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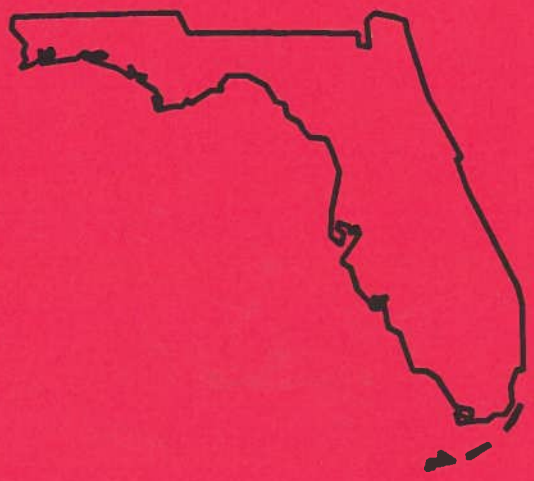
Adoption of Drip Irrigation Technology in the Florida Tomato Industry: Survey Results



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Adoption of Drip Irrigation Technology in the Florida Tomato Industry

Survey Results

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1.0 Introduction

This report presents the results of a survey on water regulation and irrigation technology adoption in the Florida Tomato Industry. The survey was designed 1) to provide growers the opportunity to describe their production situation, 2) to solicit grower attitudes toward drip technology and water use regulation, and 3) to determine if specific community groups influenced grower decisions to adopt drip technology.

1.1. Survey Methods, Geographic Coverage and Grower Selection Procedures

A survey instrument was developed in cooperation with the staff of the Florida Tomato Committee in December 1994 and North Florida Growers in August 1994. Draft questionnaires were pre-tested during this time and revised. The final questionnaires were administered to growers located in the Southwest and South Florida Water Management Districts from January through April 1995, and in the Northwest District from August to September 1994. All surveys were personally administered at the grower's farm, office, or residence.

Grower participation was solicited in two phases. First, growers were mailed letters from the Florida Tomato Committee or local extension agents to explain the purpose of the survey and asked for their participation. Growers were then contacted by phone to explain the type of survey to be administered, and arrange an interview time.

A complete list of all tomato growers in the three surveyed Districts was complied with the assistance of the Florida Tomato Committee and county extension agents. There were attempts to contact every grower. Sixty-four of the 95 growers identified participated in the survey. One-hundred percent coverage was not possible due to either the inability of some growers to participate, difficulties in scheduling suitable interview times or out-dated addresses.

The survey results reported are based on interviews with growers located in the Southwest Florida Water Management District (Ruskin-Palmetto-Bradenton areas), the western area of the South Florida Water Management District (Naples-Immokalee-Fort Meyers-Bonita Springs), and the Northwest Florida Water Management District.

For the 1994 production season, 79% percent of Northwest growers were interviewed, 77% in the Southwest, and 65% in the South. This extensive level of coverage safely allows inferences to be made to the whole population of tomato growers in the targeted water management districts.

1.2. Reporting Survey Results

The results reported represent average grower responses. Most results are presented according to two categories of growers: adopters and non-adopters of drip irrigation and by water management district location. Statistical tests were conducted to determine if the mean responses between growers in the selected categories were significantly different.

Two types of water conserving technologies were covered by the survey: drip irrigation and tensiometers. Grower responses to tensiometer use are not reported because of the low level of investment (about $20,000 over the last 10 years for all growers). Only about a quarter of all growers in the Southwest and South Florida Districts have ever tried to use tensiometers. Some growers were unaware of what tensiometers were used for, and others had tried them but had abandoned their use. Sixty-three percent of Northwest growers reported use of tensiometers, but total investment over the last 10 years was less than $8,000. Many growers were given tensiometers by the agricultural experiment station in their area. Additional information on the low level of tensiometer use is reported in Section 4.

Comparisons are made between the responses of adopters and non-adopters of drip irrigation to illustrate how they differ in their views toward water use regulations and drip technology. Reporting survey results for growers by the three water management districts is intended to compare responses across degrees of regulatory activity. The Northwest is the least regulated, the South has a medium level of regulation, and the Southwest is the most regulated.

In addition to distinguishing the results according to which groups growers belong to, much of the data is presented for two time periods: the time "just prior to adoption of drip irrigation" or "Then" and the current time period or "Now." For non-adopters of drip irrigation, the past was defined as "five to ten years ago". The objective in reporting the data for the two periods is to capture changes in grower views over time.

1.3. Organization of the Report

Discussion of survey results begins with a description of the geographic, demographic, and farm management characteristics of Florida tomato growers. Section 3 provides a context within which grower adoption behavior of drip technology can be interpreted. Section 3 discusses grower responses about their objectives and what outcomes (for example, profit maximization, compliance with water regulations, control over technology decisions, etc.) are important to them.

Section 4 presents a profile of tomato grower use of and beliefs about irrigation management practices and drip technology. Current water management practices and levels and rates of adoption of drip irrigation are described. Data is provided with respect to grower's general attitude towards, and beliefs about the profitability of drip irrigation. The implications of the survey results for future adoption of drip irrigation are discussed.

Almost by definition, resource use and resource conserving behavior are social actions. Section 5 reports survey results on grower responses as to how important certain groups were and

are to their decision to install water conserving technologies and management practices. The key question here is to what extent a grower is influenced by society in his/her decision to adopt or not adopt drip irrigation technology.

Section 6 describes two aspects of grower involvement with water use regulations. First, growers' general attitudes towards water use regulation, the costs of regulation, and growers' perceptions of the impacts of regulations are presented. Second, survey results are reported for grower perceptions of the amount of control they have over adopting drip irrigation technology, including the influence of regulation.

2.0 Geographic, Demographic, and General Farm Management Characteristics of Florida Tomato Growers

2.1 Geographic Characteristics

Table 2.1 gives basic geographic information for the entire sample and by water management district. The 134 surveyed farms represented about twenty-eight thousand acres of tomatoes. There were nineteen growers interviewed in the Northwest Florida Water Management District, 31 in the Southwest Florida Water Management District, and 14 in the west coast area of the South Florida Water Management District. Approximately forty-four percent of all surveyed farms were located in the Southwest Florida Water Management District, 25% in the South Florida Water Management District, and 31% in the Northwest Florida Water Management District.

Due to the larger field sizes in the Southwest and the South, these districts account for nearly 93% of the total acreage surveyed. While the average number of farms per grower is about the same across all three Districts, the average farm size per grower varies tremendously. In the Northwest Water Management District the average farm size is about one-hundred acres, 434 acres in the Southwest, and almost 900 acres on the west side of the South Florida Water Management District.

Table 2.1 Geographic Characteristics of Florida Tomato Growers.

Characteristic	Entire Sample	Northwest Florida	Southwest Florida	South Florida
Number of Growers	64	19	31	14
Number of Tomato Acres	27,818	1,917	13,210	12,691
Number of Tomato Farms	134	47	53	34
Acres per Grower	435	101	426	906
Farms per Grower	2.09	2.47	1.71	2.43
Acres per Farm	208	41	249	373

2.2 Demographic Characteristics

The average and range for grower age, years of education, and years of farming experience are given in table 2.2. Average age and years of education are almost identical across the three water management districts and by drip adoption status. Years of farming experience differs slightly. The average grower in the Northwest has nearly five years more farming experience than growers in the South. Regardless of water management district location or drip adoption status, the data indicate that the average grower is highly educated and has over twenty years of farming experience.

Table 2.2 Demographic Characteristics of Florida Tomato Growers.

Characteristic	Entire Sample	Northwest Florida	Southwest Florida	South Florida	Adopter	Non-adopter
Age (Years)						
Average	45.6	46.5	45	45.7	46.2	44.1
Minimum	26	26	28	31	26	32
Maximum	69	69	65	67	69	67
Education (Years)						
Average	14.5	14.1	14.7	14.5	14.8	14.5
Minimum	10	12	10	12	12	10
Maximum	20	19	20	16	19	20
Farming Experience (Years)						
Average	24.7	27.3	24.3	22.2	25.7	22.3
Minimum	5	5	6	14	5	6
Maximum	50	50	45	40	50	40

Table 2.3 Land Ownership Patterns of Florida Tomato Growers.

Characteristic[a]	Entire Sample	Northwest Florida	Southwest Florida	South Florida	Drip Adopter	Drip Non-Adopter
Total Acreage	27,818.25	1,917.25	13,210	12,691	19,787.50	8,030.75
Total Acreage Owned	16,163.25	969.25	6,702	8,492	12,800.50	3,362.75
Percent Owned to Total Average	58%	50%	51%	67%	65%	42%

[a] Acreages and total acres are rounded to the nearest hundreth. Percent owned to total acres is rounded to the nearest percent.

2.3. General Farm Management Information

2.3.1. Farm Structure

Table 2.3 summarizes land ownership patterns by district and by drip adoption status. Only about 58 percent of the 1994 tomato production area across the three regions was owned by growers. Owned land amounted to about 50% of total production area in the Northwest and Southwest, and 67 percent in the South. Adopters of drip irrigation own a much higher percentage of land than non-adopters (65% versus 42%, respectively). This finding supports the hypothesis found in most of the drip technology adoption literature that growers are more apt to invest in resource conserving technologies on their own farms than on rented land (Feder et al. Feder and Umali).

Summary data for farm organization type is given in table 2.4. While nearly 44% of the farms are organized as corporations, there are distinct differences between the three water management districts. Only 22% of the farms in the Northwest Water Management District are corporate, but over 50% of the farms in the Southwest and South are organized as such. The majority of the farms on which drip irrigation is used (61%) are organized as either sole proprietorship or as partnerships. Conversely, 57 percent of the farms which do not use drip irrigation are organized as corporations.

Table 2.4 Farm Organization Characteristics of Florida Tomato Growers.

	Sole Proprietorship		Partnership		Corporation	
	Number of Farms	Percent of Farms	Number of Farms	Percent of Farms	Number of Farms	Percent of Farms
Entire Sample	28	21%	47	35%	59	44%
Northwest Florida Water Management District	16	34%	21	44%	10	22%
Southwest Florida Water Management District	5	10%	17	32%	31	58%
South Florida Water Management District	7	20%	9	26%	18	54%
Adopters of Drip	23	25%	34	36%	35	39%
Non-Adopters of Drip	5	12%	13	30%	24	58%

Table 2.5 Cropping Practice by Florida Tomato Producers.

Cropping Practice	Entire Sample	Northwest District	Southwest District	South District	Adopter	Non-Adopter
Monocrop Tomatoes						
Number of Farms	65	17	30	18	42	23
Percent of Farms	48.51%	36.17%	56.60%	52.94%	45.65%	54.76%
Tomatoes Double-Cropped						
Number of Farms	69	30	23	16	50	19
Percent of Farms	51.49%	63.83%	43.40%	47.06%	54.35%	45.24%

2.3.2. Cropping Practices

Table 2.5. shows that the farms surveyed are evenly divided between monocropping and double cropping tomatoes with other crops. Although there is little difference between the number of farms mono and double-cropped in the two southern water management districts, a much larger percentage of farms are double-cropped in the Northwest (about 64%). On a percentage basis, adopters of drip irrigation do less mono-cropping than non-adopters, but both groups have about half their farms under each type of cropping system.

