farm. These characteristics are provided in Tables A16 through A23.

Survey Question
What is the predominant soil texture ***of the representative field***?
(i.e. sandy loam, clay, etc) _____

Survey Question
Check Ø the irrigation water source(s) used ***on the representative field***.

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

If well is used: Well capacity? _____ gpm
Depth to water? _____ feet
Pressure at well? _____ psi

Survey Question
Check Ø the irrigation application system used ***on the representative field***.

- ❍ gated pipe
- ❍ siphon tubes
- ❍ ditch & check
- ❍ lay flat/collapsible pipe
- ❍ other gravity _____
- ❍ center pivot
- ❍ sideroll
- ❍ other sprinkler
- ❍ drip tube (buried or surface)
- ❍ other system _____

Survey Question
What crops have been grown over the last three years ***on the representative field?***

	1999	*2000*	*2001*
Crop			
Yield/acre estimate			

Crops grown on the representative field were similar to those grown on the whole farm. The crop yields reported by respondents are similar those reported by the Colorado Agricultural Statistics Service (CDA, 1990-2001), suggesting that we obtained a representative sample of grower ability to produce high yields. Surprisingly, there was not much variation among years for statewide averages, but regional yield differences are apparent. Similar to results obtained from the whole farm, the irrigation system used by respondents on the representative field varied by region. The system age largely reflects (Table A23) technology of the system used and varies by region.

Survey Question
How many years out of 10 (0 to 10) are the primary and supplemental water sources t*ogether* able to provide a full water supply for the crops grown ***on the representative field***? _____years.

In irrigated cropping systems, adequate water supply in both timing and amount is critical to maximum production. Statewide, 46% of respondents indicated they had a full supply of water for 10 out of 10 years, and 20% indicated they had a full supply less than five years out of 10 (Figure 18). This compares to 65 and 6% respectively when the same question was asked in 1997, perhaps reflecting wetter conditions during that time period. The Arkansas Valley had the lowest water reliability in terms of full water supply. The number of years where producers have a full water supply influences management decisions involving risk and expected return from inputs.

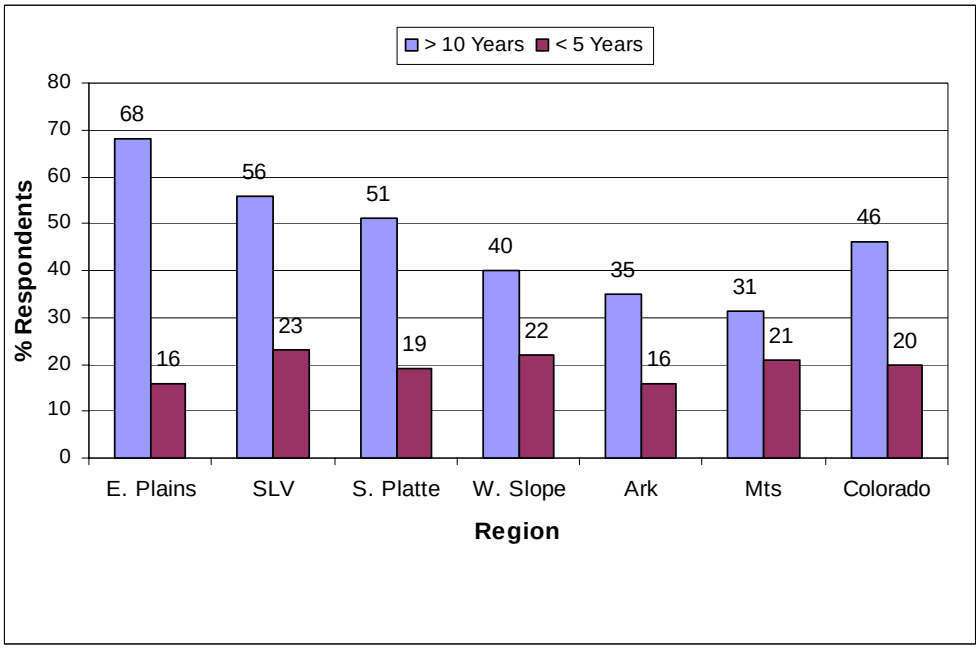


Figure 18. Reliability of the water source on the representative field as measured by having a full supply of water.

For ground water users, one aspect of water supply reliability is dictated by well capacity. A well water source generally allows greater flexibility and reliability of water timing, but often capacity is limiting (Table A20). Wells that supply less than five gallons per minute per acre are unlikely to keep up with peak crop water demand (ET). Producers in these situations may have difficulty adopting irrigation scheduling as they need to irrigate constantly in mid-season, especially without help from precipitation. However, low water

supply should influence adoption of higher efficiency systems. Producers in the Eastern Plains had a higher percentage of low capacity wells than other regions as this area is experiencing declines of its primary water source, the High Plains (Ogallala) aquifer.

Irrigation Management on the Representative Field

Two key elements of irrigation management are timing (scheduling) and amount of water applied at each irrigation. We asked respondents to tell us about their irrigation scheduling in the whole farm section, but asked about irrigation amount on the representative field, because it allowed the respondents to provide specific amounts. Statewide, almost half of the respondents indicated that they applied the same amount of water at each irrigation (Table 10). However, this decision about water application amount varied by region from 24% in the Eastern Plains to greater than 60% on the Western Slope. Eleven percent of respondents indicated that they irrigate to replenish soil water or crop water use. However, on average, growers replenished soil to less than field capacity (85% field capacity). Not fully replenishing the soil profile during each irrigation event could be due to necessity (low system capacity) or to leave soil storage for potential rainfall. As with other practices, growers in the Eastern Plains were more likely to use crop consultants for determining irrigation amounts than other regions.

Survey Question
How did you determine the amount of water to apply ***at each*** irrigation ***on the representative field***?

- ❍ Always applied the same amount each time
- ❍ Crop consultant determined the quantity applied
- ❍ Replenished crop water use since last irrigation. What portion? _____% ET
- ❍ Replenish soil profile to a given level What level? _____% available water capacity
- ❍ Other (specify)_____

The primary water source (ground water, ditch company or individual surface diversion) for the representative field had a notable influence on this management decision (Figure 19). Ground water users more frequently applied water to replenish the soil profile or crop water use and were more like to use crop consultants. Those respondents getting water from ditch companies or diversions were more likely to apply a same amount or chose

'other'. The 'other' reason most frequently listed (39%) could be categorized as water supply or amount available in the ditch, stream, or river.

Table 10. Reasons for amount applied at each irrigation.

Amount Determination	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
				% Using			
Same Each Time	54	24	42	34	49	63	48
Replenish Crop Water Use	14	7	14	15	6	7	11
% ET Replenished	82	78	73	84	82	80	81
Replenish Soil Profile	10	19	9	21	4	7	11
% Soil Water Replenished	81	88	89	76	92	91	85
Crop Consultant Determines	5	38	9	15	1	1	8
Other	16	12	27	16	40	22	21
Number of Applications	6	9	5	11	6	6	7

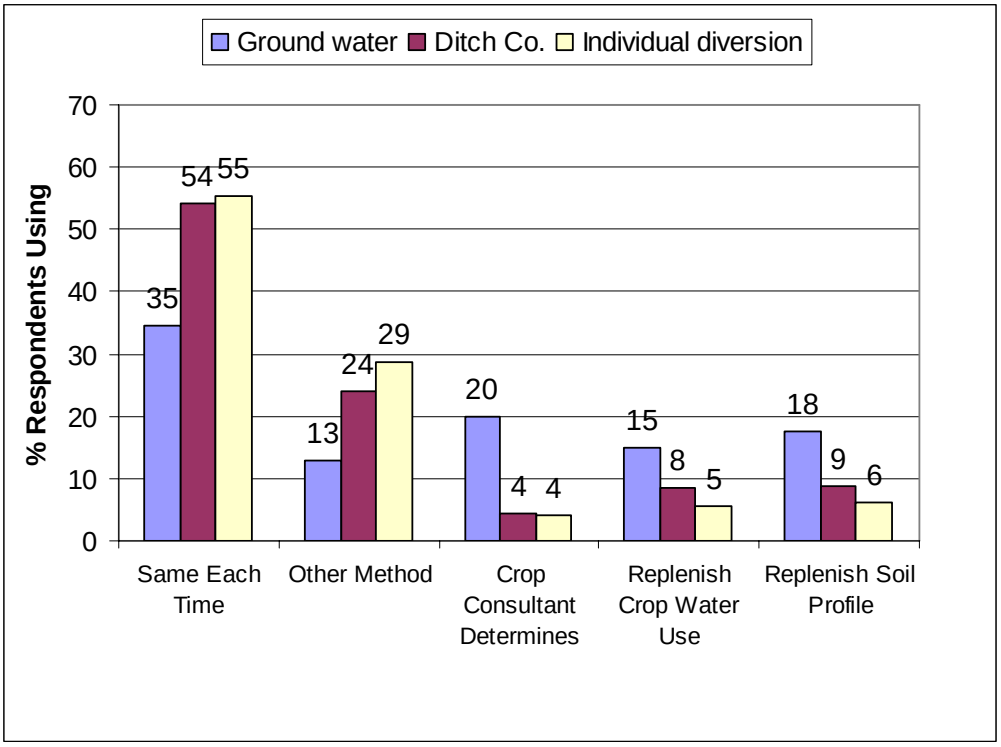


Figure 19. Reasons given for determing irrigation application amount by primary water source on representative field.

Survey Question
How many irrigation applications were made to the ***representative field*** throughout 2001? ____applications

Survey Question
How much water was applied to the ***representative field*** throughout the 2001 growing season?

_____inches/acre _____ gals/acre _____ acre feet/acre ❍ Don't know

Survey Question
Did you keep records of water applied throughout the season? ❍ YES ❍ NO

The next 3 questions on irrigation amount were included to understand the frequency and amount of water that irrigators apply in Colorado. Respondents from the San Luis Valley applied water more frequently (11 applications) than other regions and the Arkansas Valley the fewest (5) in 2001 (Table 10). Areas with higher percentage of center pivots have more applications as those systems typically apply less water per irrigation. The average number of applications was similar among regions where surface irrigation dominates. Growers in the Eastern Plains and San Luis Valley reported knowing how much water they applied at higher rates than other regions (Table 11). For growers reporting an amount of water applied, there was considerable disagreement among values reported in different units. The estimates provided by respondents of the total amount of water applied throughout the 2001 growing season were variable, often unreasonable and were therefore unable to present a meaningful result for this question. Likewise, Table 11 shows that only 41% of respondents statewide reported that they knew their total application amount. This result agrees with the low numbers of respondents keeping irrigation records (16 to 29%), but is not consistent with the earlier result that over half of the respondents had an irrigation water measurement device on their farm.

Survey Question
Do you know how much water the crop used (ET) in 2001?

