Bulletin 674
April 2011

Alabama Agricultural Experiment Station
William Batchelor, Director
Auburn University, Auburn, Alabama

Farm Operator Perceptions of Barriers to the Use of Irrigation in Alabama

J. J. Molnar, E. Sydnor, D. Rodekohr, M. Runge, and S. Fowler

INTRODUCTION AND OBJECTIVES

Though Alabama generally receives abundant rainfall, precipitation is often inconsistent during the summer months when plants are most in need of water (Ayars et al. 2006). Without irrigation, the productivity of tree crops, cereals, and vegetables diminishes, as does the livelihood of farmers that grow them (Bai 2008). Irrigation can provide water when plants need it most, reducing stress and enhancing yield quantity and quality (ACES 2011a). Understanding the barriers to the adoption of irrigation techniques is vital for increasing the use of such methods (Bjornlund, Nicol, and Klein 2009).

Much of the literature on irrigation adoption and management is based on conditions in arid regions that receive less than 6 inches (150 millimeters) of annual rainfall. Thus, frequent irrigation is necessary to maximize yields. Irrigation plays a different role in Alabama farming systems than it does in arid regions of the world, and it faces a different set of environmental constraints and advantages, in particular the abundance and reliable annual renewal of ground and surface water resources. Annual rainfall in Alabama averages more than 48 inches (1200 millimeters). But even in areas with abundant rainfall, drought stress can begin in as little as three days after a 25 millimeter rain or irrigation in such crops as tomatoes in soils like those in the Piedmont of Alabama (ACES 2011b).

This study profiles Alabama farm operators' irrigation practices, equipment, and water sources. Specifically, the study aims to identify the barriers to irrigation adoption and to provide information to policy-makers, farmers, and others to provide a greater understanding of how irrigation adoption affects the prosperity of small and medium-size farms (Whittenbury and Davidson. 2009). This report addresses farm operators' views on the needs and conditions shaping expanded use of irrigation among small, medium-size, and large farms. Objectives of the study were as follows:

- Profile the perceptions of irrigation technology as a risk reduction and productivity enhancement tool in Alabama agriculture;
- Measure attitudes, beliefs, and concerns about the barriers and impacts to the adoption of irrigation technology by Alabama producers; and
- Assess the willingness of Alabama farm operators to adopt irrigation technology.

BACKGROUND

In general, the sociological literature on agricultural innovation views the adoption of innovations as a decision-making process that is influenced by a variety of factors, including (1) characteristics of the farm; (2) characteristics of the decision maker, usually represented by the owner or manager; (3) characteristics of the technology or innovation itself; and (4) the social, institutional, and political context (Ajzen 1985; Branch and Poremba 1990).

Irrigation is used in many ways depending on the cropping system and size of operation. In general, irrigation is considered a lumpy input, which is a change in a farming system that cannot be adjusted in small quantities (Green et al. 1996). Typically, the capital investment required for larger applications cannot be recovered in a single season although a simple sprinkler system for a small vegetable farm might.

While the irrigation technology used in Alabama is similar to that used in arid regions, Alabama irrigators use that technology in quite different ways. Irrigation is a supplement to natural rainfall for most of the growing season in the State; irrigation provides a critical insurance that sufficient soil moisture will be available when needed during periods of drought or inconsistent rainfall. Farmers seek to install irrigation systems when expected returns justify the investment through yield stability, enhanced product quality, and reduced risk of crop loss (Sydnor 2010; Molnar, Bitto, and Brant 2001).

Molnar is a professor, Sydnor a graduate student, Runge an Extension program associate, and Fowler an associate professor in the Department of Agricultural Economics and Rural Sociology. Rodekohr is an advisor in the Department of Agronomy and Soils. All are at Auburn University.

From an economic constraint perspective, adoption is limited by bank monetary and loan policies, farm assets and liabilities, and the cost-returns on the irrigation investment. Government policies that cost-share, subsidize, or limit irrigation use also affect operators' decisions (Dinar, Campbell, and Zilberman 1992). Bjornlund et al. (2008) argue that the major drivers of irrigation adoption are securing water availability to plants during drought, increasing quantity and quality of crops, and saving costs. In an Australian study, the motivation for growers of tree crops to change orchard irrigation management practices was not that they needed to save water or to increase water-use efficiency. Instead, growers were changing practices in order to save time irrigating, to improve the scope for managerial flexibility in the orchard, or when redeveloping their orchard for a closer planting design (Boland, Bewsell, and Kaine 2005). These findings suggest that producers are more likely to respond to an extension program coupled with a broader program of farm changes.

Drainage policies and water scarcity are generally not limiting factors for the advancement of irrigation practice in Alabama as they are in the arid west. However, diverse and fragmented farm landscapes, uncertain market conditions, and operator perspectives on new technologies often shape the advance of agricultural technologies in the State (Negri and Brooks 1990).

METHOD

Sample and Data Collection

This study uses survey data from a statewide sample of Alabama farm operators to explore barriers to the adoption of irrigation. Survey data were collected by mail using a self-administered survey instrument adapted from the 2003 USDA Census of Agriculture Farm and Ranch Irrigation Survey. It also addressed issues specific to Alabama, such as producer knowledge of State water requirements.

The questionnaire was a 12-page document, following the Dillman method (Dillman, Smyth, and Christian 2009). Along with a cover page, an informational letter was incorporated into the questionnaire. The questionnaire included 32 questions of primarily Likert-type form. An additional page was provided for any open-ended producer comments. The survey was distributed by the United States Department of Agriculture National Agricultural Statistics Service (USDA NASS) in Montgomery, Alabama, through its regional print mail center in Jackson, Mississippi.

The target population consisted of producers who farm 100 or more acres of land in field crops or produce, as well as those with 15 or more fruit, nut, or vegetable acres. The sampling frame for this study was the USDA NASS list of agricultural row crop, vegetable, and fruit-tree crop farmers in Alabama. This list is continually updated by obtaining current information from a variety of local and state sources. A random sample of farmers was surveyed about the extent of their irrigation practices and the problems they experienced in the irrigation process.

Analysis

The tables presented in this report tabulate the survey data in terms of whether or not the farm was irrigated in the previous year and the size of the operation. Farm size was represented in three categories of total farm acres that divided the sample into relatively equal groups: small, less than 200 acres (N = 266); medium, 201 to 800 acres (N = 264); and large, more than 800 acres (N = 264). This study did not consider type of commodity produced per se, as there were small numbers of respondents in the sample, across many different vegetable, field, and tree crops.

The column heading "all" refers to percentages for all respondents across farm size category and irrigator status. The percentages refer to the proportion of that column that responded "yes" to the particular survey item or ticked the indicated response, e.g., "some" or "agree."

We annotated statistically significant differences by size and irrigation status according to chi-square (X^2) tests on cell frequencies but focused mainly on patterns of percentage response to the survey items. The sample is largely representative of the population of Alabama farm operators from which it was drawn. The narrative reviews the pattern of responses across farm size among irrigating and nonirrigating farms. We note the overall distribution of responses and identify trends or contrasts in response that contribute to understanding the objectives of the study.

RESULTS

Reasons for Not Irrigating

Table 1 tabulates a series of reasons for not using irrigation by whether or not the operator used irrigation and the size of the operation. The reasons are listed in ranked order according to the proportion of the overall sample that cited each reason.

Sufficient soil moisture was the most frequently cited reason for not irrigating for all the producers and the responses did not vary across categories of the tabulation variable. Rain saves energy costs as well as wear and tear on equipment.

About two-thirds of the operators without irrigation said that not being able to afford the investment required was the main reason that they did not use irrigation. Among those with some form of irrigation already in use on their farms, about a third cited the investment required as a reason for not irrigating. The asterisk in the table notes that this difference and others were statistically significant across categories of farm size and irrigation status.