2.3.3. Soil Type

Soil type characteristics of Florida tomato farms are shown in table 2.6. Nearly all farms (82%) are classified as well to very well drained, meaning mostly sandy soils. By water management district, most of the farms are classified as well drained; the highest level of poorly drained soils is found in the South (about 24%). Of the twenty-three farms that were classified as poorly drained, 17 have drip irrigation. This finding contradicts the results of other studies where low adoption rates of drip have been associated with poorly drained soils, i.e., soils that have better water holding capacity and less need for precision irrigation (Caswell and Zillerman, 1985, 1986).

Table 2.6 Soil Type Characteristics of Florida Tomato Farms

Soil Type	All Growers	Northwest	Southwest	South	Adopter	Non-Adopter
Well Drained						
Number of Farms	93	34	38	21	66	27
Percent of Farms	69.40%	72.34%	71.70%	61.76%	71.74%	64.29%
Extremely Well Drained						
Number of Farms	18	5	8	5	9	9
Percent of Farms	13.43%	10.64%	15.09%	14.71%	9.78%	21.43%

Table 2.7 Water Sources for Irrigating Florida Tomato Farms

Water Source	All Growers	Northwest	Southwest	South	Adopter	Non-Adopter
Ground Water						
Number of Farms	104	22	51	31	63	41
Percent of Farms	77.61%	46.81%	96.23%	91.18%	68.48%	97.62%
Surface Only						
Number of Farms	26	25	0	1	25	1
Percent of Farms	19.40%	53.19%	0.00%	2.94%	27.17%	2.38%
Ground and Surface						
Number of Farms	4	0	2	2	4	0
Percent of Farms	2.99%	0.00%	3.77%	5.88%	4.35%	0.00%

2.3.4. Water Resources and Management

The major water source for tomato irrigation is groundwater (table 2.7.). Almost 80% of the farms use only well water for irrigating. About 20% of the farms use some surface water (creeks, ponds) for irrigation, but all of these except one are located in the Northwest Florida Water Management District (Telogia Creek Basin). More than one-half the farms in the Northwest use only surface water, while over 90 percent of the farms in Southwest and South use only groundwater for irrigation.

Water quality differs over the study region. 77 percent of all growers reported no water quality problems (table 2.8.). However, nearly 40 percent of the Northwest growers reported algae and mineral problems associated with the use of surface water. Over 85 percent of the farms in the Southwest and the South had no water quality problems. In previous research on drip adoption there has been found to be an inverse relationship between adoption and water quality. This appears to hold true for the adoption of drip irrigation in the study area. Of the 31 farms reported to have water quality problems, 30 use drip irrigation.

Growers were asked who was mainly responsible for managing the irrigation system for each farm. The management categories included owner-manager, family, foreman/farm manager, irrigation manager, and laborer. For all growers, the majority of farm irrigation systems are managed by either the owner-manager or the foreman/farm manager (table 2.9). However, there are distinct differences between the irrigation management approaches amongst the three water management districts. In the Northwest, most of the farms (74 percent) have irrigation systems managed by the owner-operator, reflecting the relatively high number of farms under sole proprietorship status. In the Southwest the majority of the farm irrigation systems are managed by either the owner-operator or a foreman/farm manager, whereas in the South most of the farm irrigation systems (68 percent) are managed by a foreman or farm manager.

Among adopters of drip irrigation, the majority of systems are managed by the owner-operator and by foremen or farm managers. All nine farms with full time irrigation managers are adopters of drip. This supports research in other areas that finds that adoption rates are positively influenced by the presence of a full-time irrigation manager. However, it is not known if the decision to adopt drip occurs before or after a grower employs an irrigation manager.

Having direct use rights to a resource is usually thought of as being positively related to the adoption of new technologies. In this case, the supposition is that growers would be more apt to adopt drip irrigation if they have their own water use permits. For the entire study, about 54 percent of all farms were irrigated under the growers own permit and about 30 percent under a different land owners permit. The remaining 16 percent were not required to have a water use permit (table 2.10). However, regional differences do occur. In Northwest, where the drip adoption rate is high, 78 percent of the farms are either irrigated with the grower's own permit, or do not require a permit. While the majority of farms in the Southwest and the South are drip irrigated using the grower's permit, large numbers of farms are drip irrigated under another land owner's permit. Adoption of drip irrigation technology does not appear to be influenced by who holds the water use permit; nearly 34 percent of drip irrigation adopters do not use their own water use permits to irrigate.

Table 2.8 Water Quality Problems on Florida Tomato Farms.

Water Quality	All Farms	Northwest	Southwest	South	Adopter	Non-Adopter
No Water Quality Problems Exist						
Number of Farms	103	28	46	29	62	41
Percent of Farms	76.87%	59.57%	86.79%	85.29%	67.39%	97.62%
Water Quality Problems Exist						
Number of Farms	31	19	7	5	30	1
Percent of Farms	23.13%	40.43%	13.21%	14.71%	32.61%	2.38%

Table 2.9 Irrigation System Management Practices Used by Florida Tomato Growers.

Person Responsible for System	All Farms	Northwest	Southwest	South	Adopter	Non-Adopter
Owner-Operator						
Number of Farms	57	35	18	4	42	15
Percent of Farms	42.54%	74.47%	33.96%	11.76%	45.65%	35.71%
Family						
Number of Farms	9	2	2	5	5	4
Percent of Farms	6.72%	4.26%	3.77%	14.71%	5.43%	9.52%
Foreman/Farm Manager						
Number of Farms	56	2	31	23	33	23
Percent of Farms	41.79%	4.26%	58.49%	67.65%	35.87%	54.76%
Irrigation Manager						
Number of Farms	9	5	2	2	9	0
Percent of Farms	6.72%	10.64%	3.77%	5.88%	9.78%	0.00%
Laborer						
Number of Farms	3	3	0	0	3	0
Percent of Farms	2.24%	6.38%	0.00%	0.00%	3.26%	0.00%

Table 2.10 Ownership of Water Use Permits by Florida Tomato Growers.

Permit Status	All Farms	Northwest	Southwest	South	Adopter	Non-Adopter
Grower Holds Permit						
Number of Farms	72	21	29	22	47	25
Percent of Farms	53.73%	44.68%	54.72%	64.71%	51.09%	59.52%
Grower Does Not Hold Permit						
Number of Farms	43	10	22	11	31	12
Percent of Farms	32.09%	21.28%	41.51%	32.35%	33.70%	28.57%
No Permit Required						
Number of Farms	18	16	2	0	14	4
Percent of Farms	13.43%	34.04%	3.77%	0.00%	15.22%	9.52%

3.0 Grower Goals and Objectives

This section provides the context within which grower adoption behavior can be interpreted. Tomato producers, like the rest of us, have several goals and objectives that they simultaneously pursue, and need to trade off one against the other. In order to better understand growers perceptions of water use regulations, the profitability of water conserving technologies, the role of social groups in adoption decisions, and the role of grower control, it is important to have a clear idea of how growers rank different objectives.

3.1. Final and Intermediate Objectives by Grower Adoption Status

3.1.1. Grower's Ranking of Final Objectives by Adoption Status

Final objectives represent the major goals which growers hope to achieve. In this study we listed five major goals that a grower would pursue relative to his farming operation. These include profit maximization, security of access to water for the farm; a high quality natural environment; community recognition, respect, and admiration relative to the farming operation; and independence or free choice in making farming decisions. Each grower was asked to allocate 100 points among these five objectives. If a grower allocated 20 points to each objective he/she ranked them all as equally important.

Table 3.1 shows the average scores that non-adopters and adopters of drip irrigation assigned to each objective. Non-adopters ranked profit maximization and security to access to water the highest and about evenly. Independence or free choice in farming was the next most important goal for non-adopters. The lowest scores were given to community respect and a high quality of the natural environment.

Table 3.1 Grower Ranking of Final Objectives, Adopters and Non-Adopters of Drip Irrigation.

Final Objectives[a]	Non-Adopters	Adopters
Maximize farm profit	24.78	30.90
High quality of natural environment	14.33	17.82
Security of access to water for the farm	24.22	23.70
Community recognition, respect and admiration relative to farming	15.50	11.37*
Independence, free choice in farming decisions	21.17	17.02

[a] Growers were given 100 points to divide among each of the Final Objectives.
* Asterisks show adopters of drip irrigation differ significantly from non-adopters: (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

Adopters of drip irrigation differed in their rankings of final objectives. Adopters also ranked profit maximization as the most important objective, but more so than non-adopters. Security of access to water was the second most important objective. Unlike non-adopters, however, adopters gave less importance to the free choice objective, and placed more importance on the high quality of natural environment. Equally ranked as the third most important objective for adopters were independence in farming decisions and high quality of the natural environment. Adopters ranked community recognition as significantly less important than non-adopters. Regardless of adoption status, all growers rank profit maximization and security of access to water as their most important objectives.

3.1.2 Grower's Ranking of Intermediate Objectives by Adoption Status

Intermediate objectives are defined as the means by which final objectives are achieved. The five intermediate objectives used in this study included being self-reliant, being logical and rational in all farming decisions, being in compliance with water use rules and regulations, being capable of managing the irrigation system, and being responsible in the use of water. Growers allocated 100 points between the five objectives.

Table 3.2 shows how adopters and non-adopters of drip irrigation ranked each intermediate objective. Non-adopters gave about equal importance to being self-reliant and independent in farming decisions, being logical and consistent with respect to these decisions, and being responsible in the use of water. Next important was being capable of managing the irrigation and crop system. The least important objective was being in compliance with water use rules and regulations.

Table 3.2 Grower Ranking of Intermediate Objectives, Adopters and Non-Adopters of Drip Irrigation.

Intermediate Objectives[a]	Non-Adopters	Adopters
Being logical, consistent and rational in farming decisions	23.06	22.90
Being capable in managing the irrigation and crop system	17.94	19.01
Being responsible in the use of water	22.78	17.91**
Being self-reliant, self-sufficient and independent in farming	24.28	24.90
Being in compliance to rules and regulations	13.06	12.61

[a] Growers were given 100 points to divide among each of the Intermediate Objectives.
* Asterisks show adopters of drip irrigation differ significantly from non-adopters: (* - 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

Adopter's of drip irrigation likewise ranked being self-reliant and independence in farming, and being logical and rational in farming decisions, as their most important objectives. However, there was a significant difference in the adopter and non-adopter rankings of being responsible in the use of water. Adopters of drip irrigation, on average, place significantly less importance on being responsible in water use. This may mean that adopters believe that their adoption of drip shows them to be responsible, and thus they can give more importance to other goals.