❍ No
❍ Yes _____ inches

Understanding and tracking crop water use (ET) is useful for improved irrigation scheduling, crop selection, and water allocation planning. However, a small minority of the responding farmers reported knowing the water use (ET) by the crop grown in 2001 on the representative field (Table 11). More growers in the San Luis Valley reported knowing their crop water use, which is consistent with a higher level of ET-based irrigation scheduling in that area. Average crop water use (ET) values reported do not show the differences one would expect between regions and some crops (Table A25). Alfalfa, corn, and bean water use were underestimated by the respondents, while small grain water use reported is close to published crop water use values (NRCS, 1998).

Table 11. Irrigation record keeping on representative field.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
	---------- % of Respondents ----------						
Keep Rec. of Water Applied	21	25	25	29	15	21	23
Know Crop Water Used (ET)	7	9	7	11	4	7	7
Know Amt. of Water Applied	48	63	39	51	25	32	41

Factors Affecting Management Changes

Survey Question
Have you changed any management practices on ***the representative field*** in the last five years? ❍ No ❍ Yes, list: _____

Change in management reflects the ability or desire of growers to adopt new technology or to adapt to changing market conditions. However, advances available to growers vary by irrigation system, region, crop, and other factors. These differences are reflected in Table A26. Growers in the Eastern Plains reported more change than other regions (Fig. 20). The most frequently reported change was some aspect of the irrigation system, followed by a change in water management (Fig. 21). These water/irrigation management changes combined for over half of the changes respondents reported, which suggests that growers are more likely to make changes to manage their most important input, water. Readers are referred to Table A26 for a more comprehensive breakdown of management changes.

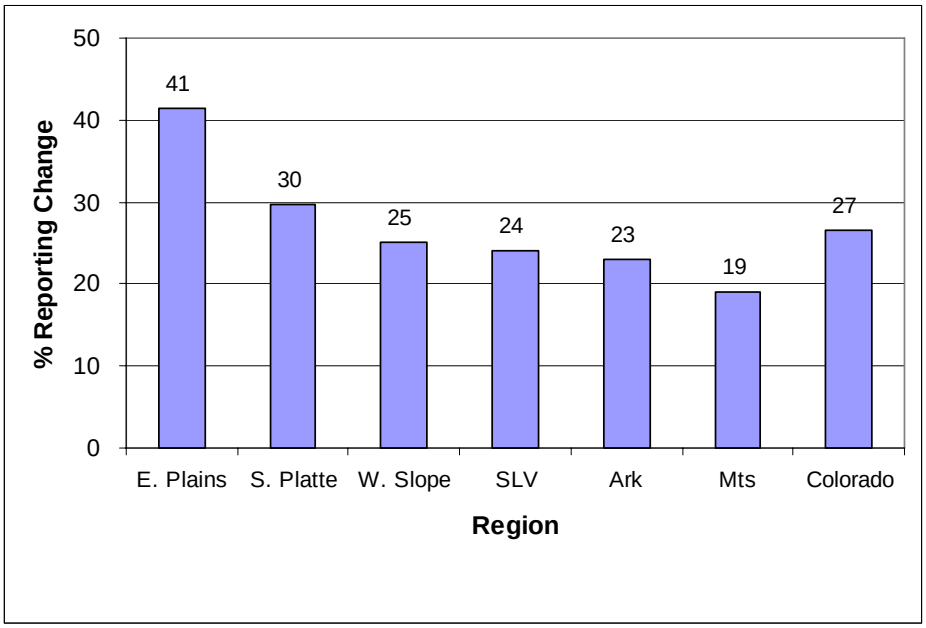


Figure 20. Percent of respondents reporting any management change within last five years

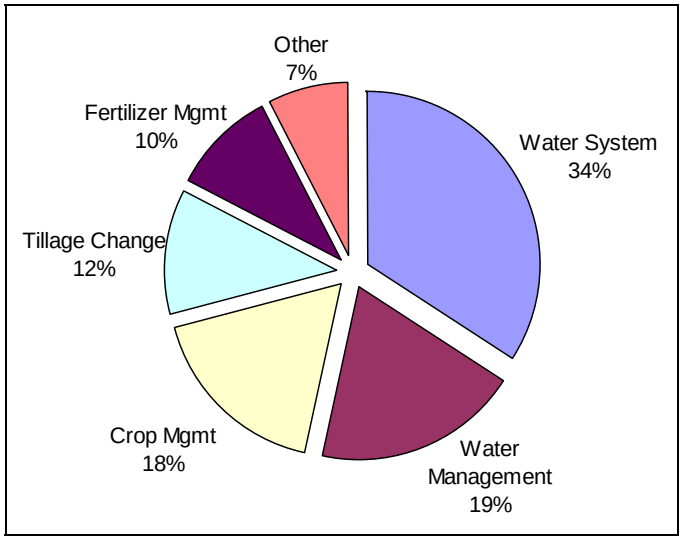


Figure 21. Type of management practice changed within last five years.

Survey Question

Check ☑ all the sources that you regularly use for irrigation and/or crop production information:

Irrigation	Crop production		Irrigation	Crop production	
❍	❍	Chemical dealer/applicator	❍	❍	Paid crop consultant
❍	❍	Neighbors	❍	❍	NRCS (formerly SCS)
❍	❍	Soil testing lab	❍	❍	Water district/Ditch Company
❍	❍	CSU/Cooperative Extension	❍	❍	Popular farm press
❍	❍	Irrigation equipment dealer	❍	❍	Seed dealer
❍	❍	Other internet sources	❍	❍	Other_____

Where growers receive information regarding decisions on crop production and irrigation management makes a difference in terms of the perceived quality of the information received and trust in the source. The traditional sources of information (Cooperative Extension, NRCS) are perhaps less directly used as farms become more specialized and require more specific information (Fig. 22). Often, these agencies are focusing their limited resources training crop advisers and others that deal directly with the farmer. Regional differences in where Colorado farmers get their information again are striking. For example, "neighbors" are the first source of information in the Mountains, but rank fourth in crop management statewide. Likewise, paid consultants for crop production advice are only used by 13% of respondents statewide, but by 44% in the Eastern Plains (Table A27).

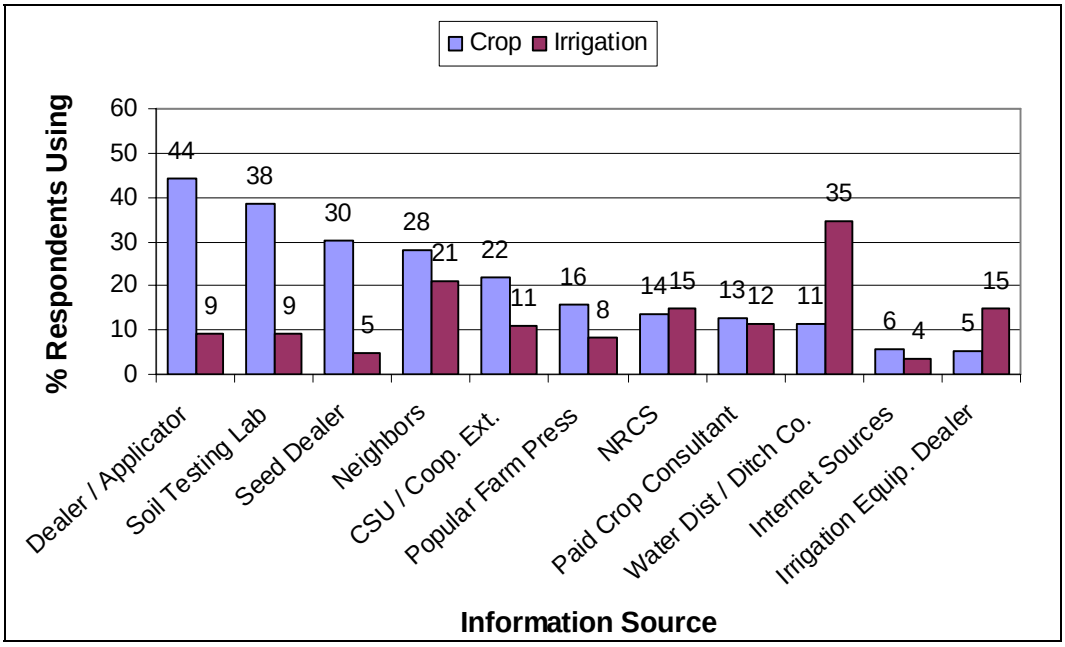


Figure 22. Sources of crop or irrigation information used by respondents.

Survey Question
What are the ***main*** factors that limit crop production or irrigation decisions on your farm?
(check ✓ all that apply)

❍ Management time
❍ Labor cost
❍ Equipment cost
❍ Lender
❍ Lack of information
❍ Landlord
❍ Water availability
❍ Other _____

Making decisions on crop production or irrigation management is often complicated with many factors influencing the final outcome. Understanding the factors that limit decisions may be educational to policy makers, researchers, extension professionals and others interested in convincing growers to consider a particular practice or new technology. Water availability, followed by equipment cost and time, were the most frequently chosen factors that limit decisions (Fig. 23). Not surprisingly, water availability was chosen more frequently in regions that reported less water reliability, such as the Arkansas Valley. Farmers have a wide range of information sources to support their decision. Perhaps this explains why lack of information was not a limiting factor for 94% of respondents (Table A28).

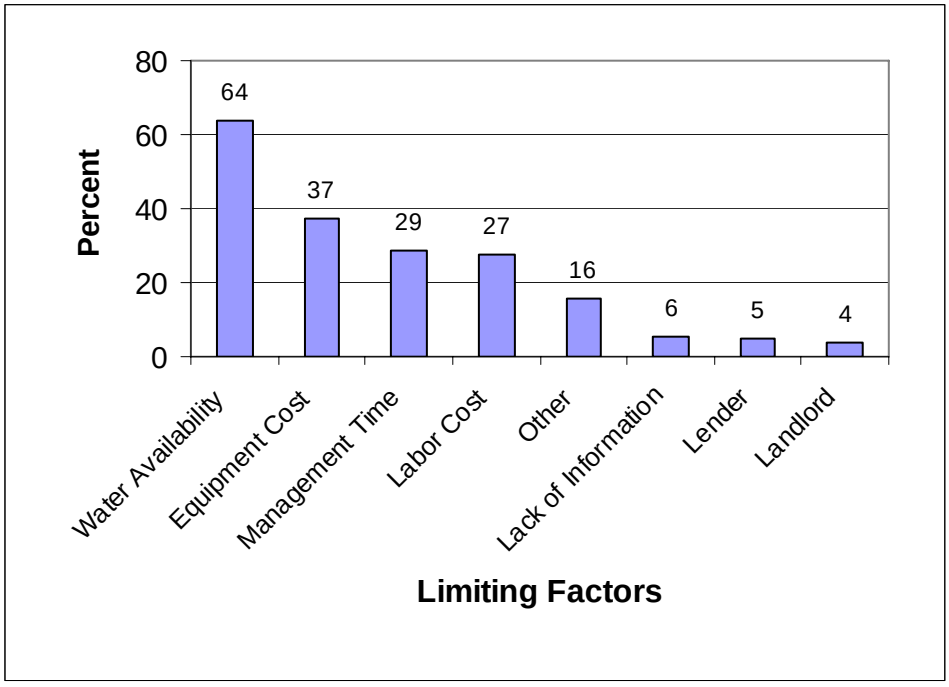


Figure 23. Factors limiting respondents' crop production or irrigation decisions.