Small profit margins were mentioned as a barrier by about half of those without irrigation, but only a quarter of those with irrigation. The largest percentage among the irrigators, 31 percent of the large farm operators, said that profit margins were a reason for not irrigating.

High energy costs were indicated as a reason for not irrigating by about half of those presently without irrigation. Energy costs were cited by 11 percent of the small operations, but 28 percent of the large operations noted energy costs as a reason for not irrigating.

A shortage of surface water was a reason given by nearly half the nonirrigating farmers. Among those with irrigation, 34 percent of the large operators cited water supply limits as a reason for not irrigating, compared to 11 percent of small operators.

A shortage of ground water was a problem for a third of the respondents. It was a reason for not irrigating for nearly 40 percent of those without irrigation and was more of a problem for large farms than small farms.

Not irrigating because one does not own the land was a reason given by 29 percent of all operators. Large farm operators (both irrigating and nonirrigating) were more likely to cite this reason for not irrigating. Investing in land one rents may not make sense without a long-term lease, cost-sharing arrangements with the land owner, or compensation provisions in the event the lease is not renewed. Larger systems require larger investments and longer payback periods.

Table 1. Reasons for Not Irrigating, Alabama Farm Operators, 2009

	Acreage size						
	—Nonirrigating—			——Irrigating——			All
Reasons for not irrigating	Small[1]	Med.	Large	Small	Med.	Large	
	percent						
Sufficient soil moisture	74	71	76	68	75	77	74
Could not afford the investment**	61	76	73	27	34	34	61
Profit margins are too small to invest in irrigation equipment**	52	63	61	24	27	31	51
Irrigation is uneconomical due to high energy costs*	42	55	55	11	20	28	43
Did not irrigate due to a shortage of surface water*	32	47	46	11	14	34	37
Did not irrigate due to a shortage of ground water*	27	44	42	13	7	24	33
Do not own the land that could be irrigated*	22	32	44	8	14	31	29
Plan to quit farming **	23	19	16	5	7	5	16
Hard to get reliable information on different irrigation methods	17	19	20	6	9	5	16
Irrigation equipment failure**	6	7	11	7	7	17	9
Pollution of water source	4	4	6	3	0	0	4
Neighbors object to irrigation operation	2	4	6	2	0	2	3
Number	***204***	***220***	***178***	***62***	***44***	***86***	***794***

[1]Chi-square test: *p < .05; **p < .001

Not irrigating because the operator planned to quit farming was cited by 23 percent of the small farm operators without irrigation. Seven percent or less of the operators with irrigation noted this reason.

About 16 percent of those sampled said that a lack of reliable information on irrigation methods was a reason for not irrigating. Equipment failure was more a problem for large farm operators, 9 percent. Water pollution was a reason cited by 4 percent of the sample, mainly for those without irrigation systems already in place. Neighbors' objections were again more of a problem for those without irrigation and larger operations, 3 percent overall.

Barriers to Implementation

Table 2 presents a series of potential barriers to installing or improving irrigation systems tabulated by farm size and use of irrigation. The items are ordered in terms of proportion of the sample. The percentages summarize the proportion citing each items as "some" or a "great" barrier.

Installation costs were the most frequently cited barrier to implementation or improvement, 64 percent overall. More of those with presently installed systems cited this reason, perhaps because they were more directly familiar with actual costs. This was true for each size category, but operators of large farms cited this barrier the most, 78 percent.

High energy costs were mentioned by 62 percent of the respondents. Small operators were less sensitive to this barrier.

Financing the improvements was a barrier for 57 percent of the sample although fewer small operators cited this barrier. About half the sample indicated that the returns from irrigation would not cover installation costs. Operators of large farms were more likely to feel this way. They also tended to feel that irrigation system operating costs were too risky. About half the sample indicated this as "some" or a "great" barrier.

Lack of a reliable source of water was a barrier for 44 percent of all respondents. More medium-size and large operations indicated this as a barrier.

About 38 percent said that getting good advice on how to make irrigation pay was a problem. More medium-size farm operators indicated this.

About a third felt that water conservation improvements had no economic benefits. A similar proportion, mainly nonirrigators, felt that irrigation takes too much time to organize and manage. A third, particularly the nonirrigators, felt that irrigation was not worth the trouble to keep it going.

About a quarter of the respondents felt that not having other farmers around them using irrigation was a problem. Somewhat less felt that difficulty in obtaining replacement parts was a barrier to implementing or improving irrigation.

Table 2. Barriers to Implementing or Improving Irrigation, Alabama Farm Operators, 2009

Barriers to installing or improving irrigation	Acreage size: Nonirrigating Small[1]	Nonirrigating Med.	Nonirrigating Large	Irrigating Small	Irrigating Med.	Irrigating Large	All
	percent						
Installation cost*	51	69	69	55	71	78	64
Energy costs are too high**	49	70	66	55	61	69	62
Cannot finance the improvements, even if they reduce costs**	49	64	58	47	61	59	57
Improvement(s) will reduce costs, but not enough to cover installation	42	52	55	40	61	69	51
Irrigation system operating costs are too risky**	44	58	60	34	36	42	50
No reliable source of water on my place**	32	53	52	27	27	51	44
Cannot get good advice on how to make irrigation pay**	35	45	42	27	41	25	38
Do not need irrigation for the way I farm**	36	47	33	26	23	24	36
Improvements that conserve water have no economic benefit	28	34	38	36	34	37	34
Takes too much time to organize and manage**	32	42	37	31	18	19	34
Not worth the trouble to keep it going**	31	33	35	31	16	22	33
Landlord(s) will not share in cost of improvements**	17	38	47	16	18	47	33
No other farmers around here irrigate**	26	38	30	21	16	8	27
Hard to get replacement parts when I need them**	17	26	22	15	16	21	21
Number	***204***	***220***	***178***	***62***	***44***	***86***	***794***

[1]Chi-square test: *p < .05; **p < .001

Helpfulness of Irrigation Information Sources

Table 3 represents how helpful various outlets of information were in implementing or improving irrigation. Respondents described each as "somewhat helpful," "very helpful," or "not helpful." The percentages shown are the proportion rating each information source as "not helpful." The items are ordered based upon the proportion rating the information source as "not helpful."

Media reports and information from the press was the most "not helpful" information source of those listed, with 59 percent rating them as "not helpful." This may be due to the generality and lack of practical insight available from these sources.

Private irrigation specialists or consultants (45 percent) and the Alabama Office of Water Resources (44 percent) were ranked next as "not helpful" sources of information about implementing or improving irrigation. Operators of medium-size farms with irrigation particularly found the Alabama Office of Water Resources to be "not helpful," 79 percent.

More than a third (37 percent) of respondents found Internet websites to be "not helpful" as well. While the Internet may be an easily accessible form of information, it may not offer the specificity desired for a complex farm situation.

Less than a third rated USDA-NRCS specialists as "not helpful"; however, small farm operators with irrigation were particularly critical, 54 percent.

Small farm operators (both with and without irrigation) gave more "not helpful" ratings to irrigation equipment dealers than did medium-size or large farm operators. Extension specialists and Auburn University researchers received "not helpful ratings" from less than 30 percent of the sample.

Respondents found other farmers with irrigation to be the least "not helpful" and informative about irrigation; less than a quarter of farmers (23 percent) found their peers to be "not helpful" information sources.