Similar to non-adopters, adopters ranked compliance with water use rules and regulations as the least important objective. This finding supports the anecdotal evidence that growers generally consider agricultural water use rules and regulations misinformed and arbitrary.

3.2. Final and Intermediate Objectives by Water Management District

3.2.1. Grower Ranking of Final Objectives by Water Management District

The rankings for final objectives by growers according to water management district are given in table 3.3. For the water management district with the least regulation (the Northwest) profit maximization is by far the most important objective. The next most important objectives for Northwest growers are independence in farming decisions, security of access to water, and high quality of the natural environment. Least important is community recognition.

Table 3.3 Grower Ranking of Final Objectives by Water Management District

Final Objectives[a]	Northwest	Southwest	South
Maximize farm profit	34.28	28.94	20.43
High quality of natural environment	18.92	15.21	17.71
Security of access to water for the farm	19.14	25.06	27.21**
Community recognition, respect and admiration relative to farming	11.22	11.60	16.36
Independence, free choice in farming decisions	21.17	19.90	18.29

* Asterisks show how growers in the Southwest and South differ significantly from growers in the Northwest Water Management District (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

[a] Growers were given 100 points to divide among each of the Final Objectives.

Table 3.4 Grower Ranking of Intermediate Objectives by Water Management District.

Intermediate Objectives[a]	Northwest	Southwest	South
Being logical, consistent and rational in farming decisions	24.19	21.77	23.93
Being capable in managing the irrigation and crop system	16.97	18.23	22.00
Being responsible in the use of water	16.31	20.08*	21.43*
Being self-reliant, self-sufficient and independent in farming	32.25	22.26*	20.50*
Being in compliance to rules and regulations	10.28	14.44*	12.14

* Asterisks show how growers in the Southwest and South differ significantly from growers in the Northwest Water Management District (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

[a] Growers were given 100 points to divide among each of the Intermediate Objectives.

Profit maximization is also the most important final objective in the most regulated district, the Southwest. This was followed by security of access to water and independence in farming decisions. The lowest rankings in importance were given to the objectives of high quality of natural environment and community recognition.

Compared to growers in the Northwest, the South ranking of final objectives differed significantly. In the South profit maximization is ranked second to security of access to water. South growers gave about equal weight to the objectives of independence in farming decisions, high quality of natural environment and community recognition.

Growers in the Southwest and South districts gave 25 percent or more of their points to achieving security of access to water for the farm, considerably more than growers in the northwest. This may be an indication that growers in the more regulated districts believe that their access to water is less secure relative to areas where there is less regulation. In a similar vein, water for irrigation in the northwest, with the exception of the Telogia Creek basin, is not considered as being particularly scarce and therefore may be less of a concern for growers in that area.

The goal of high quality of the natural environment was ranked the highest by Northwest growers, perhaps because they are located in more rural areas that still have a relative abundance of hunting and fishing habitat. Growers in all three districts ranked community recognition as the least important goal.

3.2.2. Grower Ranking of Intermediate Objectives by Water Management District Location

Grower rankings of intermediate objectives by water management district are provided in table 3.4. The most important objective of Northwest growers is being self-reliant and independent in farming, followed by being rational in farming decisions. Being capable of managing the irrigation and crop system and being responsible in the use of water were ranked as third in importance. The least important objective was being in compliance with water use regulations.

Growers in the Southwest ranked independence and being logical in farming decisions, and being responsible in water use to be their most and equally important objectives. Second in importance was being capable of managing the irrigation and crop system. Being in compliance with water use regulations ranked last.

South growers considered being logical in farming decisions to be their most important intermediate objective. Three other objectives were second in importance and ranked about equally: being capable of managing the irrigation and crop system, being responsible in the use of water, and being self-reliant. Like growers in the other districts, being in compliance with water use regulations was the least important objective.

Compared to Northwest growers, growers in the Southwest and South put significantly less importance on being self-reliant, self-sufficient, and independent in farming activities. Although growers in the Southwest rank independence as their most important objective, South growers only rank this objective fourth relative to other objectives. The data indicates that Northwest growers, who have generally experienced a relatively lower degree of water use regulation, put a higher relative value on self-sufficiency and independence.

There is also a significant difference between growers in the Northwest and the two southern districts with respect to the importance of being responsible in the use of water. Growers in the Southern districts put significantly more weight on the importance of being responsible in water use. The more restrictive rules and regulations in the southern districts, and the more pronounced level of competition for water between growers and other water users, may be reinforcing the responsibility objective.

Similar to the comparison between drip irrigation adopters and non-adopters, the goal of being in compliance with water use rules and regulations received the lowest ranking of all the objectives. However, growers in the highly regulated Southwest put significantly more importance on this objective than the less regulated Northwest and South districts. It appears that the more regulated water use is, the more important it is for growers to be in compliance with water use rules. Thus, while growers do not rank compliance high as an intermediate objective, the level of compliance is positively related to the level of water use regulation.

In general, there are two important observations to be made concerning the rankings of grower's final and intermediate objectives. The first is that the figures represent "averages" for all groups. There were many individuals who gave equal ranking to each objective, just as there were growers who gave zero points to some objectives. Those who want to promote adoption of water conserving technologies must consider the important objectives of individual producers. For example, for some growers the appeal of drip may be based on its potential to increase profits, while for others drip may help them meet their concerns over environmental quality.

Secondly, it is important to note that none of the objectives received a near zero score. The results show that even though community recognition, high quality of natural environment, and compliance with water use regulations are not the most important objectives of tomato producers, they do merit consideration and even moderate the level of importance given to other goals such as profit maximization, security of access to water, and being self-reliant and independent in farming decisions.

3.3 Grower Outcome Evaluations

Growers were asked to evaluate five outcomes, including profit maximization, compliance with water use regulations, control over decisions to install technology, improving water quality in the area, and reducing water for irrigation. Outcome evaluations are different from final and intermediate objectives in that they are not ranked relative to one another. Each outcome was evaluated by growers on a seven point scale ranging from 7 equal to "extremely important" to 1 equal to "extremely unimportant". A score of four indicated "neither important or unimportant," or a neutral position.

Outcome evaluations relate to specific types of individual behavior. Profit maximization reflects self-interested behavior. Compliance with water technology regulations and control over decisions to install technology relate to the importance of regulations on individual behavior and how important volition is to grower's technology choices. Improving water quality and reducing water for irrigation pertain to a grower's sense of social responsibility in water use.

3.3.1. Grower Evaluation of Outcomes by Adoption Status

Prior to adoption of drip irrigation, adopters evaluated profit maximization as an extremely important outcome (table 3.5). Control over technology decisions and improving water quality were considered quite important. Compliance with water use regulations and reducing water for irrigation were ranked as slightly important. For the period five to ten years ago, non-adopters of drip also ranked profit maximization as extremely important. The outcomes of control over technology decisions, improving water quality and reducing water for irrigation were considered quite important. Compliance with water use regulations by non-adopters was evaluated as only slightly important, but significantly more important than the evaluation of adopters of drip irrigation.

Relative to the period prior to adoption, adopters of drip now evaluate all outcomes as more important. Profit maximization remains extremely important, and control over technology decisions, improving water quality, and reducing water for irrigation are all quite important. Compliance with water use regulations by adopters is also considered quite important, more so than in the period prior to adoption. The importance of the outcomes for non-adopters in the current period has not changed much from the past. The major difference is that adopter's evaluation of improving water quality is significantly higher than that of non-adopters, although both groups consider this outcome as quite important. This indicates that adopters of drip irrigation may have a relatively higher concern for larger social objectives related to water conservation.

3.3.2. Grower Outcome Evaluations by Water Management District

For the period prior to adoption (or five to ten years ago for non-adopters) Northwest district growers considered profit maximization extremely important (table 3.6). Those goals that were quite important included control over technology decisions, improving water quality in the area, and reducing water for irrigation. Compliance with water use regulations was ranked between "neither important, nor unimportant" to "slightly important".

Southwest district growers likewise considered profit maximization as extremely important. Control over technology adoption, improving water quality and reducing water for irrigation were considered as quite important. Being in compliance with water use regulations was considered as slightly to very important, and was ranked higher than growers in the Northwest.

The degree of importance placed on each outcome by South growers was about the same as growers in the other districts. An important exception is that for the period prior to adoption. South growers considered compliance with water use regulations as significantly more important than growers in the Northwest. This may be because growers in the South operate in a relatively more stringent regulatory environment than Northwest growers.

In the current time period, the importance of all objectives for growers in all three districts has either increased or remained the same. All growers consider all outcomes to be very to extremely important. For example, although growers consider profit maximization now to be just as important as in the past, they also give more importance to reducing water for irrigation and improving water quality. This simultaneous pursuit of self-interested and community objectives may reflect the fact agricultural water use is increasingly a social issue. Compliance with water use regulations continues to be the relatively least valued outcome, but a more important one compared to the past. This may mean that growers, although they may not believe water use regulations are particularly beneficial, believe that compliance is necessary.

Table 3.5 Grower Rankings of General Outcome Evaluations, Prior to Adoption and 1995 for Adopters and Non-Adopters of Drip Irrigation.

	Period Prior to Adoption		Current Time Period	
Outcome[a]	Adopters	Non-Adopters	Adopters	Non-Adopters
Profit Maximization	6.61	6.94**	6.95	6.94
Compliance with water technology regulations	5.04	5.78*	5.89	5.89
Control over decision to install technology	5.98	6.17	6.41	6.28
Improving water quality in the area	5.91	6.06	6.50	6.00*
Reduce water for irrigation	5.65	6.00	6.32	6.28

[a] Outcome evaluations were measured on a scale from 7 to 1 with 7 = extremely important and 1 = extremely unimportant. Four means neither.
* Asterisks show how adopters differ significantly from non-adopters (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

Table 3.6 Tomato Grower Rankings of General Outcome Evaluations, Prior to Adoption and 1995, by Water Management District Location.

	Period Prior to Adoption			Current Period		
Outcome[a]	Northwest Florida	Southwest Florida	South Florida	Northwest Florida	Southwest Florida	South Florida
Profit Maximization	6.74	6.55	7.00	7.00	6.90*	7.00
Compliance with water technology regulations	4.68	5.39	5.71*	5.74	6.03	5.79
Control over decision to install technology	5.95	6.03	6.14	6.05	6.52	6.36
Improving water quality in the area	5.95	5.74	6.43	6.47	6.32	6.29
Reduce water for irrigation	5.68	5.65	6.07	6.37	6.32	6.14

[a] Outcome evaluations were ranked on a scale from 7 to 1 with 7 = extremely important and 1 = to extremely unimportant. Four means neutral.
* Asterisks show how growers in the Southwest and South districts differ significantly from growers in the Northwest Water Management District (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

4.0 Water Management Practices, Technology Adoption Rates, and Grower Beliefs Toward Drip Irrigation

This section provides a profile of tomato grower beliefs about irrigation management practices and technologies. Current levels and rates of adoption of drip irrigation are described. Data is presented with respect to grower's general attitudes towards, and beliefs about the profitability of drip irrigation. The implications for future adoption of drip irrigation are then discussed.

