

**Drip/Micro Irrigation Survey  
For  
Delano–Earlimart Irrigation District**

by

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## Background

Delano-Earlimart ID (DEID) has kept informal statistics on the use of drip and micro-irrigation (drip/micro) within its boundaries for several years. These statistics showed that there has been only a slight increase in the acreage of these systems over the past 10 years. Because the rate and extent of conversion to drip/micro may influence the type of future water delivery service needed from DEID, DEID management is interested in knowing more about farmer perceptions regarding these newer irrigation methods.

DEID obtained a grant from USBR Mid-Pacific region to examine perceptions of its farmers regarding future conversions to drip and micro-irrigation. DEID then contracted with the Irrigation Training and Research Center (ITRC) at Cal Poly San Luis Obispo to conduct and analyze a survey of DEID farmers with the objectives of answering these questions:

1. Do farmers with drip/micro have different perceptions of drip/micro than the farmers who do not have drip/micro?
2. What do farmers consider to be benefits and disadvantages of drip/micro?
3. What, if any, bottlenecks to drip/micro adoption exist which the district might help remove?

ITRC developed an initial survey and an ITRC representative and Dale Brogan (DEID manager) met with a small group of growers on December 9, 1997. The growers completed the survey, and in the process provided valuable input on how to improve the questionnaire.

The December meeting resulted in the following changes:

1. Questions about actual acres of various irrigation methods were removed to protect the privacy of individual ownership units. Instead, questions were phrased in terms of “percentages”.
2. Questions about specific costs were removed, since many farmers felt that this information was private.
3. Questions about fields in other irrigation districts were removed.
4. The survey was reduced in scope. The first survey asked detailed questions by crop, and also asked some questions for which everyone gave the same answer.

The final Survey can be found in Appendix A. Forty-five farmers returned the completed forms.

This report presents pertinent data and results.

## Perceptions

For data comparison purposes, the farmers were first arranged into 3 groups:

- Group 1:** Those who already have drip/micro  
22 of the 45 farmers were in this group (49% of all)
- Group 2:** Those who do not yet have drip/micro, but plan to install it in the future  
12 of the farmers were in this group (27%)
- Group 3:** Those who do not have drip/micro, and do not plan to install it in the future.  
11 farmers were in this group (24%).

A few farmers did not answer all of the questions. Whenever data is presented in this report, the “percentage of farmers” refers to the percentage that replied to the question.

The following tables and graphs illustrate the items that seem most interesting. The first categories relate to questions about the TRUTH of various statements. The detailed responses are found in the appendices, and those detailed responses also show the numbers of farmers who answered that they didn’t know, or that their response was neutral.

Table 1. Perceptions to statements which are commonly made about drip/micro.

STATEMENT	% of farmers who believe the statement is TRUE at least most of the time			% of farmers who believe the statement is FALSE at least most of the time		
	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
Yield will increase	67	67	0	5	22	33
Crop quality will increase	57	56	0	0	22	33
Less water will be applied	71	56	67	19	11	0
Less electricity will be used for pumping	19	13	17	67	50	33
Overall farming will be easier	76	44	17	10	11	17
There will be less weeds, or easier to control	62	22	17	14	33	50
Drip/micro systems require more sophisticated labor	52	56	60	33	11	0
Labor cost will decrease	38	13	0	38	38	50
Irrigating will be easier	76	56	60	10	22	40
More dependent on well water and less on DEID	5	11	0	80	44	33
Reservoir is necessary at the DEID turnout	43	33	20	43	33	0
Insect damage will be less, or easier to control	24	33	17	29	22	50
Disease/fungus damage will be less, or easier to control	33	33	17	24	44	50
Rodent/animal problems will be significantly less	0	0	20	67	56	60
\$\$ payback justifies the investment	95	33	17	0	22	17

The following graphs help to illustrate some of the answers.