Table 3. Irrigation Information Sources Rated as Not Helpful, Alabama Farm Operators, 2009

	Acreage size						
	—Nonirrigating—			——Irrigating——			All
Information sources	Small[1]	Med.	Large	Small	Med.	Large	
	percent						
Media reports or information from the press*	59	54	47	69	75	74	59
Private irrigation specialists or consultants*	56	41	30	62	49	53	45
Alabama Office of Water Resources**	39	37	30	68	79	57	44
Internet websites*	41	35	27	50	38	47	37
Specialists from the USDA-Natural Resources Conservation Service*	36	27	21	54	47	31	31
Irrigation equipment dealers**	47	36	21	42	22	13	31
County or regional extension agents*	33	26	19	36	31	38	29
Auburn University specialists or researchers*	31	24	13	38	40	19	25
Other farmers with irrigation *	34	24	12	32	16	17	23
Number	***101***	***140***	***116***	***39***	***35***	***73***	***504***

[1]Chi-square test: *p < .05; **p < .001

Information sources about irrigation include Extension agents and Internet websites.
Source: www.aces.edu/anr/irrigation

Type of Irrigation Systems

Table 4 shows the type of irrigation systems employed by respondents. Due to the questionnaire format, many respondents skipped this set of questions. Thus, the level of those not reporting is high.

Center pivots were the most commonly used irrigation system, particularly among medium-size and large farm operators. Low pressure pivots were most common among small operators, as were sprinkler systems. About 70 percent of the respondents said they used another system or did not report.

Types of irrigation systems used by Alabama farm operators include center pivot (above, top), sprinkler (above), and drip (right).

Table 4. Type of Systems, Alabama Farm Operators, 2009

Type of systems	Acreage size — Irrigating — Small	Medium	Large	All
	percent			
Center pivot high pressure (60+ PSI)*	5	18	16	13
Linear and wheel move systems	8	2	4	5
Center pivot medium pressure (30 to 59 PSI)	0	7	5	4
Drip, low flow, or trickle	2	5	2	3
Center pivot low pressure (< 30 PSI)	3	2	2	3
Sprinkler irrigation*	7	0	0	2
Hand move method	0	0	0	0
Other system or not reporting	76	66	71	71
Number	***62***	***44***	***86***	***192***

[1]Chi-square test: *p < .05; **p < .001

Reasons to Discontinue Irrigation

For those farmers who had to discontinue irrigation in 2008 long enough to affect crop yields, Table 5 tabulates a series of possible reasons for doing so. The reasons are listed in ranked order according to the proportion of respondents out of the overall sample who discontinued due to that reason. Respondents cited each as "somewhat of a reason" or "a major reason" for discontinuing irrigation. The percentages shown are the sum of the two ratings.

About a quarter of respondents, 26 percent, reported discontinuing irrigation in 2008 long enough to affect crop yields. The most commonly cited reason for doing so was a shortage of surface water, 12 percent. Another 5 percent discontinued irrigation due to a shortage of ground water.

Ten percent stopped irrigation due to irrigation equipment failure, which may cost money to repair or reflect delays in getting service. Also, water pumping costs were a cause of irrigation cessation for 6 percent of respondents. The cost of water was another reason for discontinuing irrigation in 2008, as reported by 4 percent of the total sample.

However, poor water quality, problems with hired labor, and loss of water rights accounted for only 4 percent of irrigation discontinuation. Thus, financial considerations seem to play a central role in irrigation discontinuation, whether money is spent for the repair of irrigation equipment, for water from off-farm sources due to water shortages, or for pumping costs.

Table 5. Reasons for Discontinuing Irrigation, Alabama Farm Operators, 2009

	——Acreage size——			
	——Irrigating——			All
Reasons for discontinuing irrigation	Small	Medium	Large	
	percent			
Discontinued irrigation in 2008 long enough to affect crop yields	17	23	34	26
Shortage of surface water*	3	14	19	12
Irrigation equipment failure	7	7	15	10
Pumping cost	3	7	7	6
Shortage of ground water	3	2	8	5
Irrigation cost of water	7	7	1	4
Poor water quality	2	2	2	2
Problems with hired labor	2	0	2	1
Loss of water rights	0	2	1	1
Number	***62***	***44***	***86***	***192***

[1]Chi-square test: *p < .05; **p < .001

Sources of Irrigation Water

Table 6 shows which sources respondents used most frequently for irrigation water. The respondents' usage of the listed sources is ranked in order according to the proportion of the overall sample. Respondents ranked the sources as either "some" of their water source or the "main source" of irrigation water for their system.

Most respondents reported using water that was on their farm or nearby for irrigation. Fifty-two percent reported using ground water from a well(s) located on their own farm or another farm (some, 24 percent; main source, 28 percent). The highest percentage, 47 percent, was among operators of small farms.

Overall 44 percent used an on-farm flowing surface supply, such as a stream, spring, or river. Most of these producers were on large farms; 67 percent of large farms used such sources to some extent as irrigation water and 33 percent used on-farm flowing water as their main source.

Forty-one percent of producers reported using an on-farm standing water body surface supply, such as a lake, pond, or reservoir, as a source of irrigation water; 19 percent used a standing water body for some, and 22 percent as their main source of irrigation water.

Seventeen percent of respondents reported paying for irrigation water. More than a third of the small operators paid for water, while only 2 percent of the large operators did so. Twelve percent of the respondents reported getting some or most of their irrigation water from off-farm water suppliers, such as a commercial company or municipal or community water system (some, 4 percent; main source, 8 percent). Most of these respondents were from small farms, with 18 percent using off-farm water suppliers as their main source and 7 percent for some of their water sources. No large farm operators reported using off-farm suppliers.

Table 6. Sources of Irrigation Water, Alabama Farm Operators, 2009

Sources of irrigation water	Response	Acreage size—Irrigating—Small	Med.	Large	All
		percent			
Did you have to pay for water for irrigation?**	Yes	36	14	2	17
Ground water from a well or wells located on this farm or another farm**					
	Some	11	31	30	24
	Main Source	47	16	22	28
On-farm flowing surface supply (stream, spring, or river)*					
	Some	7	21	34	20
	Main Source	13	27	33	24
On-farm standing water body surface supply (lake, pond or reservoir)**					
	Some	7	19	31	19
	Main Source	18	27	21	22
Off-farm water suppliers (commercial company or community water system)**					
	Some	7	5	0	4
	Main Source	18	7	0	8
Number		***62***	***44***	***86***	***794***

[1]Chi-square test: *p < .05; **p < .001

A reservoir is one type of on-farm standing water body used for irrigation by Alabama farmers.

Energy Source for Pumping Water

Table 7 shows which energy sources respondents used most frequently for pumping irrigation water. The items are ordered in terms of proportion of the entire sample. Respondents checked all that applied to their irrigation operation.

Diesel and electricity were the most highly reported sources of energy for pumping irrigation water, 51 percent each. Diesel was the main source of energy for 83 percent of the large farms and 50 percent of medium-size farms, but only 21 percent of small farms.

Electricity with regular farm rates was also reported to be used by 51 percent of respondents; it was used most frequently by small farm operators (57 percent), 52 percent of medium-size farm operators, and 44 percent of large farm operators for pumping. Electricity with special farm rates was used by only 5 percent, mostly by large farm operators (8 percent).

Only 9 percent reported using water pressure from a water system as an energy source for pumping water. Of these operators, 19 percent were from small and 7 percent were from medium-size farms, while no large farmer operators reported using water pressure for pumping.

Gasoline was used by 7 percent, mostly by operators of medium-size farms (11 percent). Wind or other natural sources were the least-used energy source reported, used by only 2 percent. Five percent of small farm operators used wind or another natural source, no operators of medium farms did, and only 1 percent of operators of large farms used natural energy sources.

Table 7. Energy Sources for Pumping Water, Alabama Farm Operators, 2009

	Acreage size — Irrigating			
Sources of energy	Small	Medium	Large	All
	percent			
Diesel**	21	50	83	51
Electricity (regular farm rates)	57	52	44	51
Water pressure from water system**	19	7	0	9
Gasoline	8	11	2	7
Electricity (special farm rates)	3	2	8	5
Wind or another natural source	5	0	1	2
Number	***62***	***44***	***86***	***192***

[1]Chi-square test: *p < .05; **p < .001

Purpose for Using Irrigation

Table 8 shows the extent to which respondents irrigated three categories of crops. The items are ordered in terms of proportion of the entire sample. Respondents indicated whether they irrigated row crops, fruit or vegetables, or pasture or hay land to "some" extent or if those crops were irrigated the "most."