Survey Question
What information from CSU would be most useful for making water management decisions?
Please describe: _____

One purpose for conducting this survey was to learn what information would best support irrigating crop producers in making profitable and environmentally sound decisions. As with management changes, we decided to leave this question open ended. The responses

to this question were quite varied, as would be expected with an open ended question. We categorized the responses into 12 different categories. The top two categories were responses that involve some aspect of water management (Table 12). Respondents listed some aspect of crop water use or evapotranspiration (ET) second as information that would be useful for making water management decisions. The third most frequently mentioned category, interestingly was "None" or "I don't know" suggesting that the respondent did not require more information to manage water for best economic use in their operation or did not know about what water information CSU provides or how it could be applied to their operation.

Table 12. Information requested from CSU to make water management decisions.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
	---------- Requested Information (%) ----------						
Irrigation Mgmt/Systems	22	22	31	19	27	28	25
Crop Water Use/ET	18	22	4	34	5	8	15
None/Don't Know	16	5	20	9	14	17	14
Other	9	8	9	17	13	10	11
General Crop Mgmt/Tillage	7	19	4	3	2	14	8
Weather/Water Forecasts	10	<1	13	3	10	8	8
Current Info Okay	1	8	7	3	5	6	4
Fertility/Water Testing Info.	6	<1	<1	3	8	2	4
Growth/Urban Issues	5	3	7	3	5	<1	3
Limited Irrigation	4	14	<1	<1	<1	3	3
Water Policy/Law	1	<1	2	5	8	1	3
Irrigation Infrastructure	2	<1	2	<1	5	4	2

Water Concerns

Survey Question
Are there any concerns about the quality of the water **on your farm**?

❍ No ❍ Yes: ❍ for crop production
❍ for livestock
❍ for household use
❍ other _____

The quality of the water growers have to work with can limit production and management decisions as much as quantity in many cases. Colorado is fortunate to be at the top of the watershed in all of its major basins and is the first to utilize water in these systems. However, natural and human influences can degrade water quality limiting uses to others downstream. Therefore, we were interested in whether Colorado water users had concerns

about their water quality for crop production, household, or livestock use and whether they had a recent analysis of their irrigation water. Overall, only 26% of respondents reported a concern about the quality of their water on their farm for these uses. Of those having a concern, statewide respondents were most concerned about the quality of their water for crop production, but more respondents had concerns for household uses in some regions (Table 13). The Arkansas Valley region had the highest percentage of respondents (52%) reporting a concern about the quality of their water for crop production (Fig. 24). However, only 25% reported having their irrigation water analyzed. Surprisingly, concern of water quality for household use was highest in the Eastern Plains, an area that typically has better quality water than other regions (Anonymous, 1997). However, people living in this region rely more on water from private sources (wells) than other regions.

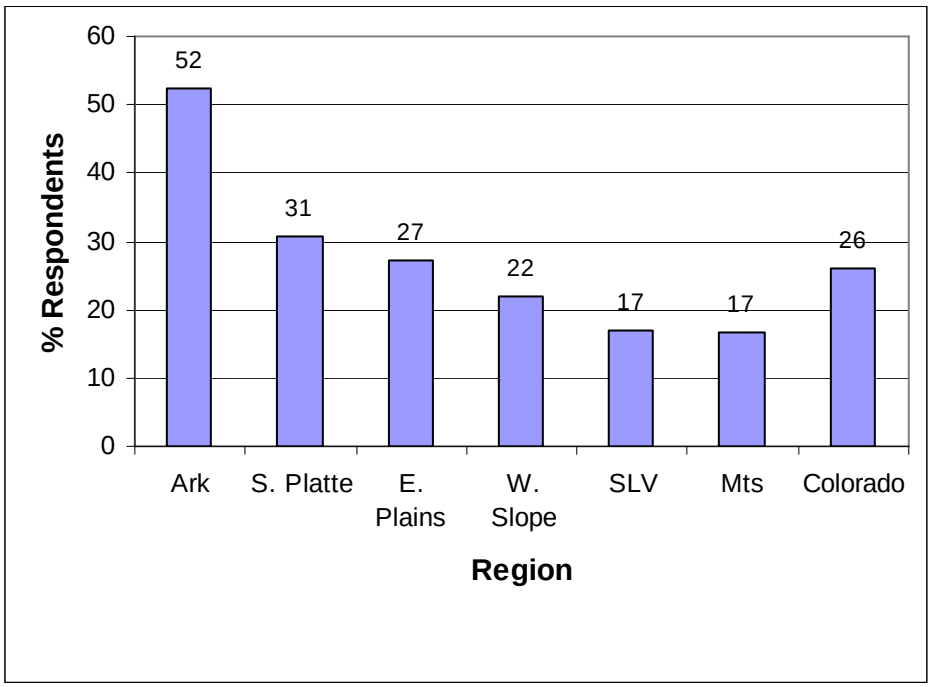


Figure 24. Percent of respondents' having any water quality concerns.

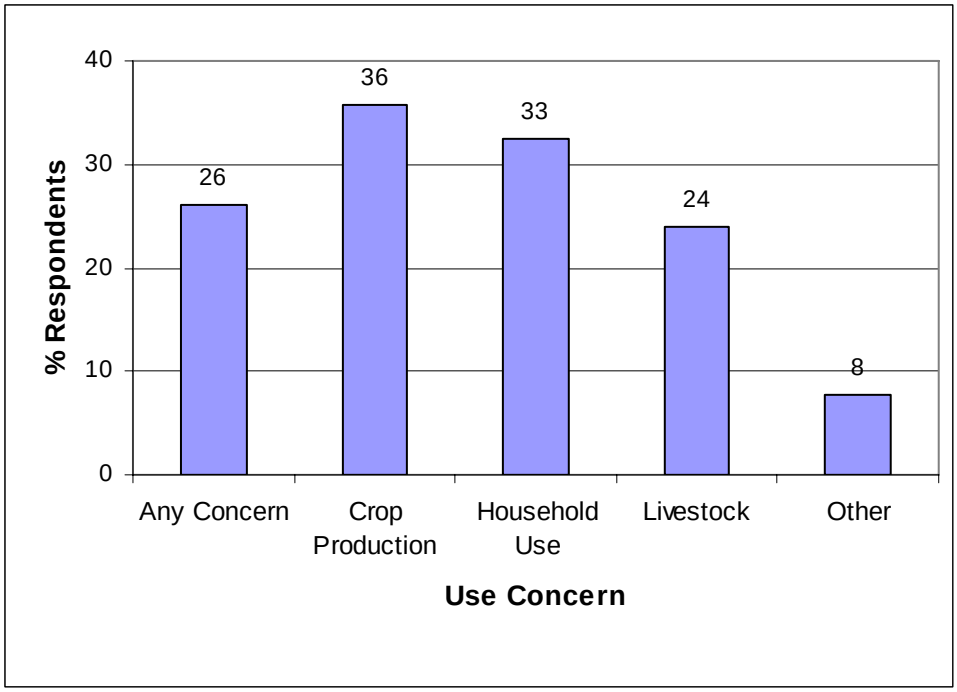


Figure 25. Respondents' water quality concerns by water use (state average).

Survey Question
Have you ever had your irrigation water analyzed?

❍ Yes ☞ When: _____ *year*
❍ No

Table 13. Irrigation water analysis and concerns about quality of water on farm.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
Irrigation Water Analyzed (%)	21	38	25	34	9	8	19
Average Years Ago	6	7	8	6	5	10	7
	----------%----------						
Water Quality Concerns	31	27	52	17	17	22	26
Crop Production	37	36	48	38	14	32	36
Household Use	30	46	20	41	46	33	33
Livestock	25	18	26	22	20	28	24
Other	8	**	6	**	20	7	8

** Five respondents or fewer in category

Survey Question

Check ❍ any concerns that you have about water on your farm and/or in your county:

on your farm	in your county		on your farm	in your county	
❍	❍	erosion/sediment	❍	❍	water availability
❍	❍	metals	❍	❍	bacteria/pathogens
❍	❍	regulations	❍	❍	fertilizer
❍	❍	urban runoff	❍	❍	salinity (salts)
❍	❍	manure runoff	❍	❍	drought
❍	❍	selenium	❍	❍	urban competition
❍	❍	weed seeds	❍	❍	none
❍	❍	nitrate	❍	❍	other _____

To learn what water quality or quantity concerns exist among Colorado irrigating producers, we provided respondents with a list of potential water concerns they may have for water either on their own farm or in their county. We purposefully mixed quantity and quality concerns in random order as to not bias selection. Not surprisingly, the top water concern for our irrigating audience was water availability for both on the farm and in the county (Table 14). Except for weed seeds, quantity issues topped the list. The most frequently water quality issue selected was salinity, followed by erosion. Salinity was chosen by half of the respondents from the Arkansas Valley and nearly a third from the S. Platte. Salinity in the lower Arkansas River Valley is a serious problem (Garcia and Foged, 2002) and this result suggests that growers in this area are well aware of the impacts to crop production caused by saline irrigation water. There did not appear to be a difference in the hierarchy of "on-farm" concerns versus in county concerns suggesting on-farm water quality problems are similar to those in the area. Statewide, only 5% of respondents reported having no concerns about water on their farm or in their county, underscoring the reliance between crop production and reliable, clean water.

Table 14. Concerns about water on farm and/or in county.