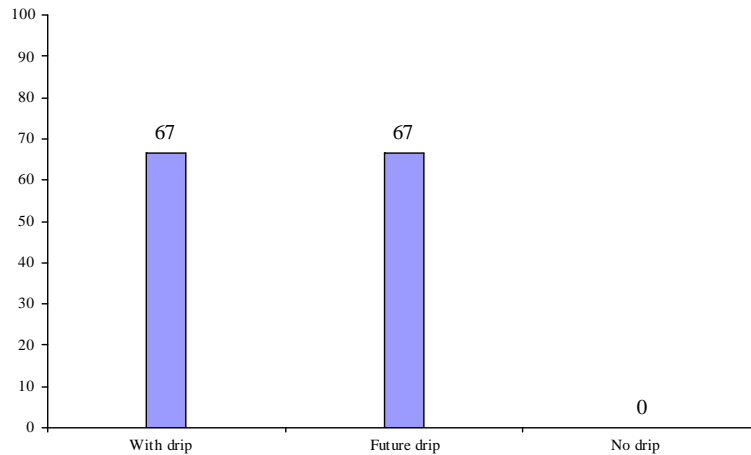


Figure 1. Percentage of farmers who think yields will increase with drip/micro irrigation.

Perhaps Figure 1 is the most interesting of all. In general, profits are closely tied to yields. If farmers do not see any potential yield increases with drip/micro, their motivation for investing in drip/micro is understandably low.

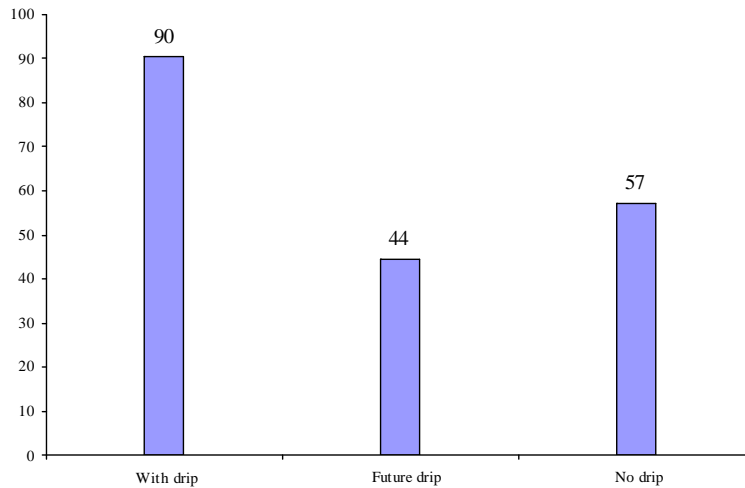


Figure 2. Percentage of farmers who think the crop quality improves with drip/micro irrigation.

Figure 2 shows that farmers who are not planning to invest in drip see some benefits in crop quality improvements, even though the overall yield may not increase (in their judgement). Those who already have drip are quite certain that both quality and yields will improve.

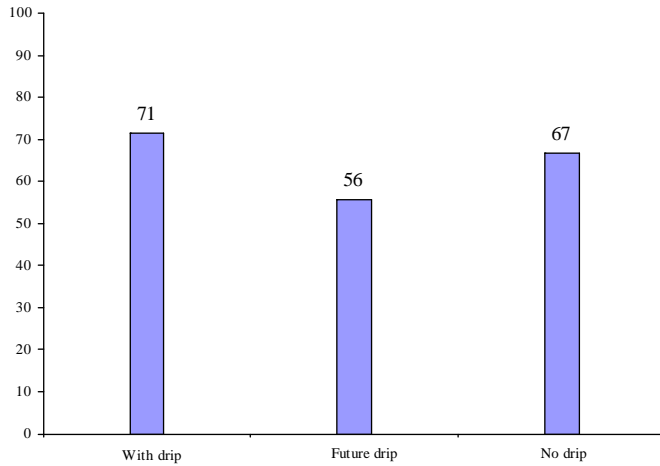


Figure 3. Percentage of farmers who think less water will be applied with drip/micro irrigation.