4.1. Current Water and Irrigation Management Practices

Growers were asked if they used specific water-conserving technologies or best management practices (BMP's) in addition to drip irrigation. The purpose was to get an indication of the effort growers put forth with respect to water conserving practices.

Specific BMP's included having a farm irrigation and water management plan, metering water use, monitoring the water table, use of laser levelling (which allows for more uniform water application rates and less pumping), satellite based weather monitoring (to better time irrigation events), and tissue testing of tomato plants (to indicate drought stress). Table 4.1 summarizes the use of these BMP's.

Table 4.1 Number and Percentage of Growers Using Selected Water-Related Best Management Practices

District	Northwest		Southwest		South		Total	
Practice	Number	%	Number	%	Number	%	Number	%
Water Table Monitoring	4	(21)	14	(45)	12	(86)	30	(47)
SCS Irrigation and Water Management Plan	12	(63)	19	(61)	8	(57)	39	(61)
Water Metering	9	(47)	28	(90)	13	(93)	50	(78)
Laser-Levelling	6	(32)	28	(90)	14	(100)	48	(75)
Satellite Based Weather Monitoring	4	(21)	13	(42)	9	(64)	26	(41)
Tissue Testing	13	(68)	24	(77)	12	(86)	49	(77)

Three quarters or more of all growers use water meters, laser levelling, and tissue testing. In addition, almost 60% of all growers have an irrigation and water management plan. Over 40 percent of all growers monitor the depth to water table and use satellite based weather monitoring as decision tools for irrigating.

Use of these BMPs varies between growers located in different water management districts. For example, while nearly all growers in the Southwest and South Districts meter their water use, less than one-half the growers in Northwest Florida do so. This is explained by the fact that most growers in the South and Southwest are required to use meters as part of permit conditions.

Nearly all growers in the South and Southwest also use laser levelling as a means to save on pumping costs. Low use rates in North Florida are explained by the more hilly terrain and the high costs of levelling.

Eighty-six percent of South Florida growers monitor the depth to water table where seep is still a dominant method of irrigation. Only 45 percent and 21 percent of the growers in Southwest and Northwest Florida, respectively, monitor the water table. More South Florida growers also use satellite based weather monitoring than growers in either of the other two districts. Almost an equal percentage of growers (60 percent or more) in each district use tissue testing and have an irrigation and water management plan.

There is a higher level of use of water metering, water table monitoring, and laser levelling in those districts with the most water use regulation. Water use permits specifying the quantities of water to be used annually are required in the South and Southwest districts. Permits are not required of all growers in the Northwest.

Laser levelling is used by growers to cut water use and may be less expensive than investing in a drip system. This may partially explain why adoption rates of drip irrigation are lower in the South and Southwest districts. (See table 4.3.)

Growers were asked what factors they take into account when they make three types of irrigation management decisions: when to start irrigating, the length of the irrigation event or "run time", and the number of times they irrigate each day. The purpose in soliciting this information was to determine which indices or methods are important to grower decision making with respect to the initiation and length of water applications. The majority of growers indicated they had a set schedule of irrigating once or twice daily.

Indices affecting the initiation, run time, and frequency of irrigation decisions were identified by IFAS field research and extension staff, and by growers during the pretest phase of the survey. The indices include looking at tomato leaves and fruit, feeling the soil by hand, using tensiometers or pan evaporation, crop stage, use of historical soil-water balance records, past and expected rainfall, irrigation system design, the pesticide spray schedule, and regulatory requirements.

Table 4.2 shows the percentage of growers that employ the various indices for making irrigation management decisions. For starting an irrigation, over 70% of all growers rely on three key variables: feeling the soil by hand, yesterday's rainfall, and expected rainfall today. Nearly

one-half of all growers indicated that they use tensiometers and/or consider crop stage. Using pan evaporation readings and/or considering the pesticide spray schedule are the least important variables. Twenty percent of all growers consider water use regulations in the decision to irrigate.

The same indices used by most growers to start irrigating are also used in the run-time decision. About two-thirds of all growers feel the soil and consider past and expected rainfall to determine the run-time of their irrigation systems. Forty and fifty percent of all growers use tensiometers or look at crop stage. Twenty percent consider regulatory requirements when deciding run-time.

Table 4.2 Frequency of Indices Used by Tomato Growers for Irrigation Management

Variable	Irrigation Management Practice		
	Start Irrigating	Run Time	Times Irrigated
Look at Leaves	40.6%	35.9%	18.8%
Look at Tomato	25.0%	23.4%	10.9%
Feel Soil	70.3%	59.4%	21.9%
Read Tensiometer	46.9%	40.6%	14.1%
Measure Pan Evaporation	9.4%	10.9%	4.7%
Crop Stage	54.7%	50.0%	20.3%
Soil Water Balance Records	15.6%	18.8%	4.7%
Rainfall Yesterday	75.0%	65.0%	29.7%
Expected Rainfall	70.3%	65.6%	29.7%
Design of the System	37.5%	25.0%	9.4%
Spray Pesticide Schedule	17.2%	10.9%	4.7%
Regulatory Requirements	20.3%	20.3%	9.4%

Although most growers irrigate a set number of times a day, some consider other indices for determining the frequency of irrigation. Almost 30% of all growers consider past and expected rainfall in making the decision, and about 20% feel the soil or consider crop stage. Less than 10% take water use regulations into account when determining the number of times to irrigate daily.

The data on irrigation management practices leads to three general conclusions. First, tomato growers continue to rely mostly on traditional, informal methods (i.e. considering rainfall amounts and feeling soil) to decide when and how much to irrigate.

Second, "modern" methods of irrigation scheduling through the use of tensiometers and pan evaporation are not now employed by most growers. Measuring pan evaporation is used by only 5% to 11% of the growers. Tensiometers are used by many growers, but several growers indicated during interviews that tensiometers are no more reliable than feeling the soil.

Third, regulatory requirements regarding water use are considered by only about a fifth of the growers when they decide when and how much to irrigate. Most growers expressed the view that water management decisions are based first and foremost on "what the crop needs".

4.2. Adoption Profile of In-Bed Drip Irrigation

Table 4.3 summarizes the survey data on adoption levels and rates of adoption for in-bed drip irrigation. At the time of the survey, 46 growers had adopted drip irrigation over nearly 14,000 acres, and had made capital investments totaling almost $8,936,000. These figures represent adoption rates of nearly 72 percent of all growers, and almost 50 percent of the 1994 tomato production area. The average investment in drip irrigation was $632 per acre.

Table 4.3 Adoption Profile of In-Bed Drip Irrigation in the Florida Tomato Industry, 1994

	Entire Sample	Northwest	Southwest	South
Number of Growers	64	19	31	14
Number of Acres	28,022	1,871	13,460	12,691
Growers Using Drip	46	19	19	8
Acreage in Drip	14,131	1,728	6,470	5,933
Total Investment in Drip Irrigation	$8,935,704	$910,989	$3,019,765	$5,004,950
Investment per Acre in Drip Irrigation	$632.36	$527.30	$466.73	$843.58
Proportion of Growers Using Drip Irrigation	71.9%	100%	61.3%	57.1%
Proportion of Acreage in Drip Irrigation	50.4%	92.4%	48.1%	46.7%

There are important differences in the rates of adoption between growers in different water management districts. In Northwest Florida, 100 percent of the growers use drip over about 92 percent of the 1994 production area. The proportion of growers using drip irrigation is lower in Southwest Florida and South Florida, measuring about 61 percent and 57 percent, respectively. The proportion of 1994 production area in drip is about 48 percent in Southwest Florida and about 47 percent in South Florida. Average investment per acre for in-bed drip ranged from about $844

per acre in South Florida, $527 per acre in Northwest Florida, to $467 per acre in Southwest Florida. The higher investment costs in South Florida are due in part to the greater use of computerized systems.

4.3. Grower's General Attitudes Toward Drip Irrigation Technology

4.3.1. Adopters and Non-Adopters of Drip Irrigation

For the period just prior to adoption, adopters of drip irrigation thought that the adoption decision would be quite wise and useful, as well as slightly beneficial and desirable (table 4.4). Adopters were neutral with respect to their expectations about whether drip would be pleasant or unpleasant. The overall general grower attitude towards adoption, as measured by "Average Attitude", ranks as slightly favorable.

Table 4.4 General Attitudes Held by Non-Adopters and Adopters of Drip Irrigation Concerning Drip Irrigation Technology, Tomato Producers, Prior to Adoption and 1995

General Attitudes	Period Prior to Adoption[a]		Current Time Period[a]	
Adoption of drip irrigation is:[b]	Adopters	Non-Adopters	Adopters	Non-Adopters
Wise:Foolish	5.61	5.11	6.54	5.11***
Beneficial:Harmful	5.41	4.50**	6.50	5.00***
Useful:Useless	5.63	4.94	6.52	5.50**
Good:Bad	5.50	3.94***	6.22	4.72**
Pleasant:Unpleasant	4.39	3.83	5.11	4.33
Desirable:Undesirable	5.20	4.56	6.41	5.11**
Average Attitude	5.29	4.48	6.22	4.96

[a] Asterisks show adopters differ significantly from non-adopters (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

[b] Defined on a 7 to 1 scale with, for example, 7 = extremely wise and 1 = extremely foolish. A score of 4 means neutral.

In the past, non-adopter attitudes towards the use of drip have been less positive than those of adopters. Non-adopters responded that adoption of drip would be either neutral or only slightly beneficial, useful, desirable, or wise. Non-adopters also thought adoption would be somewhat unpleasant, meaning it would require more labor. The Average Attitude of non-adopters showed that they were neutral to the adoption decision.

Comparisons between adopters and non-adopters show that adopters expected drip irrigation to be significantly more beneficial than non-adopters. In general, adopters had a more positive overall attitude towards drip technology as measured by the Average Attitude for each group. Whatever the reason for this favorable pre-adoption disposition towards drip (better extension, information; more exposure to the technology), it is important to note that a positive attitude toward the technology appears related to actual adoption.

It is noteworthy that the attitudes toward drip irrigation technology has grown more favorable in all categories for both groups. The Average Attitude of adopters is quite favorable now, and that of non-adopters is slightly favorable. In all categories except "pleasant," adopters now have significantly stronger positive attitudes toward drip than non-adopters.

4.3.2. General Grower Attitudes by Water Management District

For the period prior to adoption, Northwest grower attitudes towards drip were quite positive (table 4.5). Northwest growers expected the use of drip to be quite wise, beneficial, and useful, but gave a relatively low rating to "pleasantness."