	Region						
	S. Platte	E. Plains	Ark	SLV	Mts	W. Slope	Colorado
Water Concerns on the Farm	---------- % of Respondents with Concern ----------						
Water Availability	60	54	71	58	61	50	57
Drought	48	50	65	52	54	47	51
Weed Seeds	47	21	46	32	44	50	43
Urban Competition	44	15	31	30	31	26	31
Salinity (salts)	31	11	58	12	10	28	25
Regulations	24	32	20	34	24	21	25
Erosion / Sediment	25	10	16	11	22	27	21
Nitrate	19	21	18	11	8	7	13
Fertilizer	14	10	9	6	5	9	9
Bacteria / Pathogens	8	6	8	5	8	5	7
Selenium	3	4	16	2	3	10	6
Urban Runoff	11	4	10	1	5	2	5
Metals	7	6	5	5	5	4	5
Manure Runoff	7	4	1	5	7	3	5
None	4	9	2	5	5	4	5
Other	1	3	5	1	2	3	3
Water Concerns in the County							
Water Availability	49	53	58	44	50	37	46
Drought	42	48	60	51	50	45	47
Weed Seeds	47	22	46	36	48	50	44
Urban Competition	56	23	37	35	39	37	40
Salinity (salts)	21	7	54	10	11	28	22
Regulations	34	33	26	37	31	24	30
Erosion / Sediment	18	9	13	11	20	20	17
Nitrate	26	30	17	16	8	6	16
Fertilizer	11	19	5	8	3	6	9
Bacteria / Pathogens	8	10	9	5	5	5	7
Selenium	5	5	15	2	3	16	8
Urban Runoff	22	3	15	3	10	6	11
Metals	6	6	8	8	6	4	6
Manure Runoff	11	15	1	5	7	3	7
None	3	7	2	7	3	4	4
Other	1	3	6	2	5	5	3

SUMMARY

Overall, the survey results suggest that producers are accepting many of the irrigation, pesticide and nutrient management BMPs that help protect water quality and farm profitability. Adoption of nutrient and pesticide management BMPs is generally higher than irrigation management BMPs such as irrigation scheduling. Irrigation system improvements are common in most regions, but adoption of management BMPs used to determine application timing and amount are not. Practices that have an obvious economic benefit (soil sampling, pest scouting) seem to be used more often than those where the return from increased managerial input is less obvious. For example, record keeping for pest, nutrient, and irrigation water is not widely practiced and thus growers likely do not believe they will significantly benefit from their time invested in keeping these records. However, there were considerable differences in adoption rates between region of the state, crop mix, water source, and farm irrigation system. Water source appeared to have the largest impact on irrigation management. The majority of growers did not report making a management change on their representative field in the last five years, illustrating the difficulty of making management changes in irrigated agriculture.

We also learned that the decisions growers make are limited most often by water availability, equipment cost and time, but not by lack of information. However, when asked, respondents most frequently said information about irrigation systems and management and crop water use would be most useful for making water management decisions. The survey results also provided insight into sources of information irrigating crop producers use for crop production and irrigation decisions with chemical dealer and water district being the top choices, respectively. Finally, the survey results indicate that growers in Colorado do have concerns about both water quantity and quality for both human, crop and livestock needs.

REFERENCES

Anonymous. 1997. Annual Report for 1998, Status of Implementation of Senate Bill 90-126, the Agricultural Chemicals and Groundwater Protection Act. Colorado Department of Agriculture, Colorado State University, Cooperative Extension, Colorado Department of Public Health and Environment.

Bauder, T.A., Cipra, J., Waskom, R., and M. Gossenauer. 2004
Center pivot irrigation in Colorado as mapped by landsat imagery. Colo. Ag. Expt. Tech. Bulletin TB04-04

Bauder, T.A., Waskom, R.M., Frasier, W.M. and D.L. Hoag. 1997. Adoption of best management practices in Colorado. Agronomy Abstracts.

Colorado Department of Agriculture. Colorado Agricultural Statistics. 1999, 2000, 2001. Colo. Ag. Statistics Service. Lakewood, Colorado.

Dillman, D. 1978. Mail and telephone surveys: the total design method. Wiley Interscience. John Wiley and sons, New York.

Frasier, W.M., Waskom, R.M., Hoag D.L. and T.A. Bauder. 1999. Irrigation management in Colorado: survey data and findings. Colo. Ag. Expt. Station Report, TR-99-5.

Garcia, L.A. and Foged, N., "Field Scale Monitoring and Modeling of Salinity and Waterlogging in the Lower Arkansas River Basin of Colorado", published in the proceedings of the Central Plains Irrigation Short Course and Exposition, February 5-6, 2002, Lamar, CO.

NRCS, Anonymous. 1988. Colorado Irrigation Guide. USDA-SCS Soil Conservation Service.

U.S. Dept. of Agriculture- USDA, National Agricultural Statistics Service-NASS. 1999. 1997 Census of Agriculture, Farm and Ranch Irrigation Survey (1998). Vol. 3, Special Studies, Part 1.

Waskom, R. M. and J. G. Davis. 1999. Best Management Practices for Manure Utilization. Colorado State University Cooperative Extension. Bulletin 568A

Appendix A
Supporting Data Tables

Table A1. Personal characteristics of respondents.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Average Years of Irrigation Experience	30	25	28	31	32	30	30
Education Level (%)							
High School	29	28	34	22	29	32	30
Some College	23	23	30	33	19	23	24
Vocational/Tech Degree	10	10	8	5	8	8	8
Bachelors Degree	24	31	21	29	25	24	25
Graduate Degree	14	9	8	10	18	13	13
Gross Farm Sales (%)							
Under $50,000	38	15	42	35	59	57	44
$50,000 - $99,000	23	21	16	19	24	21	21
$100,000 - $249,000	21	22	23	22	13	15	19
$250,000 - $499,000	11	24	12	12	3	5	10
$500,000 - $1,000,000	4	11	2	6	1	1	3
Over $1,000,000	3	7	4	6		1	3
Off-Farm Job (%)	43	37	44	37	49	48	44
Percent of Income from Farm (respondents with off-farm employment)	35	43	30	36	21	29	31
Percent of Income from Farm (all respondents)	49	60	51	57	39	45	49

Table A2. Crops grown on entire farm.

Crop	Region: South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Western Mountains	Western Slope	Colorado
	Proportion of Respondents Growing Each Crop (%)						
Alfalfa or Other Hay	79	39	87	80	93	90	82
Corn for Grain or Silage	52	70	54	2	1	18	31
Pasture	20	7	20	31	18	32	24
Wheat	24	62	36	18	1	11	21
Other Crops	27	46	37	13	3	12	21
Beans	14	19	6	--	--	9	9
Barley	8	--	3	28	--	2	7
Potatoes	1	1	1	22	--	--	3
	Average Acreage of Respondents Growing Each Crop						
Alfalfa or Other Hay	338	265	310	316	269	150	258
Corn for Grain or Silage	235	629	233	--	--	84	296
Pasture	422	499	262	515	1476	293	481
Wheat	320	557	627	151	--	79	379
Other Crops	281	406	263	208	431	71	279
Beans	96	172	61	--	--	99	110
Barley	135	--	--	325	--	70	236
Potatoes	--	--	--	368	--	--	346
	Percent of Acres Irrigated for Respondents Growing Each Crop (%)						
Alfalfa or Other Hay	94	82	95	94	89	94	93
Corn for Grain or Silage	95	79	98	--	--	92	91
Pasture	47	11	45	61	40	66	55
Wheat	55	23	79	94	--	83	58
Other Crops	69	36	82	54	20	77	63
Beans	98	95	86	--	--	94	96
Barley	97	--	100	100	--	88	98
Potatoes	100	100	100	96	--	--	96

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

Table A3. Livestock raised 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	59	58	62	66	78	70	65
Beef Cows	37	32	42	50	62	57	48
Horses	8	2	6	11	19	17	12
Stocker Cattle	9	11	17	9	17	10	11
Sheep	5	<1	<1	9	6	8	6
Fat Cattle	4	2	3	<1	<1	<1	1
Swine	3	<1	3	<1	<1	<1	1
Dairy	2	<1	<1	<1	<1	<1	<1
	Average Number of Animals for Respondents Growing Each Type						
Beef Cows	185	348	161	183	250	157	195
Horse	29	16	35	15	34	18	24
Stocker Cattle	130	453	124	250	192	131	186
Sheep	100	3000	2500	440	93	926	580
Fat Cattle	824	1733	1133	--	--	--	1027
Swine	177	200	16	--	8	59	119
Dairy	683	400	--	--	--	400	589
	Distribution of Total Livestock Numbers (%)						
None	41	42	38	34	22	30	35
1 to 100 head	31	25	30	36	41	42	35
100 to 250 head	13	13	16	16	17	16	15
250 to 1000 head	12	13	12	12	16	10	12
> 1000 head	4	7	4	2	4	2	3

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

Table A4. Irrigation systems used on entire farm

System	Region: South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Western Mountains	Western Slope	Colorado
			Percent of Respondents Using System[a]				
Ditch & Check	44	6	39	52	80	57	51
Gated Pipe	45	18	65	9	15	51	39
Center Pivot	36	74	12	56	5	6	29
Siphon Tubes	51	3	50	27	2	17	28
Sideroll	4	6	0	1	5	23	10
Other Gravity System	5	2	2	4	15	7	6
Lay Flat/Collapsible pipe	16	0	1	1	2	1	5
Other Sprinkler	3	5	1	1	3	7	4
Other Irrigation System	1	1	0	1	4	2	1
Drip Tube	0	0	3	0	1	0	0
			Average Percent of Respondents' Acreage Served by System				
Ditch & Check	25	4	27	34	70	38	34
Center Pivot	27	78	6	46	2	3	22
Gated Pipe	14	5	30	2	5	26	16
Siphon Tubes	23	2	29	11	1	8	13
Sideroll	2	4	0	0	4	13	5
Other Gravity System	2	1	2	2	11	4	4
Lay Flat/Collapsible pipe	5	0	0	1	0	0	2
Other Sprinkler	1	3	0	0	0	2	1
Other Irrigation System	0	0	0	1	3	1	1
Drip Tube	0	0	2	0	0	0	0
			Percent of Acreage Surveyed Under Each System				
Center Pivot	41	94	9	58	1	5	38
Ditch & Check	14	1	28	30	64	40	27
Siphon Tubes	24	1	37	8	0	11	14
Gated Pipe	12	4	23	1	5	21	10
Other Gravity System	1	0	1	2	21	3	4
Sideroll	1	1	0	0	1	15	3
Lay Flat/Collapsible pipe	5	0	0	1	0	0	2
Other Irrigation System	1	0	0	0	0	4	1
Other Sprinkler	0	0	1	0	0	0	<1
Drip Tube	0	0	<1	0	<1	<1	<1

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

Table A5. Irrigation scheduling methods used anywhere on farm by irrigation system.