Overall, 41 percent of all respondents irrigated some or most of their row crops. Row crops such as corn, cotton, and soybeans were irrigated to some extent by 26 percent and were irrigated the most by 15 percent. Operators of medium-size and large farms each irrigated row crops 52 percent. Only 20 percent of small farm operators, however, irrigated row crops to any extent.

Forty-nine percent of respondents irrigated their fruit, vegetable, horticulture, or specialty crops in 2008 (some, 26 percent; most, 23 percent). The greatest percentage of operators irrigating these types of crops operated small farms; 45 percent of small farm respondents irrigated them to some extent and 36 percent for the most part. Large farm operators irrigated these types of crops the least, 19 percent.

Only 14 percent of respondents reported irrigating pasture or hay land at all (some,12 percent; most, 2 percent). Operators of medium-size farms reporting irrigating pasture or hay land more than small or large farm operators, 18 percent.

Table 8. Purpose for Using Irrigation, Alabama Farm Operators, 2009

		——Acreage size——			
		——Irrigating——			All
Purposes for irrigation use	Response	Small	Med.	Large	
		percent			
Row crops such as corn, cotton, soybeans, etc.**					
	Some	15	32	30	26
	Most	5	18	22	15
Fruit, vegetables, horticulture, or specialty crops**					
	Some	45	18	14	26
	Most	36	30	5	23
Pasture or hay land**	Some	7	16	14	12
	Most	3	2	1	2
Number		***62***	***44***	***86***	***192***

[1]Chi-square test: *p < .05; **p < .001

Drip irrigation is used for tomato production by some Alabama farm operators.

Secondary Uses of Irrigation

Table 9 represents the percentage of farmers who used irrigation for any number of secondary purposes, aside from simply supplying water to their crops. The items are ordered in terms of proportion of the entire sample. Respondents indicated all secondary uses that applied to their operation.

Thirty-nine percent of all respondents reported using irrigation for at least one other purpose other than watering crops. The most common secondary use of irrigation in 2008 was irrigation used to apply chemical fertilizers, 17 percent. Medium-size farm operators reported this purpose more than their small and large peers, 21 percent.

Crop cooling was the second most common other use, with 12 percent of all respondents using irrigation for this purpose. Nine percent reported using irrigation to prevent freeze damage. Operators of medium-size farms reported using irrigation for this purpose the most, 16 percent, with 8 percent of small farm and 4 percent of large farm operators using irrigation this way.

Only 3 percent of all respondents used irrigation to apply pesticides; no large farm operators used irrigation for this purpose; however, 7 percent of small farm operators and 2 percent of medium-size farm operators did.

About 3 percent used irrigation for other purposes, such as land disposal of liquid livestock waste. No small farm operators reported unspecified other uses, but 7 percent of medium-size farm operators and 4 percent of large farm operators did find other uses for irrigation in 2008.

Table 9. Secondary Uses of Irrigation, Alabama Farm Operators, 2009

	Acreage size — Irrigating			
Secondary uses of irrigation	Small	Medium	Large	All
	percent			
Irrigation used for any secondary purposes	42	41	35	39
Used to apply chemical fertilizers	16	21	14	17
Crop cooling to delay early budding, blooming, or to reduce heat stress	10	14	12	12
Prevent freeze damage*	8	16	4	9
Other: land disposal of liquid livestock waste, etc.	0	7	4	3
Used to apply pesticides	7	2	0	3
Number	***62***	***44***	***86***	***192***

[1]Chi-square test: *p < .05; **p < .001

How Farmers Decided When to Irrigate

Table 10 tabulates a series of methods farmers used for deciding when to use irrigation by the size of the operation. The reasons given are listed in ranked order according to the proportion of the overall sample that cited each reason. Farmers indicated all methods that they used in 2008.

Technology was not widely used to make decisions on water application by Alabama operators. The majority of respondents, 81 percent, decided whether to apply water to their crops by observation of crop condition. An overwhelming 93 percent of large farm operators used crop observation, along with 86 percent of medium-size farm operators and 63 percent of small farm operators.

Forty percent of all respondents used the feel of the soil as the basis for deciding when to apply water to their crops. Only 9 percent used soil moisture sensing devices, and only 4 percent based their decision to irrigate based on media reports on crop-water needs. Another 4 percent decided when to apply water by computer simulation models, and only 2 percent used a commercial scheduling service. Fourteen percent of the total population, however, applied water based on some other unspecified method.

Respondents, then, typically did not use more technically based methods to decide when to apply water. Instead, they relied on their own knowledge of crop and soil conditions to decide for themselves when to irrigate.

Table 10. Basis for Deciding When to Apply Water, Alabama Farm Operators, 2009

	——Acreage size——			
	——Irrigating——			All
Basis for deciding when to use irrigation	Small	Medium	Large	
	percent			
Observation of crop condition**	63	86	93	81
Feel of soil	36	43	41	40
Applied water based on other methods	16	11	14	14
Use of soil moisture sensing devices	7	11	8	9
Decided when to apply water by computer simulation models	2	5	7	4
Media reports on crop-water needs	8	0	5	4
Use of commercial scheduling service	2	2	1	2
Number	***62***	***44***	***86***	***192***

[1]Chi-square test: *p < .05; **p < .001

Information from soil moisture sensing devices (Watermark soil moisture sensor, left, and electronic meter, right) is used by some Alabama farm operators as a basis for deciding when to use irrigation.
Source: Moisture Sensor Agricultural Irrigation Design Manual
www.irrometer.com/pdf/supportmaterial/ADG2006.pdf

Irrigation Improvements Implemented in 2008

Table 11 tabulates a number of irrigation improvements farmers may have made in 2008 by the size of the operation. The improvements made are listed in ranked order according to the proportion of the overall sample. Farmers were asked to indicate all improvements that they made in 2008 from a list provided in the survey.

Thirty-two percent of all farmers expanded acres covered by irrigation in 2008, and producers with large farms expanded irrigation the most, 40 percent. Twenty-two percent of all farmers retrofitted a sprinkler system for a low pressure operation, again with larger farms in the lead, 34 percent.

Twenty percent of all farmers made irrigation changes that reduced water requirements and 19 percent made changes that decreased energy costs; more large farm operators made these two types of changes than medium-size and small farm operators, with 22 percent of all large farm operators trying to reduce water requirements and 30 percent decreasing energy costs.

Another 17 percent of the total sample made irrigation changes that improved crop yield or quality. But this time, more medium-size farm operators made these types of changes the most, 23 percent, as compared to 18 percent of small farm operators and 13 percent of large farm operators. Medium-size farm operators also adopted irrigation scheduling as a management practice the most, 16 percent, compared to 13 percent of small farm operators, only 7 percent of large farm operators, and 11 percent of all respondents.

Ten percent of all respondents changed their energy source for pumping, and three percent of all respondents added moisture instrumentation.

Table 11. Irrigation Improvements Implemented, Alabama Farm Operators, 2009

	——Acreage size——			
	——Irrigating——			All
Irrigation improvements implemented in 2008	Small	Medium	Large	
	percent			
Expanded acres covered by irrigation*	24	27	40	32
Retrofitted sprinkler system for low pressure operation**	8	18	34	22
Made irrigation changes that reduced water requirements	18	18	22	20
Made irrigation changes that decreased energy costs**	7	16	30	19
Made irrigation changes that improved crop yield or quality	18	23	13	17
Adopted irrigation scheduling as a management practice*	13	16	7	11
Changed energy source for pumping	3	9	15	10
Added moisture instrumentation	3	0	5	3
Number	***62***	***44***	***86***	***192***

[1]Chi-square test: *p < .05; **p < .001

Expenditures Made in 2008 for Irrigation Equipment

Table 12 tabulates the expenditures farmers may have made in 2008 for irrigation equipment by the size of the operation. The possible expenditures made are listed in ranked order of the percent selecting "major outlay" spent on for each irrigation improvement, according to the proportion of the overall sample. Farmers indicated all expenditures that they made in 2008 and whether they spent "some" money or the "major outlay" of their expenditures on any particular irrigation equipment.