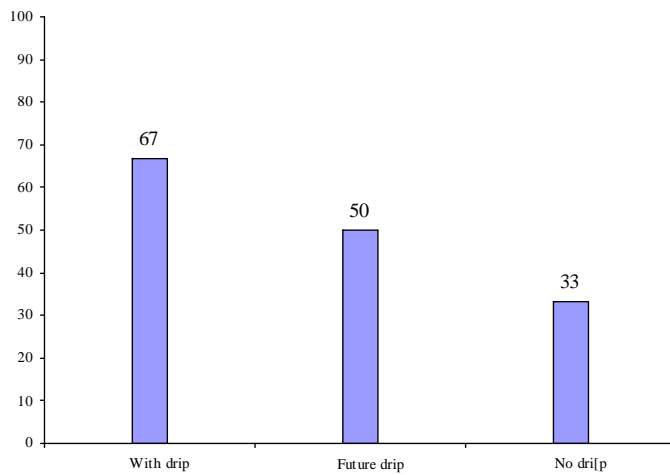


Figure 4. Percentage of farmers who do NOT think their electrical bills will decrease with drip/micro irrigation.

The difference in answers is surprising, because drip/micro systems almost always require a booster pump – as opposed to furrow/flood systems which typically do not. Perhaps those growers with drip/micro who think the electrical bills will be the same or lower are factoring in well water pumping.

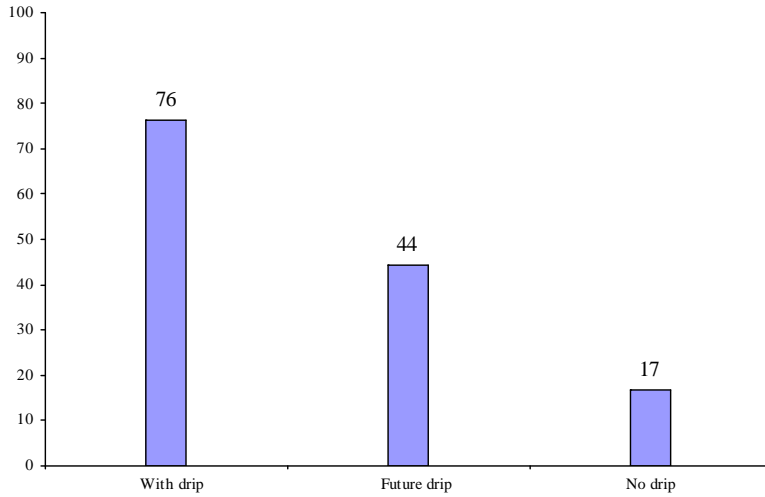


Figure 5. Percentage of farmers who think drip/micro irrigation makes farming easier.

Figure 5 can be combined with Figure 1 – if some farmers think the yields will not change, and that farming is as difficult or more difficult with drip, there is little incentive to convert to drip/micro. Again, those with drip/micro have a very different idea, based on their actual experiences.

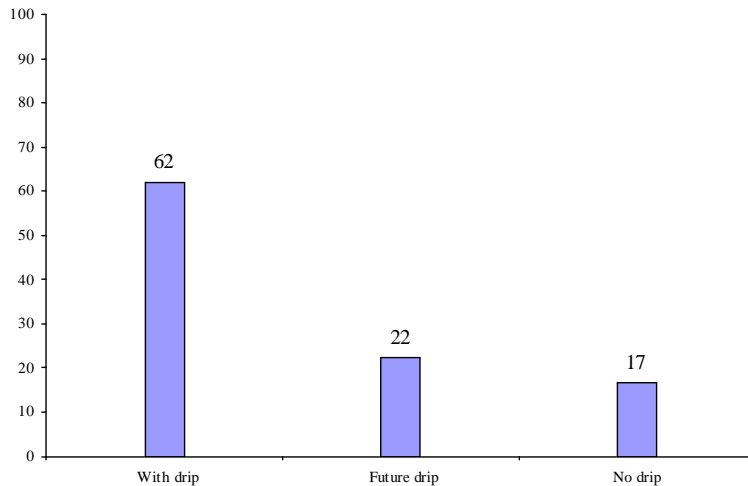


Figure 6. Percentage of farmers who think there are fewer weeds with drip/micro irrigation.