Table 4.5 General Grower Attitudes by Water Management District Concerning Drip Irrigation Technology, Tomato Producers, Prior to Adoption and 1995

General Attitudes	Period Prior to Adoption[a]			Current Time Period[a]		
Adoption of drip irrigation is:[b]	Northwest	Southwest	South	Northwest	Southwest	South
Wise:Foolish	6.05	5.23**	5.21*	7.00	5.65***	6.07**
Beneficial:Harmful	5.68	4.81*	5.21	6.95	5.58**	6.00**
Useful:Useless	5.89	5.16	5.43	7.00	5.77**	6.20**
Good:Bad	6.11	4.68**	4.50**	6.95	5.16***	5.64**
Pleasant:Unpleasant	4.63	3.87	4.50	5.74	4.29**	5.07
Desirable:Undesirable	5.37	4.61	5.43	6.84	5.52***	6.14**
Average Attitude	5.62	4.73	5.05	6.75	5.33	5.85

[a] Asterisks show at what level growers in the Southwest and South differ significantly from Northwest growers (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).
[b] Defined on a 7 to 1 scale with, for example, 7 = extremely wise and 1 - extremely foolish. A score of 4 means neutral.

Five to ten years ago Southwest and South Florida growers were not as positive about drip irrigation, as measured by their Average Attitudes. In Southwest Florida, growers rated the adoption decision as only slightly wise, beneficial, or useful, and thought that adoption would be somewhat unpleasant. They rated the adoption decision as significantly less beneficial and wise

compared to Northwest growers. Growers in South Florida expected the adoption to be slightly favorable, but their attitude with respect to the wisdom of adoption was significantly weaker compared to Northwest growers.

Compared to the period just prior to adoption, the Average Attitude of growers in all regions is now more positive. A major difference is that the view towards the adoption decision held by Northwest growers (where all growers use drip) is now significantly more positive than growers in the other districts. Northwest growers seem to be convinced of the merits of drip irrigation.

The current high Average Attitudes towards drip, combined with a high percentage of non-adopters, suggests that there may be other, more specific reasons why greater rates of adoption have not taken place in the South and Southwest areas. We thus turn to grower beliefs about the profitability and specific attributes of drip irrigation technology.

4.4 Grower Beliefs About the Attributes and Profitability of Drip Irrigation

Grower beliefs toward the specific attributes and average profitability of drip irrigation are measured by a series of statements. The statements include reducing fuel and electricity for pumping water, fertilizer, pesticides, labor and management, water withdrawn, and pump engine or motor size for irrigation. These are beliefs toward the efficacy of drip irrigation to reduce costs. Statements associated with increasing yield, and improving profit and tomato quality reflect the technology's revenue enhancing effects.

4.4.1. Attribute and Profitability Beliefs by Adopter Status

Just prior to adoption, adopters of drip irrigation had specific expectations of what drip irrigation could do for them (table 4.6). Adopters thought that it would be slightly to quite likely that using drip would reduce fuel and electricity for pumping water, decrease water withdrawn for irrigation, and increase yield. Adopters were either neutral or believed it would only be slightly likely that use of drip would result in reducing fertilizer or the engine size for irrigation, increased farm profit, or improve tomato and water quality. They also believed that it would be slightly to quite unlikely that use of drip would result in a reduction of pesticides and labor and management effort, or decrease overall production costs. Use of drip appears to be related to selected cost-decreasing features of the technology and the revenue enhancing effect of increased yields. Overall, however, the expectation that adoption would be profitable, as measured by Average Profitability, shows that adopters believed drip would be either neutral or have a slightly positive effect on profits. This relatively low expected measure of profitability can be explained by the belief that use of drip was likely to increase labor and management and overall production costs.

Table 4.6 Beliefs of Tomato Growers Concerning the Results of Using Drip Irrigation, Adopters and Non-Adopters of Drip Irrigation, Prior to Adoption and 1995

Belief Statements	Period Prior to Adoption[a]		Current Time Period[a]	
A Drip Irrigation System Results in:[b]	Adopters	Non-Adopters	Adopters	Non-Adopters
Reducing fuel and electricity for pumping water:	5.93	5.11**	6.43	5.22***
Reducing fertilizer applied:	4.76	4.22	4.80	3.94
Reducing pesticides applied:	3.89	1.89***	3.74	1.78***
Reducing labor and management:	3.02	2.17*	2.76	1.50**
Decreasing water withdrawn:	5.96	5.22**	5.89	6.00
Increasing yield:	5.26	4.50*	5.85	5.22
Decreasing overall production costs:	2.63	2.83	2.98	2.44
Reducing engine or motor size for irrigation:	4.42	3.67	4.33	3.33
Increase overall farm profit:	4.63	4.27	5.04	3.89***
Improve tomato quality:	4.82	4.17	5.26	4.56
Improve water quality:	4.73	4.11	4.96	4.11
Average Profitability	4.55	3.83	4.73	3.82

[a] Asterisks show how adopters differ significantly from non-adopters (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

[b] Defined on a 7 to 1 scale with 7 = extremely likely and 1 = extremely unlikely. A score of 4 means neutral.

How did the expected beliefs of adopters compare to non-adopters? For the period five to ten years ago, non-adopters did not have very many strong beliefs about what drip irrigation could or could not do. Most rankings of non-adopters reflect either neutral or only slightly likely belief statements (reducing fuel and electricity, reducing fertilizer, decreasing water withdrawn, increasing overall farm profit, and improving tomato and water quality). Non-adopters expected that it would be extremely to slightly unlikely that use of drip would result in reducing pesticides, labor and management effort, or motor size, or decreasing overall production costs. Overall, non-adopters believed that use of drip would be unprofitable, as measured by Average Profitability.

Compared to non-adopters, adopters of drip believed it would be significantly more likely that use of drip would result in reducing fuel and electricity, pesticide and water use, and increase yield. These beliefs may have been conditioned by more exposure to the use of drip irrigation or

perhaps better information received from equipment dealers, extension agents or experiment station personnel.

What do adopters and non-adopters of drip now believe? Compared to the period prior to adoption, adopters believe more strongly that drip results in reducing fuel and electricity, increasing yield, increasing overall farm profit, and improving tomato and water quality. Adopters' beliefs concerning reductions in fertilizer and reducing water withdrawals and engine size for pumping have not changed much. Positive beliefs are counterbalanced by adopter's stronger perception that drip results in increased labor and management costs. Adopters still believe that it is slightly to quite unlikely that adoption of drip irrigation results in a decrease in overall production costs. The Average Profitability for adopters is higher than for the period prior to adoption, but the ranking is still neutral or only slightly profitable. Thus, while growers have decided to use drip, there appears to be real financial trade-offs.

For the current time period, non-adopter beliefs about the individual characteristics of drip have changed in both a positive and negative sense. On the positive side, non-adopters now believe that it is more likely that drip irrigation results in decreasing water withdrawn, increasing yield and improving tomato quality. On the negative side, non-adopters believe that it is less likely that drip will result in reducing fertilizer, pesticides, or labor and management effort, decrease overall production costs or increase farm profit. There was virtually no change in grower beliefs concerning the reduction of fuel and electricity or engine size for pumping, or the improvement of water quality resulting from the use of drip irrigation.

In general, the positive aspects of adoption appear to be offset by negative expectations of what adoption of drip irrigation will result in. This is reflected in the measure of Average Profitability which shows that the non-adopters still believe that use of drip is unlikely to be profitable. Without some assurance that the perceived negative attributes of drip can be overcome, adoption rates are not likely to increase among current non-users.

4.4.2. Attribute and Profitability Beliefs by Water Management District

For the period prior to adoption, Northwest growers expected that it would be slightly to quite likely that adoption of drip irrigation would result in reducing fuel and electricity for pumping water, decreasing fertilizer and pesticide use and water withdrawn, reducing engine size, and improving yield, tomato quality, and overall farm profit (table 4.7). They were neutral with respect to whether drip would result in a reduction of labor and management effort, or the improvement of water quality. Northwest growers considered it slightly unlikely that adoption would result in decreased production costs. Overall, Northwest growers expected the use of drip to be slightly profitable, as measured by Average Profitability.

Table 4.7 Beliefs of Tomato Growers Concerning the Results of Using Drip Irrigation, by Water Management District, Prior to Adoption and 1995

Belief Statements	Period Prior to Adoption[a]			Current Time Period[a]		
A drip irrigation system results in:[b]	Northwest	Southwest	South	Northwest	Southwest	South
Reducing fuel and electricity for pumping water:	5.63	5.61	6.00	6.53	5.68**	6.43
Reducing fertilizer applied:	5.11	4.19*	4.86	5.79	3.90***	4.36**
Reducing pesticides applied:	4.95	2.52***	2.93**	4.84	2.45***	2.57**
Reducing labor and management:	4.32	2.06***	2.29**	3.95	1.90**	1.43**
Decreasing water withdrawn:	6.11	5.52	5.79	5.74	5.77	6.50
Increasing yield:	5.74	4.68*	4.93	6.26	5.19**	5.93
Decreasing overall production costs:	3.00	2.48	2.71	3.37	2.42*	3.00
Reducing engine or motor size for irrigation:	5.00	3.87*	3.93	4.94	3.74*	3.57*
Increase overall farm profit:	5.42	3.93**	4.64*	5.58	4.29**	4.50*
Improved tomato quality:	5.58	4.19**	4.36**	5.63	4.90	4.64
Improved water quality:	4.67	4.52	4.50	4.83	4.55	4.93
Average Profitability	5.05	3.96	4.27	5.22	4.07	4.35

[a] Asterisks show how growers in the Southwest and South districts differ significantly from Northwest growers (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

[b] Defined on a 7 to 1 scale with 7 = extremely likely and 1 = extremely unlikely. A score of 4 means neutral.

Compared to Northwest growers, Southwest and South growers expressed lower expectations that drip would result in cost-reducing or income enhancing benefits. Southwest growers had significantly lower expectations with respect to a reduction in fertilizer use, increased yields or farm profit, or improved tomato quality. Southwest growers expressed the belief that it would be slightly to quite unlikely that adoption of drip would result in reducing pesticides, engine size, or labor and management effort, decreased production costs, or increased farm profit. These low expectations are reflected in the neutral evaluation of the expected Average Profitability.

The differences in expected beliefs between Northwest and South growers were less pronounced. South growers believed that it was significantly less likely that adoption of drip would result in either increased farm profits or improved tomato quality. Similar to Southwest

growers, South growers believed that it would be slightly to quite unlikely that use of drip would result in a reduction in pesticide use or labor and management effort. The expected Average Profitability was rated as neutral.