	System									
	Gate Pipe	Siphon Tubes	Ditch & Check	Coll. Pipe	Other Grav.	Center Pivot	Side Roll	Other Sprink.	Drip Tube	Other
Primary Scheduling	---------- Percent of Respondents Using ----------									
Experience	51	53	51	55	53	53	57	67	25	59
Crop Appearance	47	55	38	52	35	38	37	14	25	36
Fixed # of Days	26	29	19	27	24	14	35	19	0	36
Ditch Schedule	36	41	32	42	26	9	11	10	25	32
Soil Probe	9	12	5	12	9	27	11	5	**	18
Tensiometers	2	4	3	6	6	5	1	**	**	14
Weather Station ET	4	6	3	6	6	10	4	5	50	14
Paid Crop Consultant	5	8	3	9	6	24	1	5	**	14
Atmometer (ET gage)	3	4	3	6	6	2	1	**	**	14
Gypsum Blocks	3	4	3	6	6	5	1	**	**	14
Computer Program	2	4	3	6	6	2	1	5	**	14
Other	7	5	7	6	12	5	7	5	**	14
Secondary Scheduling										
Experience	24	22	22	33	32	22	19	24	25	27
Crop Appearance	24	25	28	24	18	27	30	14	25	41
Fixed # of Days	19	27	15	30	12	19	18	10	25	14
Ditch Schedule	12	25	15	33	24	10	14	5	**	27
Soil Probe	13	12	8	15	12	14	7	5	50	14
Tensiometers	4	8	4	15	6	6	2	**	50	14
Weather Station ET	6	9	5	15	9	10	4	**	**	14
Paid Crop Consultant	5	8	4	12	6	11	1	**	**	14
Atmometer (ET gage)	3	6	3	12	6	2	1	**	**	18
Gypsum Blocks	3	8	3	12	6	3	1	**	**	14
Computer Program	2	6	3	12	6	3	1	5	**	14
Other	5	6	7	6	12	4	6	5	**	18

** No Respondents In Category

Table A6. Irrigation scheduling methods used anywhere on farm by water source.

	Water Source			
	All Surface Water	All Groundwater	Mixed Water	Statewide Average
Primary Scheduling	---------- % Using ----------			
Experience	48	43	60	50
Crop Appearance	37	30	51	39
Ditch Schedule	28	2	33	24
Fixed # of Days	22	9	19	19
Soil Probe	4	34	14	11
Paid Crop Consultant	1	30	10	7
Tensiometers	4	4	3	4
Weather Station ET	1	6	8	3
Atmometer (ET gage)	0	2	3	1
Gypsum Blocks	0	5	1	1
Computer Program	0	1	1	0
Other	23	28	12	21
Secondary Scheduling				
Experience	23	28	12	21
Crop Appearance	25	29	23	25
Ditch Schedule	12	0	21	12
Fixed # of Days	15	16	23	16
Soil Probe	7	8	13	8
Paid Crop Consultant	2	8	10	5
Tensiometers	1	10	8	4
Weather Station ET	4	3	3	4
Atmometer (ET gage)	1	4	6	3
Gypsum Blocks	1	2	3	1
Computer Program	1	0	2	1
Other	1	2	2	1

Table A7. Respondents using soil test analysis.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	---------- Percent of Irrigated Acreage ----------						
Sampled in 2001	45	72	28	48	13	25	41
Sampled in Last 3 Years	56	76	46	62	34	37	54
Use N Fertilizer							
Soil Test in 2001	48	75	33	54	18	27	45
Soil Test 3 Years Prior	59	78	53	70	47	39	58
Do Not Use N Fertilizer							
Soil Test in 2001	43	53	35	21	**	20	32
Soil Test 3 Years Prior	54	78	75	20	8	60	46

Table A8. Percent of acreage sampled among respondents using soil test analysis.

	Dominant Crop*						
	Alfalfa	Corn	Potato	Small Grains	Other Crop	No Primary Crop	Average
	---------- Percent of Irrigated Acreage Sampled ----------						
Sampled in 2001	25	67	95	57	87	46	41
Sampled in Last 3 Years	43	68	99	65	83	59	54

*>2/3 of irrigated acreage, >1/2 irrigated acreage for potatoes

Table A9. Adoption of nutrient management as affect by use of commercial nitrogen fertilizer.

Apply Commercial N	Region: South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Western Mountains	Western Slope	Colorado
	---------- Percent (%) of Respondents Using ----------						
Use N Fertilizer							
Soil Test Analysis	69	79	47	63	29	38	53
Keep Written Records	52	53	33	48	31	42	44
Est. Crop Yield Goals	52	63	46	48	25	32	43
Dealer Rep.	53	33	35	46	30	43	43
Deep Soil Test	23	39	13	26	6	9	18
None of These Used	7	6	11	21	36	16	15
Paid Crop Consultant	12	48	16	28	**	**	13
Variable Rate Application	8	10	6	7	7	11	9
Plant Tissue Sampling	6	10	**	22	**	5	7
Other	**	**	6	**	6	8	5
Do Not Use N Fertilizer							
Soil Test Analysis	41	**	**	30	**	**	26
Keep Written Records	22	**	**	**	**	29	21
Est. Crop Yield Goals	22	**	**	**	**	**	15
Dealer Rep.	22	**	**	**	**	23	15
Deep Soil Test	**	**	**	**	**	**	7
None of These Used	34	**	**	57	72	54	51
Paid Crop Consultant	**	**	**	**	**	**	4
Variable Rate Application	**	**	**	**	**	**	**
Plant Tissue Sampling	**	**	**	**	**	**	**
Other	**	**	**	**	**	**	7

** Five respondents or fewer in category

Table A10. Frequency of nutrient crediting practices on whole farm.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Western Mountains	Western Slope	Colorado
	---------- Percent of Respondents Using Credit ----------						
Manure Credit							
Manure Use Indicated	40	33	33	17	9	18	24
Own Livestock (>10 hd)	26	23	20	13	10	14	17
No Livestock	15	10	10	3	0	4	7
Median Credit Amount lbs. N/acre	27	**	15	**	**	30	24
Legume Credit							
Grow Alfalfa	29	29	32	24	5	19	23
No Alfalfa	12	16	**	6	3	20	13
Other Legume	21	15	27	20	4	15	17
Median Credit Amount lbs. N/acre	50	50	80	50	**	70	65
Water Credit							
All Surface Water	4	0	0	0	1	0	1
All Ground Water	20	7	10	48	**	**	17
Mixed Ground / Surface Water	14	25	7	13	**	0	13
Median Credit Amount lbs. N/acre	20	**	**	20	**	**	20
Consultant Determines Credit	12	39	12	17	2	4	12
No Credits Reported	38	25	36	47	72	59	48

** Five respondents or fewer in category

Table A11. Methods used to apply nitrogen fertilizer by crop grown on representative field.

	Crop									
	Alfalfa / Hay	Corn Grain	Grass Hay	Other Crop	Wheat	Beans	Barley	Potatoes	Corn Silage	Pasture
	---------- Percent of Respondents Using ----------									
Application Methods										
Spring preplant	26	68	15	63	68	85	89	77	71	29
Topdress	42	26	51	40	55	41	39	32	19	29
Planting (starter)	10	54	7	35	45	26	25	68	24	**
Sidedress	7	56	1	44	43	52	36	27	38	**
Fall Preplant	7	28	2	23	40	41	25	14	24	**
Fertigate	4	33	1	26	20	19	39	73	33	**
Do Not Apply	17	5	17	7	**	**	**	5	14	21
Other	5	3	8	7	5	4	**	5	**	14
None of These	17	1	14	7	3	**	**	**	**	7

** No Respondents in Category

Table A12. Adoption of pest control and pesticide best management practices (BMPs) by dominant crop.

	Dominant Crop*						
	Alfalfa	Corn	Potato	Small Grains	Other Crop	No Primary Crop	Average
Pest Management Practices	Use Among Respondents Using Any Pesticide (% using)						
Herbicide	86	84	89	100	82	88	86
Insecticides	59	81	89	81	73	72	67
Clean / Pure Seed	52	72	67	75	82	68	61
Cultivation	51	71	56	56	64	63	58
Field Scouting	48	59	78	44	55	61	54
Crop Rotation	43	62	67	63	45	65	53
Resistant Varieties	30	41	33	63	64	50	40
Residue Management	23	42	33	44	55	32	29
Fungicides	15	24	33	31	36	23	20
Sanitation Practices	11	25	22	19	36	20	16
Adjust Planting / Harvest	15	20	11	19	27	17	16
Mulching	10	14	0	6	27	14	12
Biotech Crops (GM)	8	19	11	31	0	13	11
Pest Forecasting	6	15	22	6	18	15	11
Hand Hoeing / Rogueing	21	19	22	31	55	27	24
Biological Controls	9	13	22	13	9	10	10
Other	2	0	0	0	0	3	2
None of These Used	0	0	0	0	0	0	0
Pesticide Management							
Keep Pesticide Records	34	51	67	63	67	45	40
Economic Threshold	29	42	44	50	44	44	37
Dealer Representative	31	34	11	44	11	44	36
Banding / Spot App.	26	31	11	19	11	33	30
Keep Pest Records	23	39	56	38	56	28	27
Paid Crop Consultant	20	20	44	13	44	22	20
None of These Used	21	9	11	13	11	10	16

*>2/3 of irrigated acreage, >1/2 irrigated acreage for potatoes

Table A13. Adoption of pest control and pesticide best management practices (BMPs) by respondents not using pesticides.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Use Among Respondents Not Using Pesticides* (% using)						
Pest Management Practices							
None of These Used	35	36	44	48	67	45	49
Clean / Pure Seed	16	45	32	24	14	33	25
Field Scouting	26	36	16	26	9	16	18
Crop Rotation	26	27	16	17	5	20	16
Cultivation	14	45	20	14	5	14	13
Resistant Varieties	7	0	4	14	0	13	8
Adjust Planting / Harvest	14	9	4	15	6	5	8
Other	2	9	4	3	6	7	5
Residue Management	9	18	0	3	1	7	5
Biological Controls	12	9	0	3	5	3	5
Sanitation Practices	5	0	8	8	2	4	4
Mulching	7	9	4	5	0	2	3
Pest Forecasting	2	9	0	2	0	1	1
Hand Hoeing / Rogueing	2	9	0	2	0	1	1
Biotech Crops (GM)	0	9	4	0	0	0	1
Pesticide Management							
None of These Used	71	50	70	77	79	74	74
Banding / Spot App.	2	40	4	6	3	0	4
Dealer Representative	7	0	9	13	1	4	5
Economic Thresholds	2	0	0	2	1	2	2
Paid Crop Consultants	7	10	4	8	3	4	5
Keep Pest Records	2	10	4	5	0	1	2

* Did not indicate using herbicides, insecticides, or fungicides

Table A14. Adoption of insecticide and fungicide best management practices (BMPs).

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Use Among Respondents Using Insecticides and/or Fungicides (% using)						
Pest Management Practices							
Residue Management	40	58	35	46	--	23	37
Clean / Pure Seed	69	77	72	83	39	73	72
Resistant Varieties	46	63	67	51	30	44	51
Sanitation Practices	19	16	11	48	4	19	20
Pest Forecasting	17	17	10	32	--	10	15
Crop Rotation	63	73	78	83	4	53	64
Field Scouting	67	82	65	78	30	53	65
Biological Controls	6	12	9	14	4	15	10
Adjust Planting / Harvest	18	27	16	27	9	18	19
Biotech Crops (GM)	10	41	37	--	--	6	16
Mulching	22	11	14	17	--	10	16
Pesticide Management							
Paid Crop Consultants	21	56	23	48	4	12	27
Dealer Representative	62	32	44	54	9	41	48
Economic Thresholds	51	60	59	54	13	34	49

Table A15. Adoption of herbicide best management practices (BMPs).