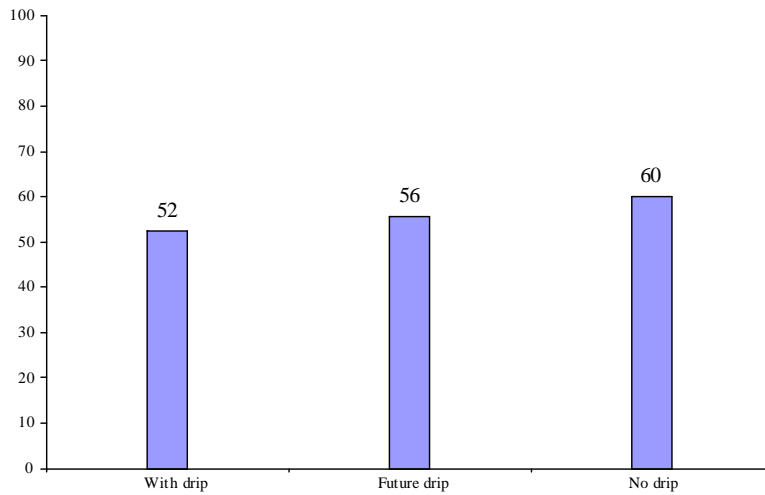


Figure 7. Percentage of farmers who think drip/micro irrigation needs more sophisticated labor.

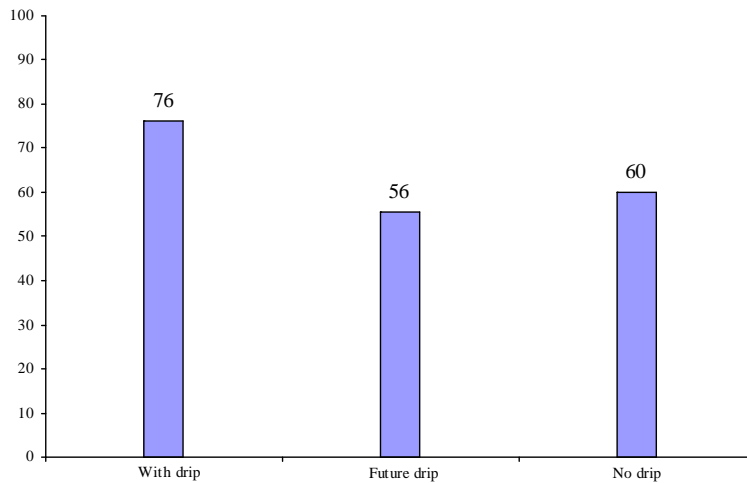


Figure 8. Percentage of farmers who think irrigation is easier with drip/micro.

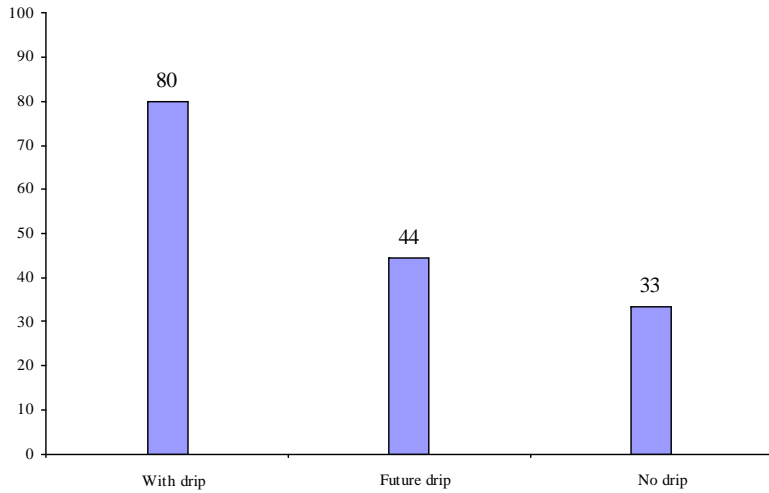


Figure 9. Percentage of farmers who do **NOT** think there is more dependency on water well with drip/micro.