Compared to the period prior to adoption, Northwest growers now believe that the drip is slightly more profitable. For example, Northwest growers consider it more likely that adoption will result in reducing fuel and electricity and fertilizer use, and increasing yield and farm profits. Although there has been some improvement, Northwest growers still believe that adoption is unlikely to result in decreased production costs. This belief is mirrored by grower responses that they now believe that adoption of drip is even less likely to reduce pesticide use or labor and management effort, or decrease the amount of water withdrawn for irrigation. Although the expected Average Profitability from adoption has increased, the increase is not significant compared to be period prior to adoption.

Southwest growers now believe that it is more likely that adoption of drip will result in reduced fuel and electricity costs, a decrease in water withdrawn, increased yields and profits, and improved tomato and water quality. These positive changes are contrasted against grower beliefs that there is less likelihood that drip will result in a reduction of pesticides, fertilizer, motor size, labor and management effort, and in general, a decrease in overall production costs. Compared to Northwest growers, Southwest growers now believe it is significantly less likely that adoption will result in reductions of pesticides, fertilizers, and labor and management effort, or a decrease in overall production costs. The Average Profitability rating of drip remains neutral for these growers.

The evolution of South grower beliefs concerning use of drip is very similar to Southwest growers. South growers now believe that drip irrigation can result in reduced use of fuel and/or electricity and water withdrawn, increased yield, and improved tomato and water quality. However, they also believe that it is significantly less likely that adoption will result in reduced use of pesticides and fertilizer or labor and management effort, or increased farm profit. The Average Profitability still shows that South growers are neutral.

5.0 Community Influence on Grower Decisions to Adopt Water Conserving Irrigation Technologies

Almost by definition resource use and resource conserving behavior are social actions because others are affected. The decision to adopt water conserving technologies and management practices can be influenced by a grower's perception of what the community at large, and what particular groups that make up that community, might expect him/her to do. This social dimension of grower choice behavior was examined in the survey.

Growers were asked if it were important to them whether specific groups in the community thought they should install and effectively manage water conserving technologies. These community groups included other growers in the area, extension and experiment station personnel, the growers association, water management district authorities, homeowners, the soil conservation service, county government personnel, irrigation equipment dealers, environmental groups, and family.

Growers were asked to rate the influence of each individual group on a seven-to-one scale with seven representing "very important" and one equaling "very unimportant." A score of four indicates "neither important nor unimportant" or "neutral". At the level of the total community influence, 70 (10 groups multiplied by a maximum score of 7) is equal to "very important," 10 is equal to "very unimportant," with 40 equal to "neither important or unimportant" or "neutral".

5.1. Influence of Community Groups by Adoption Status

Prior to adoption of drip irrigation, adopter's total community influence score was about 46, indicating a mid-way point between "neither important nor unimportant" and "slightly important" (table 5.1). The individual groups which received the highest scores (slightly important) included extension, experiment station and soil conservation service personnel, and family members. Those groups receiving the lowest scores were other farmers in the area and environmental groups. These results indicate that while total community influence was not strong, adopter-growers considered technical personnel and close family as somewhat important in their decision to adopt drip irrigation.

For the period five to ten years ago, the total community influence score for non-adopters was weak and almost identical to that of adopters (43.57). Only the water management district was cited as a group that non-adopters thought was slightly important to their decisions. With respect to the importance of specific groups, adopters did not significantly differ from non-adopters.

Compared to the period prior to adoption, total community influence now for adopters of drip irrigation, is higher and rated as more than slightly important. Overall social influence regarding the water conserving technology decisions of adopters has increased, albeit by not very much. Individual scores given to extension, experiment station, and soil conservation service personnel influence remain high, indicating that these technical assistance groups are still important to adoption decisions. Other farmers and irrigation equipment dealers remain the groups with the lowest influence.

Table 5.1 Community Influence over Grower Adoption of Water Conserving Technologies, Adopters and Non-Adopters of Drip Irrigation, Prior to Adoption and 1995

	Prior to adoption		Current Period	
Individual Groups[ab]	Adopters	Non-Adopters	Adopters	Non-Adopters
Other Area Farmers:	4.02	3.89	4.48	4.22
Extension and Experiment Station:	5.07	4.39	5.59	4.83
Growers Association:	4.59	4.22	5.00	4.56
Water Management District:	4.61	5.06	5.23	5.44
Non-Farmers (e.g. Homeowners):	4.37	4.22	4.89	4.56
Soil Conservation Service:	4.96	4.56	5.41	4.77
County Government:	4.80	4.67	5.15	4.95
Irrigation Equipment Dealers:	4.19	3.56	4.43	3.94
Environmental Groups:	4.11	4.28	4.67	4.61
Family:	5.07	4.72	5.58	4.89
Total Community Influence	45.79	43.57	50.43	46.76

[a] Asterisks show how adopters of drip irrigation differ significantly from non-adopters (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).
[b] Individual group scores are defined on a 7 to 1 scale with 7 = extremely important and 1 = extremely unimportant. A score of 4 means neutral. Total community influence scores are the sum of individual group scores. A community value score of 70 would represent that community influence is "very important" (10 groups multiplied by 7), etc.

Although current total community influence on non-adopters also increased relative to the past, the increase is marginal. The water management district continues to be the most important source of influence, and has become slightly more so over the last five to ten years. Other groups have gained in importance: extension, research station, and county government personnel, and family members.

Over time, total community influence over technology adoption decisions for adopters and non-adopters has increased, but more so for adopters. However, total community influence scores do not approach the rating of "very" or even "quite" important. This indicates that total community influence remains positive, but weak, as a factor in the adoption drip irrigation. As water becomes a scarcer resource in Florida, and as the effects of grower water use on others in community become more pronounced, the community influence over grower's technology decisions might increase. However, this influence may be in a more regulatory mode rather than adoption generated by an enhanced individual perception of social responsibility.

5.2. Community Influence by Water Management District Location

Total community influence scores prior to adoption for growers in all three districts are not significantly different from each other and range from "neither unimportant or important" to "slightly important" (table 5.2). The Northwest total community influence score comes the closest to being slightly important.

Individual groups perceived as slightly important to grower decisions varied between different districts, but none of the differences were statistically significant. In the Northwest, experiment station, research and soil conservation service personnel, and family, were all rated as being a little more than "slightly important". Those groups coming close to being slightly important included the local grower's association and county government personnel. In the Southwest district no individual group was rated as "slightly important," but family members came closest. In the South district, only the water management district received a score of "slightly important."

Similar to the results for the adopter and non-adopter categories, total community influence over grower installation and efficient management of water conserving technologies was positive, but weak in the period prior to adoption. In the Northwest, technical assistance personnel were considered as the most important influence. In the South, where growers cite some positive interactions with water management district personnel, this group was considered slightly important. In the most regulated district, the Southwest, total community and individual group influence were mostly neutral.

Relative to the past, total community influence for growers in all three districts increased in the current time period. The score for Northwest growers now exceeds the "slightly important" rating, but the total scores for the South and Southwest growers remain "neither important nor unimportant." There are no significant differences between total community influence scores or the scores for individual groups between growers in the three Districts.

The individual groups that were important to Northwest growers in the past are even more so today: extension, experiment station and soil conservation service personnel, and family members. All groups have gained in importance, but especially the water management district, environmental, and county government groups. This indicates that while Northwest growers still consider technical assistance groups to be most important to their decision making, governmental and environmental interests now play a more important role in influencing their water technology adoption and management decisions.

Table 5.2 Community Influence over Grower Adoption of Water Conserving Technologies, Growers by Water Management District, Prior to Adoption and 1995

	Prior to Adoption			Current Period		
Individual Groups[ab]	Northwest	Southwest	South	Northwest	Southwest	South
Other Area Farmers	4.00	3.90	4.14	4.47	3.89	4.35
Extension and Experiment Station:	5.26	4.74	4.64	5.79	5.29	5.00
Growers Association:	4.94	4.19	4.50	5.21	4.68	4.86
Water Management District:	4.63	4.65	5.07	5.32	5.23	4.42
Non-Farmers (e.g. Homeowners):	4.74	4.16	4.14	5.18	4.71	4.50
Soil Conservation Service:	5.16	4.71	4.71	5.68	5.09	4.93
County Government:	4.89	4.71	4.71	5.26	5.03	5.00
Irrigation Equipment Dealers:	4.32	3.71	4.26	4.42	4.10	4.57
Environmental Groups:	4.16	4.40	4.50	5.05	4.39	4.71
Family:	5.22	4.84	4.93	5.83	5.23	5.14
Total Community Influence	47.32	44.01	45.6	52.21	47.64	47.48

[a] Asterisks show how Northwest growers differ significantly South and Southwest growers. (* = 0.10 probability, ** = 0.05 probability and *** = 0.01 probability).

[b] Individual group scores are defined on a 7 to 1 scale with 7 = extremely important and 1 = extremely unimportant. A score of 4 means neutral. Total community influence scores are the sum of individual group scores. A community value score of 70 would represent that community influence is "very important" (10 groups multiplied by 7), etc.

Specific groups have become "slightly important" to Southwest growers, including experiment station, extension, soil conservation service, water management district, and county government personnel, and family members. This trend indicates a growing importance of the technical service and regulatory agency groups in grower decision making concerning water technologies.

South district growers currently rate four groups as "slightly important" to their decisions: family members, and extension, experiment station, soil conservation service, and county government personnel. Interestingly, water management district personnel are now considered less important to grower decisions than they were in the past.

There are clear trends for growers in all districts with respect to total community and individual group influence on their technology adoption decisions. First, although total community influence has increased, such influence is still only "slightly important" or "neither important nor unimportant". Secondly, growers in all three districts rate the influence of technical assistance and regulatory personnel much higher now than they did in the past. This latter finding suggests that technical assistance personnel, who can be voluntarily approached by growers, may be good channels for encouraging increased grower adoption of water conserving technologies. On the other hand, water management district and county government groups, which are associated with more control over grower technology decisions, also appear to be more important to growers.

6.0 Water Use Regulations, Grower Control, and Irrigation Technology Adoption

Historically, agricultural technology policy in Florida focused on university based extension education and demonstrations in joint partnership with the private sector. Grower associations encouraged good practices while Federal agencies provided technical assistance and cost sharing. There was little mandatory regulation.

The turning point came in the early 1970s when Floridians passed progressive environmental legislation. Florida put in place an administrative system for implementing a top down, some have called it a "micromanagement," approach to agricultural regulations. This section addresses two topics. The first is growers' perception of how water regulation affects the Florida tomato industry. The second addresses the role of control in growers' decisions to adopt drip irrigation technology.

6.1 Grower Beliefs Concerning Water Use Regulations

Table 6.1 shows grower's general views concerning water use regulations by water management district. The scale ranges from 7 to 1 with, for example, 7 equal to extremely wise and 1 equal to extremely foolish for the first scale. A score of four signifies "neither," meaning neutral. A general trend between time periods common to all three areas is that current water use regulations are considered wiser, more beneficial, and more useful than in the past. But, the general view of growers is that water use rules have only marginally become better, they are still perceived as having a neutral effect on the grower's farming operation. In the most highly regulated water use area, Southwest growers believe regulations have become more unpleasant to deal with.

