Fact sheet #19

Irrigation Best Management Practices: What Are Colorado Producers Using?

Irrigation for crop production diverts a large majority of all water used in Colorado. Coloradoans have a long history of irrigation innovation, but little is known about what updated practices producers are implementing. These innovations in irrigation practices may include new equipment, information systems, or management techniques designed to improve water distribution, uniformity, and efficiency. Collectively, these practices may be considered Best Management Practices (BMPs) because of their potential to improve water use efficiency and sustain water quality.

Colorado State University Cooperative Extension and the Colorado Department of Agriculture developed these BMPs with significant input from local producers and chemical applicators in several watersheds throughout the state. The goal of this work is to prevent degradation of water quality through voluntary adoption of BMPs by Colorado farmers. Colorado has elected to encourage the voluntary adoption of these BMPs rather than legislate overly restrictive measures on farmers and related industries.

This fact sheet was written by Troy Bauder, Reagan Waskom, Marshall Frasier, and Dana Hoag at Colorado State University in cooperation with the Colorado Department of Agriculture and the Colorado Department of Public Health and Environment. 8/99.

For more information contact the authors at 970/491-6102.

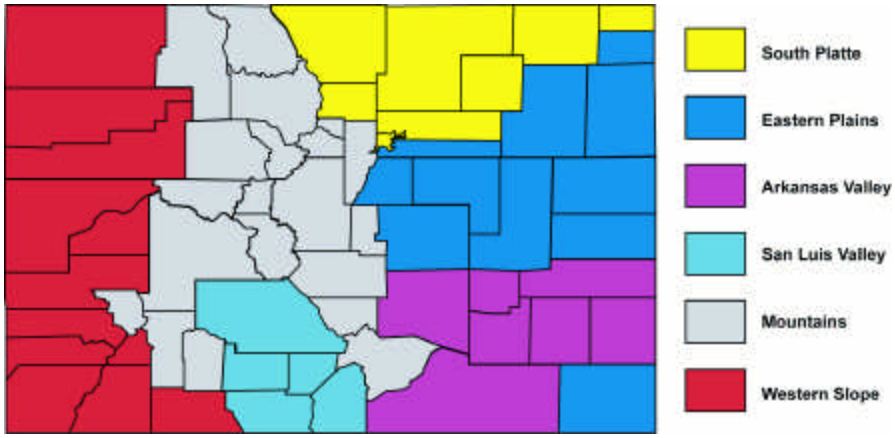

Figure 1. Regional grouping of survey responses by county given.

Table 1. Selected characteristics of responding farms.

Characteristic	Units	
Farm size	Average acres*	2009
	Median acres	480
Irrigated acres	Average	387
Irrigated area rented	Average %	29
Water Source:		
Ground water	Average % of acres irrigated	72
Surface water		28

*Average farm size was much larger than the median due to responses from a few very large operations.

Until now, there has been little quantified information on what irrigation BMPs Colorado producers are using and where they are being used. This information is necessary to conduct relevant educational programming and training in the areas and topics where it is most beneficial. The data is also helpful in documenting progress that Colorado producers are making in protecting water quality by improving their irrigation and to identify where more effort is needed.

To obtain information about BMP adoption, a written survey was conducted in February 1997. The survey was mailed to 3,281 producers who had at least 40 acres of cropland and irrigated at least one crop. The confidential survey asked producers about irrigation management and technology used in their operations and included questions about specific fertilizer and pesticide BMPs. Producers returned 1,319 usable surveys for a 40% response rate.

The survey consisted of 50 questions in five sections. Part of the survey asked about practices used anywhere on the farm, and part asked about a specific *Representative Field*. This report provides results of the survey related to irrigation BMPs for groundwater quality. More comprehensive results are provided in the technical report, "Irrigation Management in Colorado - Survey Data and Findings" (Colo. Ag. Expt. Station TR-99-5).

The results were grouped into six geographic regions for summarizing responses. (Figure 1). These regions were delineated based on known differences in water sources and cropping opportunities. General characteristics of the responding farms are provided in Table 1.