As shown in Table 12, the most common expenditure irrigating producers reported making in 2008 was the purchase or replacement of irrigation equipment and machinery, with 50 percent of all respondents spending money on this. Thirty-nine percent of all respondents spent some money on new or replacement equipment, and 11 percent spent the major outlay of their irrigation expenditures on such items. Purchasing or replacing irrigation equipment or machinery was the most common expenditure for all sizes of farms—small (42 percent overall), medium (48 percent overall), and large (50 percent overall).

The second most highly reported expenditure for irrigation in 2008 was building or improving permanent storage and distribution systems, with a total of 19 percent of respondents spending money on this particular type of improvement. Fifteen percent spent some money on building storage and distribution systems, and 4 percent spent what they considered a major outlay.

Thirteen percent of respondents cleared and leveled land for irrigation purposes, but only 2 percent spent a major outlay on this type of irrigation project. Nine percent of the total sample (some, 5 percent; major outlay, 3 percent) made expenditures for new well construction or the deepening of existing wells.

Table 12. Expenditures Made in 2008 for Irrigation Equipment, Alabama Farm Operators, 2009

		——Acreage size——			
		——Irrigating——			All
Expenditures for irrigation equipment, 2008	Response	Small	Med.	Large	
		percent			
Purchase of new or replacement irrigation equipment and machinery*					
	Some	37	32	44	39
	Major outlay	5	16	13	11
Building or improving permanent storage and distribution system					
	Some	16	14	15	15
	Major outlay	3	7	1	4
Land clearing and leveling for irrigation purposes					
	Some	8	9	14	11
	Major outlay	2	2	2	2
New well construction or deepening of existing wells					
	Some	5	5	7	6
	Major outlay	2	2	5	3
Number		***62***	***44***	***86***	***192***

[1]Chi-square test: *p < .05; **p < .001

Annual Farm Income Sources

Table 13 tabulates the average percentage of annual farm income sources by whether or not the farmer used irrigation and the size of the operation. The farm income sources are listed in ranked order according to the proportion of the overall sample receiving "some" or "most" of farm income from each.

A substantial number of respondents indicated that they receive just some of their annual farm income from government agricultural payments, 55 percent, while only 2 percent received most of their annual farm income from such subsidies. Large farms, both nonirrigating and irrigating, reported making some of their income from such government agricultural payments. Eighty percent of nonirrigating large farms and 84 percent of irrigating large farms received some income from government agricultural payments, compared to 20 percent of nonirrigating small farms and 18 percent of irrigating small farms.

Fifty-nine percent of the respondents reported row crops, such as corn, cotton, and soybeans, to be their highest source of annual farm income overall in 2008. Forty-one percent received most of their farm income from row crops, and 18 percent of the total sample received at least some of their annual farm income from this type of produce. More large farms received the most income from row crops than any other size farm; 61 percent of nonirrigating large farms and 69 percent of irrigating farms made most of their income from row crops.

Forty-five percent of respondents indicated that they earned income from livestock, such as cattle, hogs, and sheep. Thirty-one percent made some and 14 percent made most of their annual farm income from livestock.

Only 26 percent of producers indicated that they made any annual farm income from fruit, vegetable, horticulture, or specialty crops in 2008 (some, 14 percent; most, 12 percent). More small farmer operators reported making most of their income from these types of crops than medium and large farm producers; 17 percent of nonirrigating and 55 percent of irrigating small farm operators made most of their annual farm income from fruit, vegetable, horticulture, and specialty crops. This may be due to demand, commodity prices, and the labor intensity for these types of crops.

Only 6 percent of all respondents made any income from poultry, including contract broilers and eggs, in 2008. Three percent reported making most of their annual farm income from poultry.

Table 13. Farm Income Sources, Alabama Farm Operators, 2009

Annual farm income sources	Response	Acreage size: Nonirrigating Sm.[1]	Nonirrigating Med.	Nonirrigating Lg.	Irrigating Sm.	Irrigating Med.	Irrigating Lg.	All
		percent						
Government agricultural payments**								
	Some	20	67	80	18	61	84	55
	Most	2	3	3	0	0	1	2
Row crops such as corn, cotton, soybeans, etc.*								
	Some	13	25	15	13	23	23	18
	Most	19	44	61	13	41	69	41
Livestock such as cattle, hogs, sheep, etc.**								
	Some	18	35	39	18	41	44	31
	Most	9	16	18	2	19	15	14
Fruit, vegetables, horticulture, or specialty crops*								
	Some	16	10	8	24	27	14	14
	Most	17	5	1	55	18	7	12
Poultry, including contract broilers, eggs, etc.*								
	Some	3	3	5	0	5	2	3
	Most	3	7	2	2	5	0	3
Number		***204***	***220***	***178***	***62***	***44***	***86***	***794***

[1]Chi-square test: *p < .05; **p < .001

Household Debt Level in 2008

Table 14 tabulates household debt levels by whether or not the farmer used irrigation and the size of the operation. Large farm operators with irrigation reported the highest debt levels.

Thirty percent of all respondents reported having no debt in 2008. More small farm operators (nonirrigators, 44 percent; irrigators, 39 percent) reported having no debt than did medium-size and large farm operators. Twenty-seven percent of all respondents reported having very little debt, 34 percent had moderate debt, and only 10 percent had heavy debt in 2008.

Those who reported a greater debt level also tended to report having irrigated in 2008. The percentage of irrigators with moderate and heavy debt was higher than the percentage of nonirrigators with moderate and heavy debt, regardless of farm size. Twenty-three percent of nonirrigating small farm operators reported a moderate debt level, as compared to 29 percent of irrigating small farm operators. Thirty-three percent of nonirrigating medium-size farm operators and 42 percent of irrigating medium-size farm operators reported a moderate debt level; 39 percent of nonirrigating large farm operators and 42 percent of irrigating large farm operators faced a moderate debt level. This pattern is similar for the heavy debt category. Installing irrigation on one's farm is a long-term financial decision. Irrigation requires a capital investment for those producers who choose to irrigate and is reflected in their reported debt levels.

Table 14. Debt Level in 2008, Alabama Farm Operators, 2009

	Acreage size						
	Nonirrigating			Irrigating			All
Debt level in 2008**	Small[1]	Med.	Large	Small	Med.	Large	
	percent						
No debt	44	28	25	39	21	17	30
Very little	25	30	28	25	26	21	27
Moderate	23	33	39	29	42	42	34
Heavy	8	9	8	7	12	20	10
Number	***168***	***214***	***173***	***59***	***43***	***84***	***741***

[1]Chi-square test: *p < .05; **p < .001

Household Income

Table 15 tabulates 2008 household income levels by whether or not the farmer used irrigation and the size of the operation.

Thirty percent of all respondents reported an annual household income for 2008 of $100,000 or more. A higher percentage of producers with large farms (both irrigating and nonirrigating) reported an annual household income for 2008 of $100,000 or more, 79 percent, than did medium-size or small farm producers. Small farm operators had the smallest percentage in this income bracket, 41 percent.

Twenty-five percent of the total sample fell in the $60,000 to $99,999 income bracket for 2008. Again, large farms had the highest percentage in this bracket, 58 percent, as compared to 47 percent of medium-size farms and 39 of small farms.