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Use Among Respondents Using Herbicides (% using)						
Pest Management Practices							
Residue Management	34	55	35	40	4	16	30
Clean / Pure Seed	64	79	72	69	20	55	62
Crop Rotation	61	73	80	69	4	40	56
Adjust Planting / Harvest	17	29	19	19	2	15	17
Biotech Crops (GM)	9	38	37	--	--	4	12
Mulching	18	10	11	14	2	7	12
Hand Hoeing / Rogueing	30	20	27	19	28	26	26
Cultivation	73	81	83	59	9	44	61
Pesticide Management							
Paid Crop Consultants	19	52	20	35	6	7	20
Dealer Representative	53	29	42	51	6	25	37
Banding / Spot App.	39	36	18	16	37	33	32

Table A16. General characteristics of representative field.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Field Size (acres)							
Average*	59	126	53	101	96	40	70
			Soil Texture (% of respondents)				
Sandy	6	16	**	11	11	4	7
Sandy to Loamy	40	41	26	40	27	12	29
Loamy	20	27	26	23	38	27	26
Loamy to Clay	13	8	22	10	**	13	11
Clay	19	7	22	11	20	39	24

** Five respondents or fewer in category

* Average of 1999 - 2001 irrigated acres

Table A17. Crops grown on representative field.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	Percent (%) Respondents Growing Crop From Each Region						
1999 Crops							
Alfalfa / Hay	39	21	56	59	77	65	54
Corn Grain	33	58	22	**	**	8	18
Grass Hay	6	**	**	5	19	13	9
Other Crop	6	**	9	**	**	3	4
Wheat	3	7	**	8	**	3	4
Beans	5	7	**	**	**	3	3
Barley	**	**	**	11	**	**	2
Potatoes	**	**	**	12	**	**	2
Corn Silage	3	**	**	**	**	2	2
Pasture	**	**	**	**	**	2	1
2000 Crops							
Alfalfa / Hay	41	19	52	59	79	66	55
Corn Grain	28	57	27	**	**	6	17
Grass Hay	7	**	**	5	18	13	9
Other Crop	7	6	9	**	**	2	4
Wheat	3	11	**	5	**	3	4
Beans	6	6	**	**	**	5	4
Barley	**	**	**	16	**	**	3
Potatoes	**	**	**	11	**	**	2
Corn Silage	5	**	**	**	**	**	2
Pasture	**	**	**	**	**	3	2
2001 Crops							
Alfalfa / Hay	45	19	50	58	79	69	56
Corn Grain	28	57	25	**	**	6	17
Grass Hay	6	**	**	5	18	12	9
Other Crop	5	8	13	5	**	3	5
Wheat	5	10	**	4	**	3	4
Beans	2	**	**	**	**	3	2
Barley	2	**	**	13	**	**	2
Potatoes	**	**	**	14	**	**	2
Corn Silage	5	**	**	**	**	**	2
Pasture	**	**	**	**	**	2	1

** Five respondents or fewer in category

Table A18. Yield of crops reported on representative field.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	---------- Average Yield per Region ----------						
1999 Crop							
Alfalfa / Hay (ton/ac)	4.5	4.0	4.6	3.4	2.2	3.5	3.6
Barley (bu/ac)	105	**	**	112	**	115	111
Beans (bu/ac)	38	54	32	**	**	30	39
Corn (bu/ac)	171	186	183	**	**	175	177
Corn Silage (ton/ac)	26.0	**	**	**	**	24.2	25.1
Grass Hay (ton/ac)	3.6	3.0	4.5	2.3	4.4	3.3	3.7
Pasture (ton/ac)	2.0	**	**	2.0	2.0	2.0	2.0
Potato (cwt/ac)	250	**	**	369	**	**	356
Wheat (bu/ac)	53	69	79	68	50	68	64
2000 Crop							
Alfalfa / Hay (ton/ac)	4.0	3.8	4.3	3.2	2.0	3.5	3.4
Barley (bu/ac)	96	**	**	124	**	100	118
Beans (bu/ac)	39	47	35	**	**	25	35
Corn (bu/ac)	171	175	173	**	**	194	175
Corn Silage (ton/ac)	24.2	**	**	**	**	**	24.3
Grass Hay (ton/ac)	3.9	3.0	3.5	**	4.5	3.0	3.6
Pasture (ton/ac)	1.0	**	**	**	2.0	2.0	1.8
Potato (cwt/ac)	**	**	**	321	**	**	321
Wheat (bu/ac)	79	58	60	80	**	61	66
2001 Crop							
Alfalfa / Hay (ton/ac)	4.3	4.0	4.4	3.4	2.0	3.7	3.5
Barley (bu/ac)	96	**	**	125	**	128	117
Beans (bu/ac)	44	38	46	**	**	27	38
Corn (bu/ac)	175	185	172	**	**	201	180
Corn Silage (ton/ac)	25.0	**	**	**	**	**	24.9
Grass Hay (ton/ac)	4.1	3.0	3.0	**	4.1	4.6	4.1
Pasture (ton/ac)	2.0	**	**	**	2.0	2.0	2.0
Potato (cwt/ac)	435	**	**	334	**	**	339
Wheat (bu/ac)	67	63	95	73	**	66	66

** Five or fewer respondents in category

*Some adjustments to actual responses were made to achieve these values.

Unreasonable or uninterpretable responses were excluded.

Table A19. 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	43	90	33	54	15	13	38
% supplemental	22	4	59	34	16	13	21
Ditch Company	44	7	53	33	45	65	45
% supplemental	25	13	11	49	5	12	19
Individual Surface Diversion	13	3	14	13	40	22	18
% supplemental	18	33	0	47	37	35	31
Water Reliability[a] (%) (years out of 10)							
10	51	68	35	56	31	40	46
9	5	3	5	4	4	7	5
8	11	3	10	10	17	12	11
7	5	2	8	7	13	9	7
6	3	3	8	4	7	5	5
5	4	4	11	4	7	6	5
Fewer than 5	19	16	23	16	21	22	20

[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 A20. Well characteristics on representative field.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Those Pumping Ground Water:							
Depth to Water (%)							
0 - 25 feet	21	5	27	38	**	**	22
25 - 50 feet	31	5	40	20	**	**	21
50 - 100 feet	34	16	10	18	**	**	22
100 - 200 feet	13	37	3	6	**	**	18
200 - 300 feet	<1	27	7	5	**	**	11
> 300 feet	0	10	13	12	**	**	7
Well Pumping Capacity (%)							
0 - 250 gpm	4	3	7	9	**	**	5
250 - 500 gpm	7	21	27	2	**	**	12
500 - 750 gpm	14	22	30	8	**	**	16
750 - 1000 gpm	35	30	13	13	**	**	25
1000 - 1500 gpm	26	18	10	47	**	**	28
>1500 gpm	13	7	13	22	**	**	14
Gallons/Minute/Acre (% fields)							
<2 gpm/acre	3	4	4	9	**	**	5
<3 gpm/acre	1	5	4	4	**	**	4
<4 gpm/acre	3	8	8	1	**	**	4
<5 gpm/acre	5	12	4	4	**	**	7
<6 gpm/acre	4	15	8	4	**	**	7
>=6.0 gpm/acre	84	55	73	78	**	**	73
Those with Sprinkler Systems:							
Well head Pressure (%)							
0 - 10 psi	29	3	0	15	**	**	13
10 - 20 psi	5	14	71	1	**	**	9
20 - 30 psi	15	21	14	22	**	**	20
30 - 40 psi	24	26	0	47	**	**	31
40 - 50 psi	17	13	14	14	**	**	14
>50	10	23	0	1	**	**	13

Table A21. Irrigation systems used on representative field.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	---------- Percent Using System From Each Region ----------						
Ditch & Check	23	3	27	30	69	35	32
Center Pivot	23	81	6	51	4	4	22
Gated Pipe	15	6	33	3	5	30	18
Siphon Tubes	26	3	30	12	<1	9	15
Sideroll	2	3	<1	<1	3	17	6
Other Gravity	1	<1	2	1	9	2	2
Lay Flat / Coll. Pipe	7	<1	<1	<1	2	<1	2
Other System	<1	<1	<1	2	5	1	2
Other Spinkler	1	3	<1	1	2	2	1
Drip Tube	<1	<1	1	<1	<1	<1	<1
Avg. Age of System	25	19	27	30	67	27	32

** Five or fewer respondents in category

Table A22. Average age of irrigation systems used on representative field.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	---------- Average Years----------						
Gated Pipe	12	21	15	14	13	10	12
Siphon Tubes	37	40	33	30	40	19	32
Ditch & Check	47	30	50	56	75	52	58
Lay Flat / Coll. Pipe	13	**	**	**	40	20	17
Other Gravity	44	0	40	39	88	60	68
Center Pivot	10	18	9	16	11	11	14
Sideroll	14	16	**	**	12	11	11
Other Sprinkler	11	33	**	12	49	17	23
Drip Tube	10	**	6	**	**	10	8
Other System	7	**	32	45	66	37	45

** No Respondents in Category

Table A23. Reasons for amount applied at each irrigation by irrigation system and average number of applications.