Survey Results

Properly timing water applications to fulfill crop demand is a basic irrigation BMP that greatly improves overall seasonal efficiency and eliminates unnecessary applications. The most reliable way to closely time water applications to crop demand is to schedule according to accumulated crop evapotranspiration (ET) and/or soil moisture depletion. Less than one-third of all the respondents indicated they used accumulated ET or depleted soil moisture to time their water applications. Figure 2 shows that "crop appearance" is the most popular determination of when to irrigate. Judging water stress through crop appearance usually is an inaccurate method of irrigation scheduling and can be deceiving even for experienced irrigators. Respondents choosing "other" often listed tradition and experience as their guiding mechanism.

These application-timing results vary considerably with the water source (Table 2). Producers with more control over when they can irrigate (groundwater pumpers) use ET and soil moisture more often and irrigated less by "fixed number of days" than surface water users. Groundwater users also tend to use a consultant more often to help schedule irrigation. Differences in timing water applications are also found between regions and irrigation systems as would be expected given the diversity of water sources and systems found across the state.

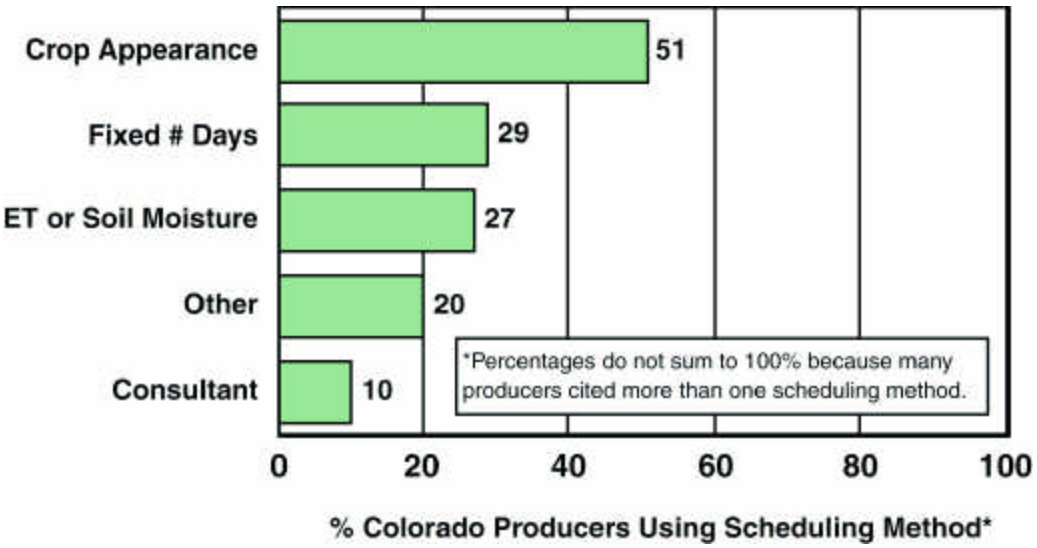

Figure 2. Results of the following question:
Check the ONE primary method that you used in 1996 to decide WHEN to irrigate.

Table 2. Differences in scheduling water application as affected by water source.

	Irrigation Timing Criteria				
Water Source	**Crop Appearance**	**Fixed Number of Days**	**Accumulated ET or Soil Moisture***	**Other Method**	**Consultant Determines**
	----------% Respondents Using Scheduling Method**----------				
Groundwater	41	24	38	10	29
Ditch Company	58	33	24	20	4
Direct Diversion	48	25	19	34	0

* Accumulated ET and soil moisture depletion was offered as two separate responses. However, most respondents indicating the use of one also indicated use of the other; therefore both practices are presented together.