Nineteen percent of all respondents fell into the $40,000 to $59,999 bracket. Eleven percent of all respondents made between $30,000 to $39,999, 6 percent made $20,000 to $29,999, and 10 percent made less than $20,000. A higher percentage of producers with small farms (both irrigating and nonirrigating) reported an annual household income for 2008 of less than $20,000, 37 percent, than did medium-size or large farm producers.

Most of the respondents made less that 24 percent of their income from irrigated enterprises during the past three years. Nonetheless, about 32 percent said they received 90 percent of their income from farming, particularly the respondents from large farms with irrigation, 65 percent.

Table 15. Household Income and Sources, Alabama Farm Operators, 2009

	Acreage size						
	—Nonirrigating—			——Irrigating——			All
Income	Small[1]	Med.	Large	Small	Med.	Large	
	percent						
2008 Household Income*							
Less than $20,000	15	12	2	22	15	1	10
$20,000 to $29,999	10	5	7	2	5	4	6
$30,000 to $39,999	14	11	8	16	8	8	11
$40,000 to $59,999	20	21	16	22	18	18	19
$60,000 to $99,999	18	27	25	21	20	33	25
$100,000 or more	24	24	42	17	35	37	30
Proportion of income from irrigation over past three years**							
Less than 24%	100	100	99	50	50	40	87
25 to 50%	0	0	0	19	20	42	7
51 to 89%	0	0	1	18	20	16	4
90% or more	0	0	0	13	9	2	2
Proportion of income from farming over past three years**							
Less than 24%	70	36	26	44	25	9	40
25 to 50%	15	25	13	24	14	5	17
51 to 89%	5	11	17	10	18	21	12
90% or more	10	28	44	23	43	65	32
Number	***149***	***198***	***166***	***58***	***40***	***79***	***690***

[1]Chi-square test: *p < .05; **p < .001

Socioeconomic Characteristics

Table 16 shows respondents' gender and other attributes by whether or not the farmer used irrigation and the size of the operation.

Ninety-seven percent of respondents were male and only 3 percent were female. There was some tendency for women to operate small farms and to irrigate less. The differences were not large.

Table 16 also tabulates producers' education level by whether or not the farmer used irrigation and the size of the operation. Five percent of respondents reported having some high school or less. The highest persentage of small farm operators reported having some high school or less, 21 percent (nonirrigators, 11 percent; irrigators, 10 percent).

The highest percentage of respondents graduated from high school, 30 percent. Twenty-four percent of the sample had some college/technical school, and another 40 percent graduated from college. Operators of large farms reported graduating from college more often than did operators of small and medium-size farms (nonirrigators, 47 percent; irrigators, 52 percent). College graduates were slightly more likely to irrigate than those in parallel farm size categories; the differences were consistent.

Table 16 tabulates respondents' ethnicity by whether or not the farmer used irrigation and the size of the operation. Ninety-one percent of producers self-identified themselves as "white or Caucasian." Seven percent were "black or African-American." One percent was American Indian or Alaskan native and 1 percent self-identified as "other." No respondents reported being Asian, Pacific, Spanish, Hispanic, or Latino origin. There was a slight tendency for smaller, nonwhite farm operators to irrigate less, but the differences were not great.

Age is related to irrigation use. The highest proportions of young farmers (age 50 or less) were found among the medium-size and large farms with irrigation, 30 percent and 36 percent, respectively. The highest proportion of farmers over age 66 was among those operators of small farms with irrigation, 45 percent. The lowest proportion of older farmers was among operators of medium-size farms with irrigation, 14 percent.

Table 16. Socioeconomic Characteristics, Alabama Farm Operators, 2009

	Acreage size						
	Nonirrigating			Irrigating			All
Socioeconomic characteristics	Small[1]	Med.	Large	Small	Med.	Large	
	percent						
Gender*							
Male	93	97	99	97	98	100	97
Female	7	3	1	3	2	0	3
Education**							
Some high school or less	11	3	3	10	0	1	5
High school graduate	31	35	27	32	34	20	30
Some college/technical school	21	29	23	15	30	26	24
College graduate or more	37	32	47	44	36	52	40
Ethnicity*							
Black or African American	15	5	1	8	5	5	7
Other minority	1	3	3	11	0	0	2
White or Caucasian	84	93	97	81	96	95	91
Age*							
50 or less	18	24	28	18	30	36	24
51 to 65	41	49	47	37	57	48	46
66 and older	42	28	25	45	14	17	30
Number	***188***	***216***	***175***	***62***	***44***	***84***	***769***

[1]Chi-square test: *p < .05; **p < .001

Adopter Status and Internet Access

Table 17 tabulates producers' type of Internet access by whether or not the farmer used irrigation and the size of the operation.

The majority of respondents had cable or DSL Internet access at the home. Large farms tended to have high-speed Internet (nonirrigators, 63 percent; irrigators, 67 percent) more often than their smaller counterparts. Seventeen percent of producers had dial-up Internet only, and 31 percent of the total population had no Internet access at all. Those without Internet access were consistently less likely to irrigate across farm size categories.

Table 17 also indicates how producers identified themselves in terms of innovativeness. The items are ordered in terms of proportion of the entire sample. Respondents described themselves as an "innovator" who often tries new approaches before anyone else, an "early adopter" of new practices, not the first but part of the "early majority" of users, part of the "later majority" of users of new ideas, or "often one of the last to try new things."

Thirty-three percent of the sample in this study reported being part of the "early majority." Approximately two-thirds of all respondents reported being either an "innovator" (12 percent), an "early adopter" (21 percent), or part of the "early majority" (33 percent), while one-third identified themselves as part of the "late majority" (20 percent) or a "often one of the last to try new things" (13 percent).

Only 8 percent of respondents plan to decrease the amount of land irrigated in the coming year, while 70 percent do not plan to change the amount of land irrigated. More irrigating farmers plan to irrigate in the coming years. A third of the large operators planned to increase the amount of land irrigated.

The nonirrigating operators who said they were going to decrease their acreage were likely referring to the overall acreage that they farmed. In particular, 20 percent of the nonirrigating, small farm operators said they were going to decrease their acreage. About 44 percent percent of the small farm operators with irrigation said they planned the increase irrigated acreage, the highest rate in the sample, followed by 42 percent of the medium-size farm operators with irrigation.

Table 17. Self-identified Adopter Status and Type of Internet Access, Alabama Farm Operators, 2009

	Acreage size						
	Nonirrigating			Irrigating			All
Access	Small[1]	Med.	Large	Small	Med.	Large	
	percent						
Internet access*							
None	46	34	23	36	18	9	31
Dial-up only	14	20	15	11	21	23	17
Cable or DSL	41	46	63	53	61	67	52
Adopter status*							
Innovator trying before anyone else	9	10	15	15	14	17	12
Early adopter of new practices	12	18	24	28	34	30	21
Not first, but part of early majority of users	29	34	37	22	30	43	33
Part of later majority of users of new ideas	24	25	18	17	18	8	20
Often one of the last to try new things	27	14	7	18	5	2	13
Plan to change the amount of land irrigated**							
Decrease	20	12	2	3	2	4	8
Stay the same	71	77	81	53	56	64	70
Increase	9	11	17	44	42	33	22
Number	***150***	***198***	***166***	***60***	***44***	***84***	***702***

[1]Chi-square test: *p < .05; **p < .001

Farmer Attitudes

Table 18 tabulates producers' attitudes regarding five statements about irrigation by whether or not the farmer used irrigation and the size of the operation. Producers marked whether they "agreed," "disagreed," or were "undecided" about the statements.

Sixty-one percent of respondents agreed that Alabama farmers need a cost-share program to implement or improve irrigation systems, while 26 percent disagreed and 18 percent were undecided. Nonirrigating farmers were consistently more likely to disagree with the statement. Fifty-six percent of respondents thought that they need subsidized loans to implement or improve irrigation, while 27 percent do not feel the need for subsidies and 22 percent were undecided.