Figure 9 shows some surprising results. In many districts it is well known that farmers switch to well water once they convert to drip/micro irrigation. The DEID situation may be different because of the availability of piped water and a fairly flexible operation.

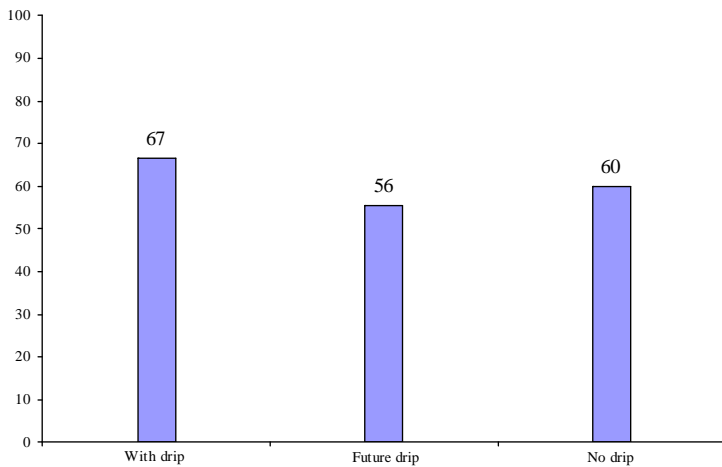


Figure 10. Percentage of farmers who believe the statement “there will be less rodent problems with drip/micro” is FALSE.

It appears that rodent problems with drip/micro are well known.



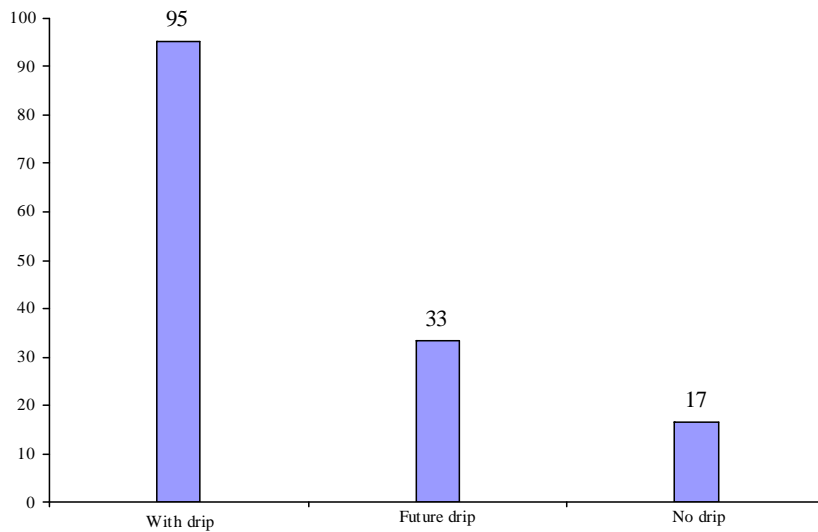


Figure 11. Percentage of farmers who think the dollar payback justifies the investment in drip/micro.

Figure 11 is literally a “bottom line” type of graph. Those with drip are typically convinced that it pays off, those who don’t have drip but are planning on it aren’t yet convinced about the payoff, and those who have no plans for drip are convinced that it won’t payoff.

It is one thing to believe that a statement is true or false. That factor may or may not be important when one considers whether to purchase a drip/micro irrigation system. The following table relates to such a question. Farmers were asked to rank factors in terms of the importance to them in deciding to convert to drip/micro irrigation.

Table 2. Importance of various factors in considering whether or not to purchase a drip/micro irrigation system.