** Percentages do not sum to 100% because many producers cited more than one scheduling method.

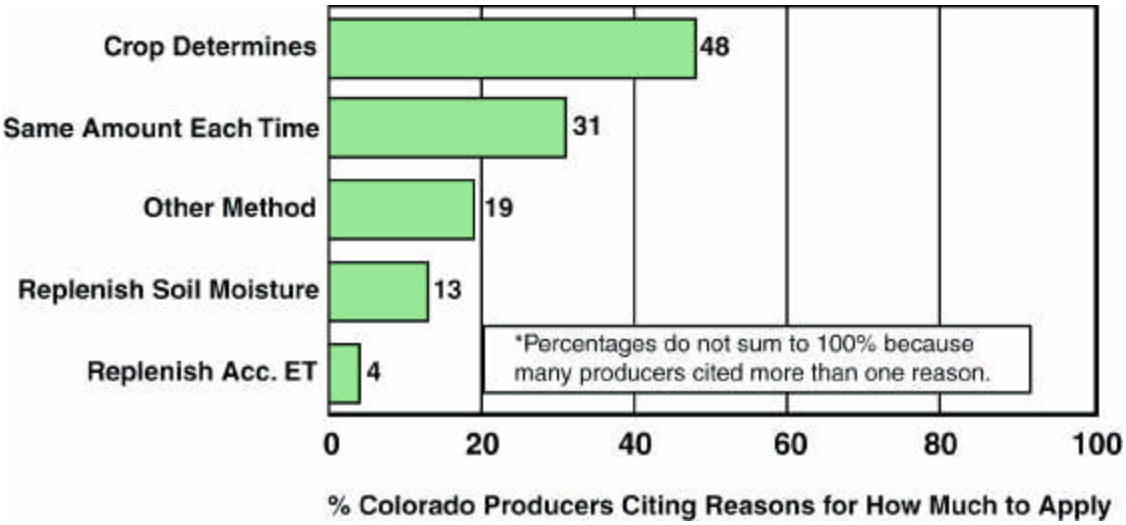

Figure 3. Results of the following question:

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

Table 3. Differences in amount of water applied as affected by water source.

	Amount of Water to Apply				
Water Source	**Crop Determines**	**Same Amount Each Time**	**Other**	**Replenish Soil Moisture**	**Replenish Accumulated ET**
	----------% Respondents Citing Reasons for How Much to Apply----------				
Groundwater	49	23	10	27	9
Ditch Company	51	33	21	7	2
Direct Diversion	38	33	29	7	2

Another fundamental irrigation BMP involves applying the water necessary to replace crop consumption. Respondents indicated that the "crop determines amount" of irrigation water to apply as the most commonly used method (Figure 3). We can infer from this that producers consider crop growth stage and accumulated ET when making an application decision. It is also possible that they were equating "crop determines amount" with the idea that crop appearance indicates how much water is needed. Interestingly, this response was a misprint, and the question was originally intended to read "Crop consultant determines amount". As with the irrigation timing method, groundwater users also base their application decisions more on ET and soil moisture and were less likely to apply the same amount each time than surface water users (Table 3).

Much of the survey consisted of questions regarding irrigation systems used and technology upgrades to these systems. These upgrades generally are designed to improve the uniformity of application and/or increase irrigation efficiency. Figure 4 characterizes upgrades to irrigation systems on respondents' *Representative Field*. These results suggest that producers choose to use some irrigation upgrades more often than implement management changes. Nearly all the respondents using center pivot irrigation systems installed at least one of the upgrades provided in the question. The frequency of upgrades decreases as the system changes to surface systems and side roll systems. Options available for upgrading systems such as center pivots are numerous, but the only way to upgrade a flood system is to change to a different system.

The upgrades most frequently selected were field leveling for surface systems and low pressure for sprinkler systems. One tool that is not used often is flow meters. This finding is consistent with the low number of people reporting knowledge of how much water they applied (Table 4).