Twenty-two percent of the sample felt that they need more training and technical assistance to implement or expand irrigation, while 46 percent did not feel that they need more training. Twenty-three percent were undecided.

Ten percent of all respondents felt that they were familiar with Alabama requirements that irrigation systems using greater than 100,000 gallons per year must register with the Office of Water Resources. Fifty-two percent were not familiar with this requirement and 28 percent were "undecided."

Table 18. Perceptions of Irrigation, Alabama Farm Operators, 2009

Item	Acreage size: Nonirrigating Small[1]	Nonirrigating Med.	Nonirrigating Large	Irrigating Small	Irrigating Med.	Irrigating Large	All
	percent						
Alabama farmers need a cost-share program to implement/improve irrigation systems.*							
Disagree	43	28	21	18	5	6	26
Undecided	20	19	14	16	30	17	18
Agree	30	57	87	77	82	72	61
Farmers need a subsidized loans to implement or improve irrigation.*							
Disagree	41	27	22	26	11	18	27
Undecided	28	23	21	13	30	16	22
Agree	31	56	67	74	82	67	56
Farmers need more training and technical assistance to implement or expand irrigation.*							
Disagree	57	46	43	39	39	37	46
Undecided	20	24	20	32	25	24	23
Agree	18	23	33	19	23	14	22
Am familiar with Alabama requirements that irrigation systems using greater than 100,000 gallons per year must register with the Office of Water Resources.*							
Disagree	63	51	52	50	43	29	52
Undecided	24	30	30	27	34	21	28
Agree	7	7	10	3	9	33	10
Number	***204***	***220***	***178***	***62***	***44***	***86***	***794***

[1]Chi-square test: *p < .05; **p < .001

Closest AAES Research Station

Table 19 tabulates the closest Alabama Agricultural Experiment Station (AAES) research station to producers' location by whether or not the farmer used irrigation and the size of the operation. The highest percentage of producers, 23 percent, indicated that the closest Auburn research station to their farming operation is the Wiregrass Research and Extension Center. Seventeen percent of respondents are closest to the Tennessee Valley Research and Extension Center and 12 percent are located closest to the Gulf Coast Research and Extension Center. Another 10 percent of the sample is closest to the Black Belt Research and Extension Center. The Sand Mountain Research and Extension Center is closest to 9 percent of the sample and 8 percent are closest to the Brewton Agricultural Research Unit. Seven percent of respondents are located closest to the E.V. Smith Research Center, 6 percent nearest the North Alabama Horticulture Research Center, 5 percent nearest the Chilton Research and Extension Center. The Prattville Agricultural Research Unit is the closest AAES research station to 4 percent of the sample population.

Table 19. Nearest Alabama Agricultural Experiment Station, Alabama Farm Operators, 2009

	Acreage size						
	Nonirrigating			Irrigating			All
Nearest AAES station	Small[1]	Med.	Large	Small	Med.	Large	
	percent						
Wiregrass Research and Extension Center	19	26	15	18	34	37	23
Tennessee Valley Research and Extension Center	12	18	27	7	5	20	17
Gulf Coast Research and Extension Center	20	6	6	27	11	7	12
Black Belt Research and Extension Center	16	6	11	5	9	6	10
Sand Mountain Research and Extension Center	8	15	7	5	0	6	9
Brewton Agricultural Research Unit	5	10	12	8	2	6	8
E.V. Smith Research Center	6	4	12	5	11	7	7
North Alabama Horticulture Research Center	7	7	2	15	7	1	6
Chilton Research and Extension Center	4	6	3	11	14	4	5
Prattville Agricultural Research Unit	3	4	6	0	7	7	4
Number	***204***	***220***	***178***	***62***	***44***	***86***	***794***

[1]Chi-square test: *p < .05; **p < .001

Regression Analysis

Table 20 regresses the use of irrigation on selected perceptions and characteristics of farm operators. Three equations are shown, equation 1 regresses use–nonuse on the perception variables. The second regresses user–nonuser on personal characteristics. The third combines both sets of variables. Each equation explains a modest, but statistically significant proportion of the variation in irrigation use. The variables are shown in order of the absolute value of the standardized regression coefficients in each variable set.

Although not shown in the table, other statistical tests indicated that the perceptions and characteristics explain a significant and unique proportion of variation. Perception variables were the most potent means of differentiating irrigating and nonirrigating farm operators in the Alabama sample.

Perceptions. The most important predictor of the use of irrigation was perception of risks associated with operating costs. Nonusers of irrigation were more likely to view operating cost risks as a great barrier.

Users of irrigation were more likely to view irrigation improvements as reducing costs but not covering the installation outlays. Current irrigation users were perhaps more familiar with the actual prices and returns from irrigation.

Nonusers of irrigation were more likely to assert that no other farmers around them used irrigation. Such perceptions may reinforce their own nonuse of irrigation.

We asked operators to rate various information sources as "not helpful," "somewhat helpful," or "very helpful," and a composite measure counts the number they rated as "not helpful." Irrigation-practicing farmers rated more sources as "not helpful." This may reflect a lack of consistent technical direction for irrigation development in Alabama.

Nonusers of irrigation were more likely to agree that more training and technical assistance were needed. Nonetheless, there were no differences between irrigating and nonirrigating farmers over the availability of guidance on how to make irrigation pay. Similarly, these were no differences in the perception of the lack of reliable water supply as a barrier to irrigation. Water supply is not seen as a systematic barrier to the use of irrigation.

Characteristics. Equation 2 in the table shows selected personal and farm characteristics that may differentiate irrigation users and nonusers. Operators who received a higher portion of their income from farming were more likely to irrigate; they had more education and also received less of their income from government payments.

Table 20. Using Irrigation Regressed on Selected Perceptions and Characteristics, Alabama Farm Operators, 2009

	Was any land on farm irrigated in 2008 at any time (2=yes) Standard beta coefficients		
Varable (high score = category)	(1)	(2)	(3)
Perceptions			
Irrigation system operating costs are too risky (3=great barrier)	-.311**		-.294**
Irrigation improvements(s) will reduce costs, but not enough to cover installation costs (3=great barrier)	.161**		.153**
No other farmers around here irrigate (3=great barrier)	-.150**		-.137*
Number of "not helpful" information sources (9=highest)	.143**		.114
Need more training and technical assistance to implement or expand irrigation (5=strongly agree)	-.101*		-.107
Familiar with State requirements that large irrigators must register (5=very familiar)	.063		.066
Cannot get good advice on how to make irrigation pay (3=great barrier)	-.052		-.048
No reliable source of water on my place (3=great barrier)	-.052		-.049
Characteristics			
In past three years, proportion of income from farming (4=100%)		.260**	.218**
Education level (5=postgraduate)		.131**	.102**
Annual farm sales from government agricultural payments (3= more than 50%)		-.163**	-.093*
Total combined household income during 2008 (5= more than $250,000)		-.051*	-.049*
Minority farm operator (1=yes)		.055	.072
Total farm acres rank (794=highest)		.084	.040
Gender (2=female)		-.024	-.011
Age (95=highest)		-.005	-.032
R^2	***.199***	***.089***	***.254***
adjusted R^2	***.186***	***.076***	***.229***
F-ratio	***15.1****	***6.9****	***10.8****
(N=794) df	***7***	***7***	***16***

[1]Chi-square test: *p < .05; **p < .001

Minority farmers, who were were only five percent of the sample, were not different in the likelihood that they practiced irrigation. Farm households with higher incomes were less likely to irrigate. There was no difference by total farm acreage in the use of irrigation, no difference by gender, and no difference by age.

Equation 3 combines the perceptions and characteristics in predicting irrigation use. In general, the relationships identified in the first two equations were sustained in the combined analysis. Together, the two variable sets explained about a quarter of the variation in irrigation use. Perceptions explained about twice the variation than did characteristics, suggesting that information and technical support can be a significant means for expanding irrigation development among Alabama farm operators.