Table 6.2 provides the same information as table 6.1 but on the basis of adopters versus non-adopters of drip irrigation. On average, adopters and non-adopters believe that water use regulations have become wiser, and more useful and beneficial over time. The mean score on how good regulations are now is significantly higher for the adopters. Both groups expressed the belief that water use regulations were and are neutral in their effects. However, adopters and non-adopters believe that water regulations have become more unpleasant over time.

Table 6.1 General Views Held by Tomato Producers Concerning Water Use Regulations Prior to Adoption (then) and in 1995 (now)

General Views						
	Northwest[a]		Southwest[a]		South[a]	
Agricultural Water Use Regulations are[c]:	Then[b]	Now	Then[b]	Now	Then[b]	Now
Wise:Foolish[d]	4.00	4.89	4.55	5.00	4.36	4.57
Beneficial:Harmful	4.15	4.63	4.33	4.26	3.71	3.85
Useful:Useless	3.84	4.52	4.40	4.43	3.86	4.43
Good:Bad	4.05	4.90	4.23	4.53	4.07	4.50
Pleasant:Unpleasant	3.31	3.36	3.13	2.87	3.35	3.50
Desirable:Undesirable	3.63	4.42	3.87	3.96	3.42	3.85

[a] Figures represent mean responses of growers.
[b] "Then" represents five years prior to adoption for adopters and "5 to 10 years ago for non-adopters."
[c] The differences between mean grower responses between districts were not statistically significant.
[d] Defined on a 7 to 1 scale, with, for example, 7 = extremely wise and 1 = extremely foolish.

Table 6.2. General Views Held by Non-adopters and Adopters of Drip Irrigation Concerning Water Use Regulations, Tomato Producers, Prior to Adoption (Then) and in 1995 (Now).

General Attitudes	Non-Adopters[a]		Adopters[a]	
Agricultural Water Use Regulations are:[cd]	Then[b]	Now	Then[b]	Now
Wise:Foolish	4.44	4.50	4.30	5.02
Beneficial:Harmful	4.00	4.05	4.20	4.37
Useful:Useless	4.11	4.44	4.11	4.47
Good:Bad	3.78	4.00	4.29	4.88**
Pleasant:Unpleasant	3.27	3.06	3.22	3.20
Desirable:Undesirable	3.89	3.78	3.62	4.20

[a] Figures represent mean responses of growers.
[b] "Then" represents five years prior to adoption for adopters and "5 to 10 years ago for non-adopters."
[c] Asterisks show adopters differ significantly from non-adopters
(* = 0.10 probability; ** = 0.05 probability; and *** = 0.01 probability).
[d] Defined on a 7 to 1 scale, with, for example, 7 = extremely wise and
1 = extremely foolish.

Tables 6.3 and 6.4 show the percentage of growers that invest different levels of time and money in compliance with water use regulations in a typical year. Time and money costs include resources expended in attending district meetings, hiring consultants, and obtaining, modifying or renewing water use permits. Over eighty percent of growers in the Southwest and South spend from 8 or more days complying with water use regulations (table 6.3). Over 50% of these growers spend more than 14 days. This time investment is compared to the time used by growers in the relatively unregulated Northwest district. In the Northwest, only 11% of the growers spend 14 days or more in complying with water use regulations, and 63% spend 1 day or less.

The distribution of money costs of compliance across the three districts are similar to time investments. 53 percent of the South growers, and 41% of Southwest growers, reported expenditures of $30,000 or more, respectively. None of the Northwest growers fell into this cost category. About 11% of the Northwest growers reported money expenses of $2001 to $10,000. 86 percent of the South growers and 67% of Southwest growers spent $2001 or more in complying with water use regulations in 1994.

Non-adopters of drip irrigation technology invest both more time and money in complying with water use regulations than adopters (table 6.4). In terms of time, 78% of non-adopters expend 8 or more days in compliance, with 56% spending more than 2 weeks. This is compared with adopters of drip, 50% of whom spend 8 days or more in compliance.

In terms of money expenditures, 63% of non-adopters spend $30,000 or more in a typical year complying with water use regulations. Only 21% of the adopters spend this much money. Over one-half of the adopters (53%) spend $2000 or less in annual compliance costs, while only 31% of non-adopters fall within this expenditure category.

Two observations are clear from the data in tables 6.3 and 6.4. First, growers in the relatively less regulated Northwest spend substantially fewer resources in terms of time and money in compliance with water use regulations than growers in the southwest and south. Secondly, a higher percentage non-adopters of drip irrigation expend more resources than adopters in compliance. Because Northwest growers are all adopters of drip, and face fewer regulatory costs, non-adopters of drip in the Southwest and South represent the majority of growers who invest the most time and money in complying with water use regulations.

A geographic shift in production area was considered unlikely by growers in all districts (table 6.5). However, growers in the Southwest and the South areas indicated that it is now more likely that water use regulations will result in less production and higher production costs than in the past. In terms of water security, growers in all districts expressed uncertainty over whether the amount of water permitted to them would be adequate over the next 10 years, and whether or not adoption of water conserving technologies would ensure renewal of their water use permits. The highest level of uncertainty was recorded for growers in the relatively more regulated Southwest and the South areas. Adoption is viewed as increasing the probability of permit renewal in all districts.

Table 6.3 Percentage of Growers Investing Time and Money in Complying with Water Use Regulations, by Water Management Districts, 1994-95.

Time Cost	Northwest	Southwest	South
One Day or Less	63%	17%	8%
Two to Seven Days	21%	10%	8%
Eight to 14 Days	5%	17%	31%
More Than 14 Days	11%	63%	53%
Money Cost			
$100 or Less	50%	19%	7%
$101 to $500	17%	0	0
$501 to $1000	11%	7%	7%
$1001 to $2000	11%	7%	0
$2001 to $10,000	11%	16%	33%
$10,001 to $20,000	0	7%	0
$20,001 to $30,000	0	3%	0
$30,001 to $50,000	0	22%	33%
More Than $50,000	0	19%	20%

Table 6.4 Percentage of Growers Investing Time and Money in Complying with Water Use Regulations, by Non-Adopter and Adopter Status.

Time Cost	Percentage of Non-Adopters	Percentage of Adopters
One Day or Less	16%	34%
Two to Seven Days	6%	16%
Eight to 14 Days	22%	14%
More Than 14 Days	56%	36%
Money Cost		
$100 or Less	19%	29%
$101 to $500	0	7%
$501 to $1000	6%	9%
$1001 to $2000	6%	7%
$2001 to $10,000	6%	19%
$10,001 to $20,000	0	5%
$20,001 to $30,000	0	3%
$30,001 to $50,000	50%	7%
More Than $50,000	13%	14%

Table 6.5 General Beliefs Held by Tomato Growers Concerning the Impacts of Water Use Regulation, Prior to Adoption and in 1995.[a]

Belief Statements	Northwest		Southwest		South	
	Now	Then[b]	Now	Then[b]	Now	Then[b]
Florida Water Use Regulations:[cd]						
Will Cause Me to Shift Production to Other areas of Florida	2.85	3.37	3.30	3.93	2.57	2.71
Will Cause Me to Shift Production to Other States	2.79	3.37	2.87	3.07	2.62	2.46
Will Cause Me to Produce Less (Double Cropping Not Possible)	3.95	4.42	4.12	4.96	3.71	4.63
Will Increase Production Costs	5.16	5.16	5.35	6.10*	6.07	6.36**
Water Security:						
Amount of Water Permitted for My Use Will Be Adequate Over the Next Ten Years	4.63	4.94	4.83	4.69	5.35	5.14
The Use of Water Conserving Technology Ensures Renewal of My Water Use Permit	4.27	5.26	4.59	5.00	5.14*	5.21

[a] Figures represent mean responses of growers.

[b] "Then" represents five years prior to adoption for adopters and 5 to 10 years ago for non-adopters.

[c] Asterisks show growers in the Southwest and South differ significantly from growers in the Northwest (* = 0.10 probability; ** = 0.05 probability, and *** = 0.01 probability).

[d] Defined on a 7 to 1 scale, with 7 = extremely likely and 1 = extremely unlikely. A score of 4 means neutral.

Table 6.6 shows that adopters and non-adopters anticipate no geographic shift in production due to past or current water use regulations. Both groups believe that while it was unlikely that regulation caused less production in the past, it is now slightly likely. Adopters and non-adopters think it is likely that regulations cause increases in costs, but adopters relatively less so. Adopters differ from non-adopters in their current estimates of security to access of irrigation water. Adopters now have slightly less confidence than non-adopters that the amount of water permitted to them over the next ten years will be adequate. Adopters believe relatively more strongly that their current use of water conserving technologies ensures renewal of their water use permits.

6.2. The Role of Control in Grower Decisions to Adopt Drip Irrigation

A major supposition of economic theory is that producers can freely substitute inputs in order to maximize technical efficiency and income. In reality, however, no producer exercises complete volition over the inputs he/she uses in the production process. Growers face several types of constraints to free input substitution including, but not limited to, the availability of capital and the knowledge or ability these inputs. Drip irrigation is an input that is both expensive and difficult to operate efficiently.

Florida crop growers face an additional and increasingly important constraint to their ability to choose which irrigation systems they use. Over the past few years some of Florida's water management districts have set water use efficiency levels which can only be met by modern irrigation technologies (e.g. drip irrigation). Some districts have also tried to micro-manage agricultural water use, and indirectly, crop choice. Thus, regulatory policy is acting as an additional constraint to grower technology selection.

This section describes survey results with respect to grower's perceptions of the amount of control they have over the adoption of drip irrigation. Also discussed is how important control over technology decisions is to growers and whether compliance with water-related technology regulations is important. Grower perceptions were solicited using control statements that represented four general categories of constraints. The first category asks growers how much control they have over the decision to install drip irrigation. The second statement asks growers if they believe regulatory agencies can require them to use drip irrigation. Thirdly, growers were asked if using drip was easy or difficult in order to indicate the degree to which knowledge or ability is a constraint to adoption. Lastly, growers rated the degree to which investment capital acted as a constraint to the adoption decision.

The individual scores for five control statements were totaled to give a measure of the overall control that growers perceived they had over the adoption decision. Finally, growers were asked if control over technology decisions and compliance with water use regulations were important to them.

How much control or volition do growers believe they have over technological choices, how important is this control to growers, and how important is it to growers to comply with technology regulations? Table 6.7 shows the degree of control growers in different water management districts believe they have over choices of water conserving technologies. While the growers in all areas, and across time, believe they have a high degree of control over the choice to use drip irrigation, they also believe that regulatory agencies are now better able to require use of drip.