FACTOR	This is a POSITIVE factor that influences the decision			This is a NEGATIVE factor that influences the decision		
	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
Yield will change	86	56	0	0	11	0
Crop quality will change	90	44	57	0	0	14
Less water will be applied	86	56	71	10	0	14
Less electricity will be used for pumping	43	33	57	48	56	0
Overall farming ease will change	81	56	50	0	22	17
Weed control	52	44	43	14	22	14
Degree of labor sophistication	24	33	50	24	22	17
Labor costs	43	50	40	10	0	40
Irrigating ease	76	67	60	0	0	40
Depend more on well water and less on DEID	0	22	60	48	33	20
Reservoir is necessary at the DEID turnout	25	67	17	35	11	50
Insect problems/control	33	50	17	5	13	33
Diseases/fungus problems/control	48	63	50	5	13	17
Rodent/animal problems	24	25	50	24	50	17
Payback period	67	50	50	19	38	50
Initial purchase cost	29	38	50	67	63	33

The top positive factors when considering a purchase, for those with drip/micro are:

- Yield will change
- Crop quality will change
- Less water will be applied
- Overall farming ease will change
- Irrigating will be easier

The top negative factors when considering a purchase, for those who are NOT planning to install drip/micro are:

- A reservoir is necessary at DEID turnouts
- The payback period is too long (although this was split 50/50 among this group)

The previous graphs intuitively indicate that there are large differences in the “YES” answers among the three groups of farmers. A Chi-Square statistical analysis was run to determine if the differences between responses of the three groups of farmers are statistically significant. Only one question did not show a statistical difference between the three groups – the question asking about the importance of weed control in making a purchase decision.

## Conversion to Drip/Micro

Farmers were asked about their current drip/micro status, as well as plans for the future. The survey did not ask for specific acreage numbers, so an answer of “50%” for one farmer may represent 5% of the district acreage of that crop, while another answer of “50%” may represent 20% of the district acreage of that crop. The table below indicates the average % values of the responses given in each category, not the % of acreage in the whole district. Nevertheless, the table below gives some indication of future trends.

There are three points which might be taken from the table:

1. For almonds and grapes, farmers are more willing to use drip/micro on new plantings than on existing plantings.
2. Most of the prunes, plums, olives, and pecans in the district can be expected to be under drip/micro irrigation in the near future.
3. Although drip/micro is widely used on grapes, almonds, and pistachios, there will only be a moderate (perhaps 50%) switch to drip/micro on new fields or on present surface irrigated fields.

Table 3. Trends with drip/micro acreage.

Crop	% of present acreage under drip/micro	% of future plantings to be put under drip/micro	% of present furrow/flood acres to be put under drip/micro
Grapes	29	45	33
Almonds	49	57	34
Pistachios	75	60	67
Apples	0	0	n/a
Cherries	33	0	n/a
Prunes	0	100	100
Plums	50	100	100
Olive	67	100	100
Pecans	0	0	100
Citrus	81	80	33

## Improved Service from DEID

Farmers were asked for recommendations, comments, and suggestions on how DEID can improve service. The survey did not contain a list of possible answers; rather, the farmers generated the recommendations and comments, themselves. The table below shows their responses.

Table 4. Farmer comments directed at DEID.

<u># of farmers giving this comment</u>	<u>Item</u>
<b>Concerns about Flexible Water Delivery</b>	
3	The 24 hours of notice to turn on and off the water causes increases of well water usage. They would like to have a shorter notice time
4	Steady flow rates into the reservoir are needed, or constant flow meters or head sensing devices at the district outlets.
2	DEID should guarantee delivery of water when requested, and it should be shut off when it is necessary.
2	Farmers should be allowed to adjust their flow rate to maintain a constant water level at the reservoirs.
1	Farmers themselves should be able to turn the water on and off.
1	Pressurized steel lines should be installed, so a reservoir would not be necessary.
<b>Information Requests</b>	
1	More detailed information on the monthly bills as daily GPM, on and off times, acre/feet per irrigation
1	Develop a yearly water district schedule
1	Proof that drip is better than furrows, if change is recommended.
1	Results from this survey
<b>Other</b>	
2	Cheaper water
1	Financing to change to drip systems
3	Pre-filtered water is needed, or at least water with less dirt