CONCLUSION

Alabama agriculture has new possibilities for growth and stabilization through the implementation of irrigation. The data suggest that farmers view water constraints and economics of irrigation as central barriers to implementing or expanding its use. We examined survey results among small, medium-size, and large farms using acreage operated as the means for tabulating the data. The regression analysis suggested that operator perceptions encompassed a central set of differences between those who irrigated and those who did not.

Operators of large farms made larger outlays for equipment, wells, pumps, and energy costs. The data show they were more concerned about these items as limitations to adoption and expansion of irrigation. Payback periods are typically longer for large investments. The overall commitment to irrigation systems often requires a more comprehensive set of changes in the farming system.

Large and medium-size farm operators were more concerned about water sources than operators of small farms. In a period of drought when irrigation is most needed, surface water sources are more readily depleted and conflicts with other users of surface sources are more readily manifested. Planning for drought periods may require deeper wells and larger storage ponds than might be expected. Medium-size and large farm operators who did not use irrigation were more likely to report water source issues as barriers to using irrigation.

Operators of small farms were more likely to purchase water from municipal sources and were somewhat less concerned about capital and operating costs. Small farm operators can more readily implement systems that can be managed and maintained on limited budgets. It is easier to try irrigation on a small operation and to extend sprinkler and other lower cost approaches to more acres.

All operators faced information limitations that impeded the ready utilization of irrigation in their farming systems. The diversity of Alabama terrain, field shapes, and hydrology frequently requires technical assessment that may be difficult to provide in an era when the number of qualified providers may be declining. Public agencies can assist in siting wells and water storage ponds, but mating irrigation systems to farming situations often takes more comprehensive determinations that are difficult to make in a single year. Thus, farmers often take a partial and incremental approach based on the water they have, or can get, and the investment they are willing to make.

When commodity prices seem to be on the increase, irrigation may become more interesting to more farmers seeking stable and expanded yields from irrigated crops. Climate fluctuations may motivate lenders to require irrigation as a condition for operating loans on certain crops. Research and extension efforts may focus on identifying a portfolio of supplemental irrigation approaches that fit the humid Southeast and the diversity of resources and needs of Alabama farms.

REFERENCES

ACES. 2011a. Managing an Irrigation System. Alabama Ag Irrigation Info Network, Alabama Cooperative Extension System. Available at: http://www.aces.edu/anr/irrigation/farmsystems.php

ACES. 2011b. Basics of Vegetable Crop Irrigation. Alabama Ag Irrigation Info Network, Alabama Cooperative Extension System. Available at: http://www.aces.edu/pubs/docs/A/ANR-1169/

Ajzen, I. 1985. From Intentions to Actions: A Theory of Planned Behavior. In Action Control: From Cognition to Behavior, edited by J. Kuhl and J. Beckmann. New York, NY: Springer Verlag.

Ayars, J. E., E. W. Christen, R. W. Soppe, and W. S. Meyer. 2006. The Resource Potential of In-situ Shallow Ground Water Use in Irrigated Agriculture: A Review. Irrigation Science, 24:147-160.

Bai, D. 2008. Irrigation, Income Distribution, and Industrialized Agriculture in the Southeast United States. Master's Thesis, Department of Agricultural Economics and Rural Sociology, College of Agriculture, Auburn University.

Bjornlund, H., L. Nicol, and K. K. Klein. 2009. The Adoption of Improved Irrigation Technology and Management Practices-a Study of Two Irrigation Districts in Alberta, Canada. Agricultural Water Management, 96:121-131.

Boland, A., D. Bewsell, and G. Kaine. 2005. Adoption of sustainable irrigation management practices by stone and pome fruit growers in the Goulburn/Murray Valleys, Australia. Irrigation Science 24 (2) 137-145.

Branch, K. M. and G. A. Poremba. 1990. Adoption and Diffusion of Innovative Irrigation and Drainage Management Technologies and Practices: A Sociological Perspective. Report for the San Joaquin Valley Drainage Program, Sacramento, CA, under the U. S. Bureau of Reclamation Contract 7-CS-20-05200. Sacramento, CA: San Joaquin Valley Drainage Program.

Dillman, D.A., J. D. Smyth, and L. M. Christian. 2009. Internet, Mail, and Mixed Mode Surveys: The Tailored Design Method. 3rd edition. Hoboken, NJ: John Wiley & Sons, Inc.

Green, G., D. Sunding, D. Zilberman and D. Parker. 1996. Explaining Irrigation Technology Choices: A Microparameter Approach. American Journal of Agricultural Economics 78(4): 1064-1072

Molnar, J. J., A. Bitto, and G. Brant. 2001. Technical Report-Core Conservation Practices: Adoption Barriers Perceived by Small and Limited Resource Farmers. Social Sciences Institute Technical Report Bulletin 646 Release 11.1.

Negri, D. H. and D. H. Brooks. 1990. Determinants of Irrigation Technology Choice. Western Journal of Agricultural Economics, 15(2):163-174.

Sydnor, E. 2010. Using and Improving Irrigation: Producer Perceptions and Possibilities. Master's Thesis, Department of Agricultural Economics and Rural Sociology, College of Agriculture, Auburn University.

Whittenbury, K. and P. Davidson. 2009. Beyond Adoption: The Need for a Broad Understanding of Factors that Influence Irrigators' Decision-making. Rural Society, 19(1):4-16.

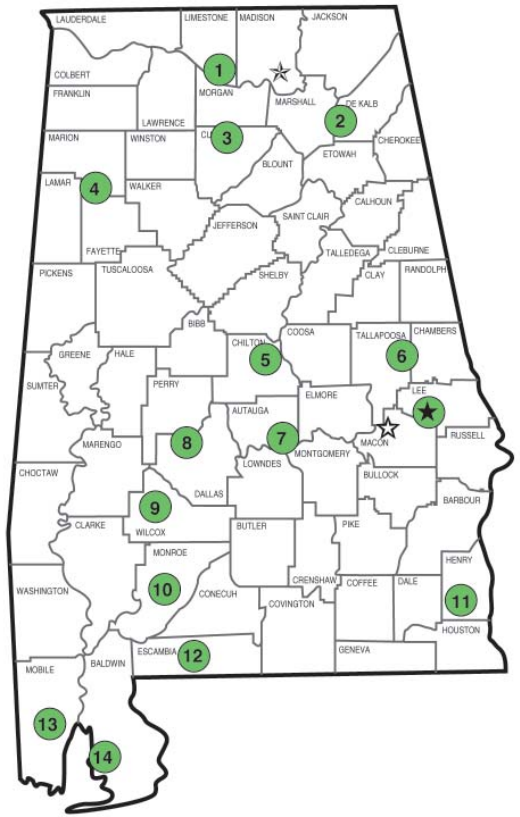
Web publication, April 2011

http:www.auburn.edu
http:www.aaes.auburn.edu

Names of products are mentioned only for describing the production practices used. This represents neither a recommendation nor an endorsement of these products.

Alabama's Agricultural Experiment Station
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the state has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.
☆ Alabama A&M University.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Research and Extension Center, Belle Mina.
2. Sand Mountain Research and Extension Center, Crossville.
3. North Alabama Horticulture Research Center, Cullman.
4. Upper Coastal Plain Agricultural Research Center, Winfield.
5. Chilton Research and Extension Center, Clanton.
6. Piedmont Substation, Camp Hill.
7. Prattville Agricultural Research Unit, Prattville.
8. Black Belt Research and Extension Center, Marion Junction.
9. Lower Coastal Plain Substation, Camden.
10. Monroeville Agricultural Research Unit, Monroeville.
11. Wiregrass Research and Extension Center, Headland.
12. Brewton Agricultural Research Unit, Brewton.
13. Ornamental Horticulture Research Center, Spring Hill.
14. Gulf Coast Research and Extension Center, Fairhope.