Amount Determination	Irrigation System									
	Ditch & Check	Center Pivot	Gated Pipe	Siphon Tubes	Sideroll	Other Gravity	Lay Flat Coll. Pipe	Other System	Other Sprinkler	Drip Tube
	---------- Percent (%) of Respondents Using ----------									
Same Each Time	53	27	55	60	69	53	56	50	55	0
Replenish Crop Water Use	7	17	12	14	5	7	13	5	10	60
% ET Replenished	79	83	81	78	0	50	100	0	0	85
Replenish Soil Profile	7	21	10	8	8	0	6	5	10	20
% Soil Water Replen.	84	83	90	84	80	92	75	100	75	80
Other	31	10	20	16	16	40	25	35	25	20
Crop Consultant Determines	1	26	3	2	1	0	0	5	0	0
Average Number of Applications	5	13	5	5	6	7	10	5	5	34

Table A24. Number of applications in reference to representative field crop.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Crop	---------- Average Number of Applications ----------						
Alfalfa	6	6	3	8	7	6	6
Barley	5	--	2	17	--	6	13
Beans	5	9	6	--	--	7	7
Corn	8	13	10	--	--	7	10
Corn Silage	12	--	3	--	--	7	10
Grass Hay	3	2	7	5	6	7	6
Other	7	3	10	12	3	12	8
Pasture	3	--	--	--	10	5	5
Potato	--	--	--	24	--	--	23
Wheat	3	5	4	14	--	4	5

Table A25. Respondents' reported water use by crop on representative field in 2001.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Crop	---------- Inches ----------						
Pasture	**	**	**	**	**	**	**
Alfalfa	21	18	20	23	30	21	22
Corn	25	17	22	**	**	**	21
Wheat	12	18	15	17	**	38	21
Other Crop	16	5	13	22	**	22	17
Barley	7	**	**	18	**	**	16
Potato	**	**	**	16	**	**	16
Beans	**	18	**	**	**	12	15
Corn Silage	7	**	**	**	**	**	7
Grass Hay	**	**	**	**	1	**	1
All Crops	19	16	19	19	24	23	20

** No response

Table A26. 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 Reporting Change						
All Categories	30	41	23	24	19	25	27
By Application System							
Center Pivot	39	46	50	28	17	50	39
Sideroll	14	**	**	**	**	28	26
Other Sprinkler	**	**	**	**	**	17	28
Gated Pipe	35	17	25	**	33	26	28
Siphon Tubes	24	**	21	24	**	13	21
Flood	18	**	14	15	18	20	18
By Water Source							
Groundwater	33	42	19	25	28	27	32
Ditch Company	28	25	24	24	13	27	25
Direct Diversion	35	**	45	15	15	22	22
By 2001 Crop							
Barley	50	**	**	41	**	**	38
Other Crops	31	30	**	40	**	67	37
Pasture	33	50	25	25	**	33	36
Corn (grain & silage)	34	43	28	**	**	12	33
Grass Hay	28	**	**	17	23	33	28
Beans	17	**	**	**	**	10	27
Wheat	**	**	**	26	**	**	25
Alfalfa & Hay	26	42	18	20	19	24	23
Potatoes	**	**	**	**	**	<1	17
Type of Change Implemented							
Water System	36	25	33	28	61	31	34
Water Management	14	25	29	28	18	17	19
Crop Mgmt	20	13	13	8	11	25	18
Tillage Change	13	23	13	6	0	8	12
Fertilizer Mgmt	9	10	8	14	4	13	10
Other	8	4	4	17	7	6	7

** Five respondents or fewer in category

Table A27. Sources regularly used for irrigation and/or crop production information.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
Irrigation	Percent (%) Using						
Water Dist / Ditch Co.	42	8	37	33	25	41	35
Neighbors	18	17	17	21	26	25	21
Irrigation Equip. Dealer	16	26	8	13	6	18	15
NRCS (formerly SCS)	8	10	15	13	21	22	15
Paid Crop Consultant	8	48	16	21	0	1	12
CSU / Coop. Ext.	7	13	7	16	13	12	11
Chemical Dealer / Applicator	10	21	8	7	4	8	9
Soil Testing Lab	8	26	10	7	6	6	9
Popular Farm Press	10	11	6	9	7	7	8
Other	7	4	9	9	13	7	8
Seed Dealer	5	10	8	3	0	4	5
Other Internet Sources	4	6	3	6	1	2	4
Crop Production	Percent (%) Using						
Chemical Dealer / Applicator	63	61	52	36	13	35	44
Soil Testing Lab	51	57	33	42	19	28	38
Seed Dealer	41	44	43	14	11	27	30
Neighbors	23	30	35	30	22	34	28
CSU / Coop. Ext.	16	32	14	21	23	26	22
Popular Farm Press	18	21	15	13	13	15	16
NRCS (formerly SCS)	10	10	13	18	21	15	14
Paid Crop Consultant	11	44	14	24	1	2	13
Water Dist / Ditch Co.	12	0	14	14	5	14	11
Other	8	8	9	10	21	12	11
Other Internet Sources	6	9	7	10	1	4	6
Irrigation Equip. Dealer	5	8	3	3	4	7	5

Table A28. Factors limiting crop production and/or irrigation decisions.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	---------- Percent Limiting ----------						
Water Availability	63	48	83	60	70	61	64
Equipment Cost	40	50	33	34	22	42	37
Management Time	33	24	19	32	27	30	29
Labor Cost	30	26	29	22	22	31	27
Other	13	22	9	19	22	12	16
Lack of Information	7	4	4	5	4	7	6
Lender	4	10	6	7	3	3	5
Landlord	7	6	2	2	4	2	4

Table A29. Water quality concerns by type of water source.

	Water Source		
	Mixed Water	Ground Water	Surface Water
Water Quality Concerns	---------- Percent (%) ----------		
Crop Production	40	33	35
Household Use	23	22	25
Livestock	31	42	31
Other	6	4	9

Table A30. Average time since irrigation water analyzed.

	Region						
Years Ago	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Colorado
	---------- Percent (%) ----------						
0 to 2	38	29	25	40	22	13	33
3 to 5	30	26	38	33	33	40	31
6 to 10	16	15	17	16	44	7	17
> 10	16	29	21	12	0	40	20

Table A31. Number of Surveys Mailed 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	373	686	634	591	549	246	189	3,268
South Platte	151	221	172	177	107	38	30	896
Adams	2	5	3	5	3	2	4	24
Boulder	17	17	3	4	3	2	0	46
Denver	0	1	0	0	0	0	0	1
Jefferson	1	1	0	0	0	0	0	2
Larimer	20	34	27	17	11	5	8	122
Logan	5	16	15	22	20	9	4	91
Morgan	14	47	42	32	25	9	7	176
Sedgwick	2	1	1	4	6	4	0	18
Weld	90	99	81	93	39	7	7	416
Eastern Plains	1	17	38	59	118	85	50	368
Arapahoe	0	2	2	1	5	2	2	14
Baca	0	2	5	12	17	12	4	52
Cheyenne	0	0	1	2	6	8	9	26
Douglas	0	2	3	4	1	1	0	11
El Paso	1	1	2	3	4	1	3	15
Elbert	0	2	0	1	4	3	5	15
Kit Carson	0	0	5	4	20	13	9	51
Lincoln	0	0	0	0	1	2	4	7
Phillips	0	3	4	5	13	5	3	33
Washington	0	4	7	12	15	17	7	62
Yuma	0	1	9	15	32	21	4	82
Arkansas Valley	30	47	69	48	47	19	23	283
Bent	0	6	14	9	12	4	3	48
Crowley	0	1	6	1	5	2	3	18
Kiowa	0	0	0	1	1	2	4	8
Las Animas	3	2	6	9	2	1	4	27
Otero	19	21	29	11	7	0	2	89
Prowers	2	4	7	8	13	9	5	48
Pueblo	6	13	7	9	7	1	2	45
San Luis Valley	30	91	116	127	110	27	12	513
Alamosa	4	20	16	23	23	4	1	91
Conejos	12	29	40	33	21	6	4	145
Costilla	5	13	6	12	8	4	2	50
Rio Grande	6	22	33	38	27	7	0	133
Saguache	3	7	21	21	31	6	5	94

(continued)

Table A31 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	33	78	66	64	80	39	29	389
Chaffee	5	13	13	5	4	1	1	42
Clear Creek	1	0	0	0	0	0	0	1
Custer	1	5	5	6	5	1	2	25
Eagle	4	10	1	5	4	0	2	26
Fremont	0	10	5	1	7	5	2	30
Grand	2	3	6	9	13	7	5	45
Gunnison	6	8	11	8	12	4	3	52
Hinsdale	1	0	0	1	1	0	0	3
Huerfano	1	4	3	2	6	1	1	18
Jackson	0	1	2	7	4	7	2	23
Lake	0	1	0	1	0	0	0	2
Mineral	0	0	0	0	0	0	0	0
Ouray	0	2	4	4	4	3	2	19
Park	0	3	3	1	2	2	4	15
Pitkin	2	4	3	1	1	1	0	12
Routt	10	13	7	12	16	5	4	67
Summit	0	0	2	0	1	1	0	4
Teller	0	1	1	1	0	1	1	5
Western Slope	128	232	173	116	87	38	45	819
Archuleta	3	3	4	4	3	1	1	19
Delta	33	49	36	11	11	3	4	147
Dolores	0	1	3	6	7	1	3	21
Garfield	7	11	5	11	12	3	6	55
La Plata	25	43	28	23	7	8	3	137
Mesa	27	35	23	9	4	3	7	108
Moffat	1	0	6	7	4	5	9	32
Montezuma	8	26	24	12	16	2	0	88
Montrose	20	51	33	28	15	5	2	154
Rio Blanco	3	9	10	5	8	6	6	47
San Miguel	1	4	1	0	0	1	4	11
Colorado	373	686	634	591	549	246	189	3,268

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

Table A32. 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	Size not Provided	All Farms
Colorado	166	301	227	192	181	80	45	29	1,221
South Platte	51	106	42	51	34	17	11	6	318
Adams	0	2	0	2	1	0	1	0	6
Boulder	6	13	3	2	4	2	0	1	31
Larimer	6	13	6	9	2	5	3	0	44
Logan	2	7	5	6	4	2	2	1	29
Morgan	7	16	11	12	5	1	3	1	56
Sedgwick	0	0	0	0	1	1	1	0	3
Weld	30	55	17	20	17	6	1	3	149
Eastern Plains	2	10	9	23	37	21	10	2	114
Arapahoe	0	1	0	1	2	1	1	0	6
Baca	0	3	2	6	1	2	1	0	15
Cheyenne	0	0	0	0	4	0	1	0	5
Douglas	0	1	1	1	1	0	0	0	4
El Paso	2	0	0	0	2	0	1	0	5
Elbert	0	0	0	1	3	1	0	0	5
Kit Carson	0	1	2	2	5	1	2	0	13
Lincoln	0	0	0	0	0	0	1	0	1
Phillips	0	2	1	1	8	1	0	0	13
Washington	0	1	1	2	2	6	1	0	13
Yuma	0	1	2	9	9	9	2	2	34
Arkansas Valley	14	23	32	16	15	4	7	2	113
Bent	0	0	6	2	1	2	0	0	11
Crowley	0	2	1	1	2	1	0	0	7
Kiowa	0	0	0	1	0	0	1	0	2
Las Animas	2	1	3	2	0	0	1	0	9
Otero	7	12	15	2	3	0	0	0	39
Prowers	0	2	2	3	7	1	5	1	21
Pueblo	5	6	5	5	2	0	0	1	24
San Luis Valley	14	29	33	39	34	6	1	6	162
Alamosa	2	8	5	7	9	0	0	0	31
Conejos	4	8	8	11	6	2	0	1	40
Costilla	3	3	3	4	3	1	0	0	17
Rio Grande	2	8	14	8	10	1	0	2	45
Saguache	3	2	3	9	6	2	1	3	29

(continued)

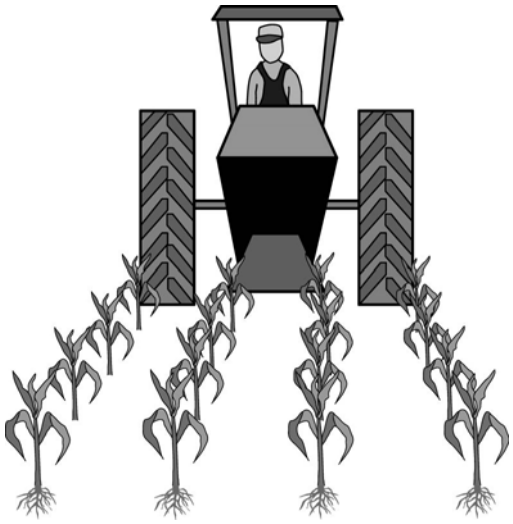
Table A32 continued.