All of the items dealing with water delivery flexibility are being addressed by DEID at the moment, through its pilot SCADA (Supervisory Control and Data Acquisition) system, and its work with Cal Poly ITRC and USBR on new water ordering software and new turnout designs. The large number of responses about these issues indicates that they are important. It is unclear if the farmers are aware of these problems because DEID is now addressing them, or if they are aware of the problems but are unaware that DEID is trying to address them.

## Technical Questions About Drip/Micro

Farmers were also asked to list any technical questions regarding Drip/Micro that they might have, which DEID might help find answers for. Farmers asked the following questions:

- Is it a mistake to install a microsprinkler system without a storage reservoir? (The grower with this question has already installed a 160 acre system without a reservoir).
- What are the ET rates for crops within the district (per plant, per day)?
- Is it possible for DEID to provide irrigation design and “do it yourself” help to cut costs?

## Advice from Farmers Who Currently Have Drip/Micro

Farmers who currently have drip/micro systems were asked to pass advice along to persons who might be considering a switch from surface irrigation. The table below documents their responses to several questions.

Table 5. Advice from farmers with drip/micro. The number refers to the number of responses.

Question		Comments, largely unedited.
1. What are typical mistaken perceptions?	4	Large water savings.
	1	It's a money saver
	2	Use about same amount of water.
	1	Need for reservoir
	1	Ease of operation
	1	Don't use drip like flood - a little every day or at least often is better than a few large irrigations
	1	It is the best during 100 degree HOT days. In fact, there is no alternative to drip irrigation
	1	Improper design
	1	That it is difficult to repair
	1	That it is automatic
	1	Micro is easier than furrow
	1	Farming <b>will not</b> be easier or cheaper - just different
	1	Be patient, it takes time to get used to a new system. Carefully consider the type of filter you will use with your system. Ask friends for advice.
	1	Flood is cheaper!
1	It is not as easy as it seems to run short sets, such as 12 hours on/12 hours off.	

Question		Comments, largely unedited.
2. What problems did you did not foresee?	1	Poor service after installation and initial operation of system.
	3	Rodent damage
	1	Labor
	2	Maintenance
	1	Filter maintenance
	3	Coyotes
	1	Laborers cutting hoses
	1	Using canal or district water for drip irrigation
	2	Sand became a problem for filter
	1	Water penetration
	1	Hanging drip lines
	1	Control
	1	Too many to list
	1	It now takes an electrician to irrigate
	2	Vandalism
	1	Timing vs. need to irrigate
	1	Clogged or fully open emitters
	1	Kids pulling off emitters
1	Money needs	

Question	Comments, largely unedited.
3. For people in DEID who are planning to start with drip, what can you recommend regarding the following:	
Best soil type?	6 All
	3 Sandy loam
	1 High infiltration rate, very permeable
	1 Pistachios love drip, better environment (dry)
	1 Soil type not big factor
	1 Drip ok for new planting; don't use drip - use micro sprinkler for large trees
Best crop age (at planting, at 2 years, etc.)?	11 at planting
	1 2 years
	2 prior to planting
	1 all ages
	1 planting to 2 years
What major problems should they avoid, and how can they avoid them?	1 Make sure design of system will allow for at least 50% more than peak ET. We have one system that is marginal.
	1 Redesigning underground
	1 Don't spray for weeds under the vines and then start drip system. Chemical concentrate takes place.
	1 Develop clear understanding about design, method of installation, and time of installation.
	1 Accept higher initial cost for lower operating costs
	1 Get or use a certified IA designer for the system
	1 Best to wet all soil surface
	1 Improper system design & inadequate delivery capacity to trees
	1 Do not get behind on irrigation, you will never catch up. Avoid this by constantly checking soil moisture.
	1 Slack time, put in early
	1 Installation in slow period with no rain and pressure to irrigate
	1 Filtration important
	1 Gear up to irrigate large block, not 20 acres
What cautionary advice would you offer?	3 No cutting corners
	1 Put best system in
	1 Don't listen to people scared for drip irrigation
	1 Do not completely depend on system provider. Plan your own system in consultation with the engineer.
	1 Must be willing to relearn irrigation concepts
	1 Get a reputable installer or do it yourself
	1 Start slow or small
	1 Be sure you can cover the ranch in one day at 8 gallons per vine per day