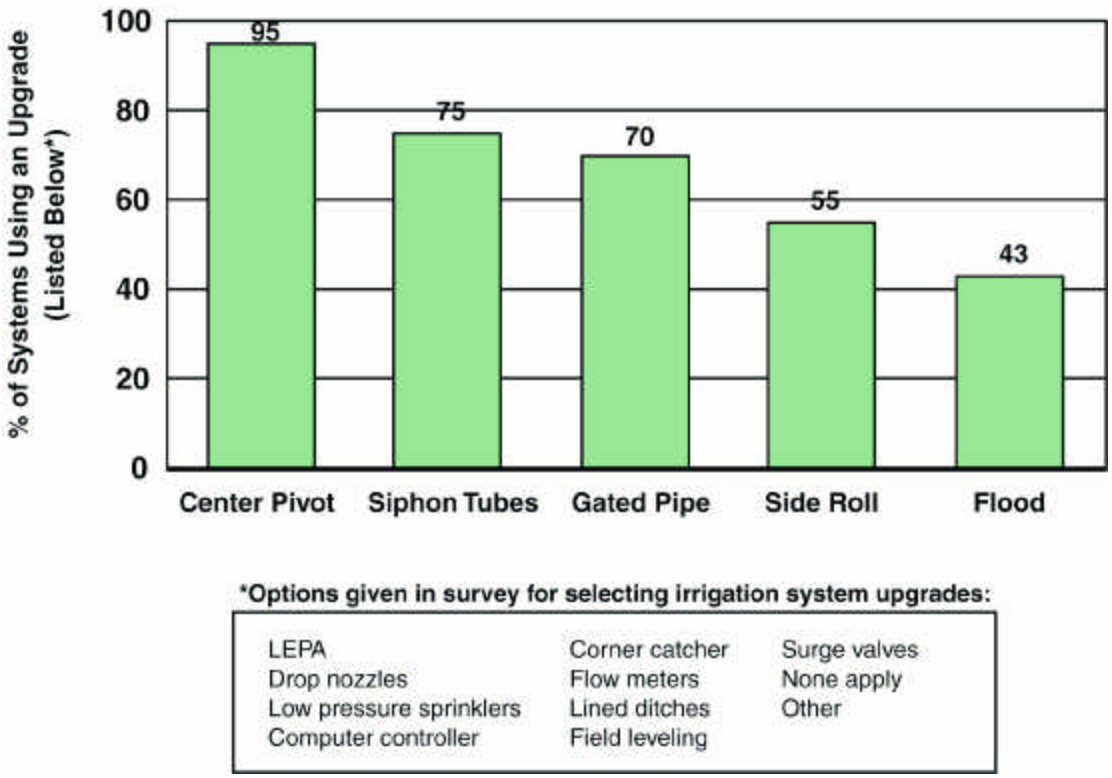

Figure 4. Results of the following question:

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

Table 4. Respondents knowing and keeping records on the amount of water applied*.

	Region						
	South Platte	Eastern Plains	Arkansas Valley	San Luis Valley	Mountains	Western Slope	Statewide Average
	----------% Respondents per Region----------						
Know Amount Applied	36	38	25	30	17	17	28
Keep Records	16	19	15	25	12	12	16

*Questions read: Do you know how much water was applied to the representative field in 1996?
Did you keep written or computerized records of water applied throughout the season?

Another significant finding from the survey was producers' perception of their *Representative Fields'* irrigation application efficiency (Figure 5) and their knowledge of the quantity of water applied (Table 4). Slightly over one-quarter of respondents reported they knew the amount of water applied to their *Representative Field*, and less than one-sixth of respondents indicated keeping records of water application. Sixty-eight percent of those producers who kept records knew their water application amount compared to 20% of those that did not. The majority of respondents indicated they knew system efficiency, but their estimates of application efficiency tended to be much higher than commonly measured values obtained from research and field demonstration projects, especially among surface irrigators.

Without knowledge of water application amounts and records of these applications, improvement in water management such as advanced scheduling techniques may be difficult to implement. This may also help irrigators plan water needs during drought years and assist in conflicts over water rights. Helping producers to realize the efficiency limits of their irrigation systems may help them irrigate in dry years and make improvements to their systems and management where feasible.

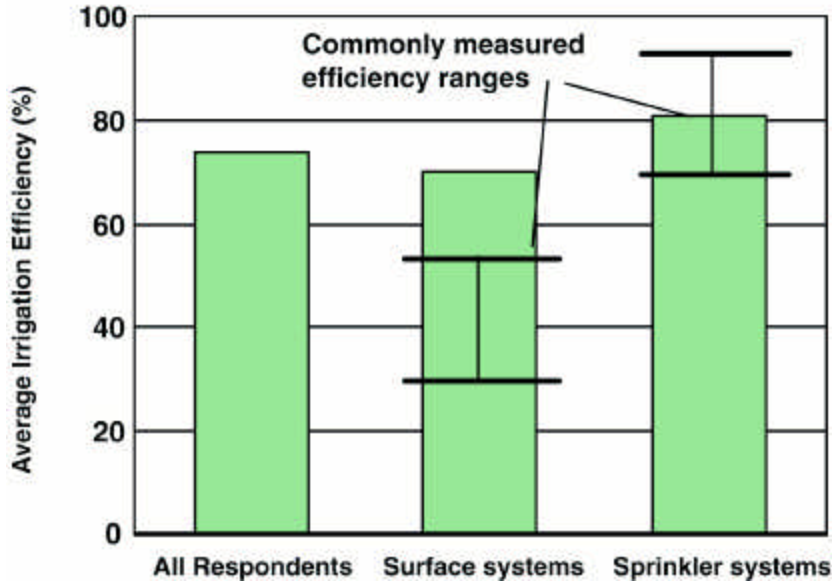

Figure 5. Result of the following question:

Check your best estimate of the system's average field application efficiency for 1996.
Application efficiency = crop use ÷ water applied

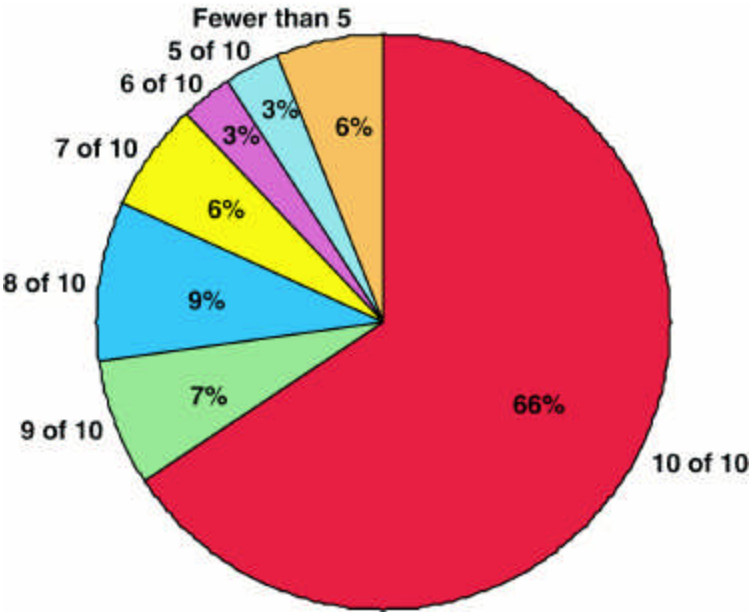

Figure 6. Results of the following question:

Check the number of years out of 10 that your water sources are able to provide a full water supply for the crops grown on the Representative Field.

Some Colorado producers have more opportunities and incentives to adopt new technologies and management techniques than others do. For example, Figure 6 shows that the majority (66%) of respondents statewide was not limited on their *Representative Field* by water sufficiency and had an adequate supply of water 10 years out of 10. However, some regions of the state (Arkansas Valley) are more limited in water supply and should have more incentive to adopt irrigation technologies and management strategies that conserve water (Table 5). These survey results suggest that stretching water supplies is not a significant incentive to change irrigation management for the majority of Colorado irrigating producers.

Table 5. Regional differences in water supply on respondents' *Representative Field*.

	Region						
Number of Years out of 10	**South Platte**	**Eastern Plains**	**Arkansas Valley**	**San Luis Valley**	**Mountains**	**Western Slope**	**Statewide Average**
	----------% of Respondents----------						
10	74	82	46	63	59	54	65
9	7	4	6	9	7	10	7
8	7	4	14	8	13	13	9
7	5	2	14	6	4	7	6
6	2	2	2	4	7	4	3
5	1	1	9	4	4	3	3
Fewer than 5	4	5	10	7	6	9	6

[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 6. Age of system installed on the *Representative Field* and irrigation experience of respondents.

	Irrigation System					
	Center Pivot	Side Roll	Gated Pipe	Siphon Tubes	Flood	All Systems
	---------- Average Years ----------					
Age of system	14	10	11	35	74	32
Irrigation experience	28	26	30	32	33	31

Irrigation management and technology adoption in Colorado is progressing, but many producers have not incorporated irrigation best management practices in their operations. The age of many irrigation systems and the average irrigation experience of Colorado irrigators may represent significant barriers to improving water management (Table 6). Colorado irrigators are highly experienced and may not perceive a need to make management changes. Additionally, most producers are apparently not motivated to keep an accurate accounting of crop water use and irrigation water applied. This may be partially explained by the fact that many irrigators feel their water supplies are adequate during most years. The management time and costs required to implement higher levels of water management may not be justified or economically feasible for these irrigators. However, the results of this irrigation survey show that Colorado irrigators will implement improved technology when it is practical, economical or when other significant motives exist. It may be inferred that higher levels of irrigation water management will be adopted in Colorado as farmers perceive an incentive to do so.

Robert P. Wawrzynski
Colorado Department of Agriculture
Division of Plant Industry
(303) 239-4151

Brad Austin
Colorado Department of Public
Health and Environment
(303) 692-3572

Reagan Waskom
Troy Bauder
CSU Cooperative Extension
(970) 491-6201