	Farm Size (acres)								
	Under 100	100 to 249	250 to 499	500 to 999	1000 to 2499	2500 to 4999	Over 5000	Size not Provided	All Farms
Region/County									
Mountains	11	30	31	21	38	17	8	6	162
Chaffee	3	5	5	0	0	1	0	0	14
Custer	0	1	1	1	2	1	0	0	6
Eagle	2	7	1	0	1	0	1	0	12
Fremont	0	4	2	0	5	2	0	1	14
Grand	1	2	2	2	10	1	0	1	19
Gunnison	3	3	3	5	5	2	2	0	23
Huerfano	0	0	3	1	1	1	0	0	6
Jackson	0	1	1	3	2	4	1	1	13
Lake	0	1	0	0	0	0	0	0	1
Mineral	0	0	0	0	1	0	0	0	1
Ouray	0	2	1	2	1	2	1	0	9
Park	0	0	4	1	0	0	2	1	8
Pitkin	0	0	2	0	1	0	0	0	3
Routt	2	4	5	5	8	1	1	2	28
Summit	0	0	1	0	1	2	0	0	4
Teller	0	0	0	1	0	0	0	0	1
Western Slope	74	103	80	42	23	15	8	7	352
Archuleta	1	3	1	1	0	0	1	0	7
Delta	19	23	12	2	5	1	1	1	64
Dolores	0	1	3	2	1	0	0	1	8
Garfield	4	1	8	6	5	3	2	1	30
La Plata	16	13	12	8	2	1	1	0	53
Mesa	14	19	15	4	1	1	2	1	57
Moffat	1	2	4	1	1	6	0	0	15
Montezuma	3	13	6	10	2	2	0	2	38
Montrose	12	21	14	5	3	1	0	1	57
Rio Blanco	4	6	4	3	2	0	1	0	20
San Miguel	0	1	1	0	1	0	0	0	3
Colorado	166	301	227	192	181	80	45		1,221

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

Appendix B
Survey Instrument Used

Survey of Irrigated Crop Production in Colorado



Colorado State University Cooperative Extension
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 10 to 15 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!

Reagan Waskom
(970) 491-2947

Troy Bauder
(970) 491-4923

General Farm Information

1. In what county is the majority of your farm located? _____ county

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

3. List your ***major*** farm enterprises:

Crop	Number of Acres*	Percent Irrigated

Livestock Type	Peak # of Head

*Total number of dryland and irrigated acres.

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. What is the depth to water in your farmstead well? _____ ft.

❍ No well exists.

Irrigation System(s) on Whole Farm

1. 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	%	Sprinkler:	center pivot	%
	siphon tubes	%		sideroll	%
	ditch and check	%		other sprinkler	%
	lay flat/collapsible pipe	%	Drip tube (surface or buried)		%
	other gravity	%	Other		%

2. Check Ø ***all*** irrigation components used on your farm:

❍ Surge valves	❍ Polyacryamides (PAM)	❍ Drop nozzles
❍ Field leveling	❍ Flow meters	❍ Low pressure nozzles (<25 psi)
❍ Lined ditches	❍ Computerized panel	❍ None of these used
❍ Flume or weir	❍ LEPA	❍ Other

3. Check Ø the ***primary*** and ***secondary*** scheduling method(s) that you use to determine when to irrigate on your farm:

Primary	Secondary		Primary	Secondary	
❍	❍	Fixed number of days	❍	❍	Paid crop consultant
❍	❍	Ditch schedule	❍	❍	Atmometer (ET gage)
❍	❍	Soil probe	❍	❍	Gypsum blocks
❍	❍	Tensiometers	❍	❍	Computer program
❍	❍	Weather station ET	❍	❍	Experience
❍	❍	Crop appearance	❍	❍	Other

Fertilizer Management on Whole Farm

1. With respect to your nutrient (fertilizer) management do you .....***(check ☑ all that apply)***

❍ Keep written records	❍ Use variable rate application (VRT)
❍ Establish crop yield goals	❍ Use soil test analysis to determine fertilizer rate
❍ Take plant tissue samples	❍ Use dealer rep for fertilizer recommendation
❍ Use paid crop consultant	❍ None of these used
❍ Deep soil test	❍ Other

2. Do you use livestock manure or effluent for fertilizer?

❍ Yes ❍ No… *go to question 3*

If yes, how do you determine your application rate? ***(check ☑ all that apply)***

❍ Soil test analysis	❍ Manure nutrient table values	❍ Use paid crop consultant
❍ Manure analysis	❍ Same amount each time	❍ None of these are used
❍ Spreader capacity	❍ Use all manure from pens	❍ Other

3. Do you reduce your N fertilizer or manure rate for any of the following?

	Approximate reduction?
❍ Previous manure application	lbs N/ton
❍ Previous legume crop	lbs N/acre
❍ Irrigation water nitrate	lbs N/acre
❍ Consultant determines	
❍ None of these used	

4. If you soil test, approximately what percent of your ***irrigated*** acreage was soil sampled in:

2001: ____ % last 3 years: ____ %

5. Check ☑ ***all*** the methods that you use to apply N fertilizer:

❍ Fall preplant	❍ Sidedress	❍ Do not apply commercial N fertilizer
❍ Spring preplant	❍ Fertigate	❍ None of these application methods
❍ Planting (starter)	❍ Topdress	❍ Other

Pest Management on Whole Farm

1. Check ☑ ***all*** pest management practices that you routinely use:
   (Include all weed, insect, and disease controls)

❍ Residue management	❍ Biological controls
❍ Clean/pure seed	❍ Adjust planting/harvest dates
❍ Fungicides	❍ Biotech crops(GM)
❍ Resistant varieties	❍ Mulching
❍ Sanitation practices	❍ Herbicides
❍ Pest forecasting	❍ Hand hoeing/rogueing
❍ Crop rotation	❍ Cultivation
❍ Field scouting	❍ None of these used
❍ Insecticides	❍ Other _____

2. With respect to your pest management program do you… (check ☑ ***all*** that apply)

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

Representative Irrigated Field Questions

The following questions target a specific field that you farm. Select ONE irrigated field that is ***most*** representative of your irrigated farm acres. Please answer all questions in this section thinking only about this ***representative field***.

1. What is the predominant soil texture ***of the representative field***?
   (i.e. sandy loam, clay, etc) _____

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

	1999	*2000*	*2001*
Crop			
Yield/acre estimate			

3. Check ☑ the irrigation water source(s) used ***on the representative field***.

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

If well is used: Well capacity? _____ gpm
Depth to water? _____ feet
Pressure at well? _____ psi

4. How many years out of 10 (0 to 10) are the primary and supplemental water sources *together* able to provide a full water supply for the crops grown ***on the representative field***? _____ years.

5. Check ☑ the irrigation application system used ***on the representative field***.

- ❍ gated pipe
- ❍ siphon tubes
- ❍ ditch & check
- ❍ lay flat/collapsible pipe
- ❍ other gravity _____
- ❍ center pivot
- ❍ sideroll
- ❍ other sprinkler
- ❍ drip tube (buried or surface)
- ❍ Other system _____

6. How long ago was this system installed?

years

2001 Irrigation Management of the Representative Field

1. How did you determine the amount of water to apply ***at each*** irrigation ***on the representative field***?

   ❍ Always applied the same amount each time
   ❍ Crop consultant determined the quantity applied
   ❍ Replenished crop water use since last irrigation
   What portion? _____ % ET
   ❍ Replenish soil profile to a given level
   What level? _____ % available water capacity
   ❍ Other (specify)_____

2. How many irrigation applications were made to the ***representative field*** throughout 2001? _____ applications

3. How much water was applied to the ***representative field*** throughout the 2001 growing season?

   _____inches/acre _____ gals/acre _____ acre feet/acre ❍ Don't know

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

5. Do you know how much water the crop used (ET) in 2001?

   ❍ No
   ❍ Yes _____ inches

6. Have you changed any management practices on ***the representative field*** in the last five years?

   ❍ No ❍ Yes, list:_____

   _____

This ends the questions about your representative field. Please answer the remainder of the survey based upon the management of your whole farm

Water and Crop Management Decisions on Whole Farm

1. Check Ø all the sources that you regularly use for irrigation and/or crop production information:

Irrigation	Crop production		Irrigation	Crop production	
❍	❍	Chemical dealer/applicator	❍	❍	Paid crop consultant
❍	❍	Neighbors	❍	❍	NRCS (formerly SCS)
❍	❍	Soil testing lab	❍	❍	Water district/Ditch Company
❍	❍	CSU/Cooperative Extension	❍	❍	Popular farm press
❍	❍	Irrigation equipment dealer	❍	❍	Seed dealer
❍	❍	Other internet sources	❍	❍	Other_____

2. What are the ***main*** factors that limit crop production or irrigation decisions on your farm? ***(check Ø all that apply)***

❍ Management time	❍ Lack of information
❍ Labor cost	❍ Landlord
❍ Equipment cost	❍ Water availability
❍ Lender	❍ Other _____

3. What information from CSU would be <u>most</u> useful for making water management decisions? Please describe: _____

_____

Water Concerns

1. Have you ever had your irrigation water analyzed?

❍ Yes ☞ When: *year* [ ]
❍ No

2. Are there any concerns about the quality of the water **on your farm**?

❍ No ❍ Yes: ❍ for crop production
❍ for livestock
❍ for household use
❍ other _____

3. Check ☑ any concerns that you have about water on your farm and/or in your county:

on your farm	in your county		on your farm	in your county	
❍	❍	erosion/sediment	❍	❍	water availability
❍	❍	metals	❍	❍	bacteria/pathogens
❍	❍	regulations	❍	❍	fertilizer
❍	❍	urban runoff	❍	❍	salinity (salts)
❍	❍	manure runoff	❍	❍	drought
❍	❍	selenium	❍	❍	urban competition
❍	❍	weed seeds	❍	❍	none
❍	❍	nitrate	❍	❍	other _____

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 estimated 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. Your response **will be kept confidential**. 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.