Table 6.6 General Beliefs Held by Tomato Growers Concerning the Impacts of Water Use Regulation, Prior to Adoption and in 1995.[a]

Belief Statements[cd]	Non-Adopters		Adopters	
	Then[b]	Now	Then[b]	Now
Florida Water Use Regulations:				
Will Cause me to Shift Production to other Areas of Florida	2.94	3.06	3.02	3.82
Will Cause me to Shift Production to Other States	2.16	2.06	3.05*	3.43***
Will Cause me to Produce Less (Double Cropping not Possible)	4.00	4.56	3.98	4.74
Will Increase Production Costs	5.89	6.44	5.28	5.65*
Water Security:				
Amount of Water Permitted for my Use will be Adequate Over the Next Ten Years	5.31	4.93	4.74	4.83
The Use of Water Conserving Technology Ensures Renewal of my Water Use Permit	4.75	5.06	4.59	5.14

[a] Figures represent mean responses of growers.

[b] "Then" represents five years prior to adoption for adopters and 5 to 10 years ago for non-adopters.

[c] Asterisks show adopters differ significantly from non-adopters. (* = 0.10 probability; ** = 0.05 probability, and *** = 0.01 probability).

[d] Defined on a 7 to 1 scale, with 7 = extremely likely and 1 = extremely unlikely.
A score of 4 means neither.

Table 6.7 Perceived Grower Control over the Adoption of Drip Irrigation by Water Management District, Prior to Adoption and 1995

	Prior to Adoption			Current Period		
Control Issue[a]	Northwest	Southwest	South	Northwest	Southwest	South
Control over Installation of Drip Irrigation[b]	6.47	5.65*	5.35*	5.57	5.68	5.64
Regulatory Agencies Cannot Require Drip Installation[c]	5.53	3.97**	3.93**	3.58	2.90	3.29
Drip Irrigation is Easy to Use[d]	3.52	2.71	2.71	5.26	2.93***	3.29**
Borrowing Money to Invest in Drip is Easy[e]	3.84	3.48	3.57	3.37	3.65	3.50
Taking Money from Current Income to Invest in Drip is Easy[e]	3.63	3.19	3.57	3.58	3.29	3.50
Total Perceived Control[f]	22.99	19.00	19.13	21.36	18.45	19.22
Control Over Decisions[g] to Install Technology is Important to Me	5.95	6.05	6.03	6.51	6.14	6.35
Compliance with Water[g] Technology Regulations is Important	4.68	5.74	5.38	6.03	5.71	5.79

[a] Asterisks show how adopters of drip irrigation differ significantly from non-adopters (* = 0.10 probability, ** = 0.5 probability and *** = 0.01 probability).

[b] The level of grower control is defined on a 7 to 1 scale with 7 = extreme complete control and 1 = extremely little control. A score of 4 means neither.

[c] The level of regulatory control is defined on a 7 to 1 scale with 7 = extremely likely and 1 = extremely unlikely. A score of 4 means neither.

[d] The level of difficulty is defined on a 7 to 1 scale with 7 = extremely easy and 1 = extremely difficult. A score of 4 means neither.

[e] Borrowing or using current income is defined on a 7 to 1 scale with 7 = extremely true and 1 = extremely false. A score of 4 means neither.

[f] Total grower perception of control is the sum of individual group scores. A total control score of 35 would represent extremely complete control.

[g] Defined on a 7 to 1 scale with 7 = extremely important and 1 = extremely unimportant.

Two interesting observations can be made from the data in table 6.7. First, in the period prior to adoption, growers in the South and Southwest believed it was significantly less likely that regulatory agencies could require the use of drip irrigation. Second, growers in the South and Southwest Districts currently believe that drip is significantly more difficult to use than Northwest growers.

Table 6.8 looks at control and compliance evaluations of adopters and non-adopters. Growers in both groups believe they now have control over the decision to use drip irrigation, but less so than in the past. They also perceive that while regulatory agencies are slightly likely to require use of drip irrigation, the perception has become stronger over time.

Though compliance with water technology regulations has become more important over time for both groups, even adopters believe they have less control over irrigation technology choices now than in the past. Control over technology choices are now more important for adopters than non-adopters, reflecting the view that compliance today does not necessarily guarantee freedom of choice tomorrow.

6.2.1. Perceived Control by Adopter Status

Prior to the adoption of drip, adopters were generally neutral with respect to the level of control they had for the decision to install drip irrigation, as measured by Total Perceived Control (table 6.8). However, individual constraints were evaluated differently. In general, adopters thought they had almost complete control over the adoption decision (Statement 1). On the other hand, adopters were neutral or thought that it was only slightly likely that water management districts could require the use of drip. Some doubt therefore existed over whether the districts could or could not require them to use this technology, indicating that growers did not consider the choice as completely free.

Concerning knowledge or ability to use drip, adopters indicated they expected drip to be slightly difficult to use. They also said that borrowing money or taking money from current income to invest in drip would not be easy. Thus, while adopters believed they exercised a high degree of control over the choice to use drip, they also believed that there were knowledge and financial constraints to adoption.

Compared to adopters, non-adopters perceived they had less control over the potential adoption decision. The total perceived control score indicates that non-adopters believed the (potential) adoption decision would not be completely voluntary. Their score ranged between "slightly little control" to neutral and was lower than that for adopters of drip. There appear to be several reasons for this.

First, non-adopters believed that it was likely that regulatory agencies could require installation of drip irrigation. Secondly, non-adopters believed that using drip would be quite difficult, indicating that the knowledge or ability to effectively use the technology could be acting

as a constraint to adoption. Non-adopters perceived that drip would be significantly more difficult to use than adopters expected. Thirdly, non-adopters also responded that borrowing money or taking money out of current income would be difficult for them, even more so than adopters.

Table 6.8 Perceived Grower Control Over the Adoption of Drip Irrigation, Adopters and Non-Adopters of Drip Irrigation, Prior to Adoption and 1995

	Prior to Adoption		Current Period	
Control Issue[a]	Adopters	Non-Adopters	Adopters	Non-Adopters
Control Over Installation of Drip Irrigation[b]	5.96	5.50	5.74	5.39
Regulatory Agencies Cannot Require Drip Installation[c]	4.70	3.72	3.17	3.22
Drip Irrigation is Easy to Use[d]	3.20	2.33*	3.98	3.00*
Borrowing Money to Invest in Drip is Easy[e]	3.65	3.50	3.63	3.28
Taking Money from Current Income to Invest in Drip is Easy[e]	3.48	3.22	3.54	3.06
Total Perceived Control[f]	20.99	18.27	20.06	17.95
Control Over Decisions to Install Technology is Important to Me[g]	6.17	6.28	5.98	6.37
Compliance with Water Technology Regulations	5.78	5.89	5.04*	5.89

[a] Asterisks show how adopters of drip irrigation differ significantly from non-adopters (* = 0.10 probability, ** = 0.5 probability and *** = 0.01 probability).

[b] The level of grower control is defined on a 7 to 1 scale with 7 = extreme complete control and 1 = extremely little control. A score of 4 means neither.

[c] the level of regulatory control is defined on a 7 to 1 scale with 7 = extremely likely and 1 = extremely unlikely. A score of 4 means neither.

[d] The level of difficulty is defined on a 7 to 1 scale with 7 = extremely easy and 1 = extremely difficult. A score of 4 means neither.

[e] Borrowing or using current income is defined on a 7 to 1 scale with 7 = extremely true and 1 = extremely false. A score of 4 means neither.

[f] Total grower perception of control is the sum of individual group scores. A total control score of 35 would represent extremely complete control.

[g] Defined on a 7 to 1 scale with 7 = extremely important and 1 = extremely unimportant.

In the current time period both adopters and non-adopters perceive that they have less control over the drip adoption decision than they did in the past, as measured by the Total Perceived Control score for both groups (table 6.8). Adopters still believe that, in general, they

have quite a bit of control over the adoption decision. However, they believe that it is now significantly more likely that regulatory agencies can require them to use drip. Adopters currently use of drip is neither easy nor difficult, an improvement over what they perceived before adoption.

Non-adopters now believe they have less over all control over the adoption decision and that regulatory agencies are now more likely to require them to use drip. Compared to the period five to ten years ago, non-adopters still rate the use of drip as difficult, and perceive they have less financial ability to invest in drip.

6.2.2. Perceived Control by Water Management District Location

In the period prior to adoption, Northwest growers were either neutral or believed they had a slight degree of control over the decision to adopt drip irrigation, as measured by Total Perceived Control (table 6.7). Because the Northwest water management district had been relatively non-regulatory, growers believed that it was quite unlikely that the district could require them to use drip irrigation. However, Northwest growers did perceive potential constraints to adoption. Specifically, that drip irrigation would be slightly difficult to use and that capital to invest in drip would not be easy to come by.

Compared to the Northwest, South and Southwest growers expressed the belief that they had less total control over the adoption decision. In particular, growers in both southern districts perceived that they had significantly less control of the adoption decision overall, and that it was significantly more likely that regulatory agencies could require them to use drip. This latter finding is not surprising given the more regulatory nature of the water management districts in these areas. Although there were no significant differences between growers with respect to capital constraints, South and Southwest growers also believe that financial resources for investing in drip are not easy to come by. Finally, drip was believed to be relatively more difficult to use by Southwest and South growers.

How have current beliefs about control over adoption evolved over time for growers in the three water management districts? First, Northwest and Southwest growers perceive that they have less control in the current period, while growers in the South district have about the same neutral perceptions as before (see scores for Total Perceived Control). The major reason for the perceived decrease in control amongst Northwest and Southwest growers is that they now feel more strongly that regulatory agencies can require them to use drip irrigation. Capital to invest in drip is still difficult to come by. While growers in all districts now consider drip easier to use than in the past, Southwest and South growers still find drip irrigation a difficult technology to employ.

6.3. Importance of Control over Technology Choice and Regulatory Compliance

Prior to adoption and now, both adopters and non-adopters of drip irrigation technology indicated that control over technology decisions was very important to them (table 6.8). Similarly, compliance with water regulations was quite important to adopters and non-adopters, for both the period before adoption and now. The only significant difference in response was that adopters, prior to the adoption of drip, thought it was less important to comply with water technology regulations than non-adopters. This may be due to adopter's perceptions that the water management districts have more power than they did in the past.

Table 6.7. shows grower scores with respect to technology control and regulatory compliance on the basis of water management district. For both time periods, growers in all districts indicated that control over technology decisions was very important to them. Compared to "Then", growers in all districts now consider control over technology decisions to be relatively more important. This is especially true amongst growers in the Southwest, which is the most heavily regulated in terms of agricultural water use.

In the "Then" period, compliance with water technology regulations differed between growers in different districts, but not significantly. Southwest and South growers indicated that it was slightly to quite important to comply, while Northwest growers said that compliance was "neither important or unimportant" to slightly important. For all growers, compliance now is more important than in the past, indicating that they may perceive compliance with technology regulations to be more strongly linked with continued access to water.