Question		Comments, largely unedited.
4. For people in DEID first starting drip, what situations should they <b>avoid</b> ?		
Soil type	1	Complete sand? Although hydroponics is complete sand/rocks
	1	Sandy soil
	1	Low infiltration rate
	2	All
Crop age	1	Start young at the earliest possible, good for root formation
	1	First time drip irrigators should begin on young plantings
	1	Best at planting
	1	For grapes - no older than at 7-8 years
	1	Old crops
	1	Don't put in old crops
	1	More difficult to convert older vine, also need to have furrow system along with drip
Other	1	Use domestic components for ease of service and parts availability
	1	If the furrows you have work good, why change?
	1	Do it right



## Appendix A

### Grower Survey

**Page 1 – Grower Survey**

Name: \_\_\_\_\_

Farm: \_\_\_\_\_

Please answer the following for your **tree/vine** fields in **Delano-Earlimart ID**, only.

Crop	Percentage of all your present acreage under drip/micro (0-100 %)	Percentage of future plantings that will be put under drip/micro (0-100 %)	Percentage of present furrow/flood irrigation acres that will be converted to drip/micro (0-100 %)
Grapes			
Almonds			
Pistachios			
Apples			
Cherries			
Other			

\*\* For example, if 60 % of your grapes are furrow/flood irrigated and you plan to convert half of those to drip/micro, the answer would be 50 %.

Please list anything that DEID could do, related to its water service or regulations, which would influence your decision to use drip/micro irrigation or to improve your ease to water management with drip/micro irrigation: (use back of page if necessary).

Please list any technical questions regarding Drip/Micro irrigation that you have, for which DEID might help find answers: (use back of page if necessary).

**Page 2 – Grower Survey**

Please rank each of the statements in terms of their TRUTH. Use this scale.

1. Definitely true
2. True most of time
3. Neutral
4. Somewhat false, at least in some cases
5. Definitely false
6. Don't know

1	2	3	4	5	6	Statement
						Yield (tonnage per field) will increase
						Crop quality will increase
						Less water will be applied
						Less electricity or power will be use for pumping
						Overall farming will be easier
						There will be less weeds or they will be easier to control
						Drip/micro systems require more sophisticated labor
						Labor cost will decrease
						Irrigating will be easier
						You would need to depend more on well water and less on DEID
						A reservoir is necessary at the DEID turnout
						Insects/damage will be less or be easier to control
						Disease/fungus damage will be less or be easier to control
						Rodent/animal problems will be significantly less
						Considering all the factors, the \$\$ payback justifies the investment.

Please rank each of the following factors in terms of the IMPORTANCE to you in deciding to convert to drip/micro irrigation. Use this scale:

1. VERY important in a positive decision to convert.
2. This influences my decision positively, but is not very important.
3. Not a factor.
4. This is a negative factor in my decision, but it is not very important.
5. VERY important reason to not convert.

1	2	3	4	5	Factor
					Yield (tonnage per field) will change
					Crop quality will change
					Less water will be applied
					Less electricity or power will be used for pumping
					Overall farming ease will change
					Weed control
					Degree of labor sophistication
					Labor costs
					Irrigating ease
					You would depend more on well water and less on DEID
					A reservoir is necessary at the DEID turnout
					Insects problems/control
					Disease/fungus problem/control
					Rodent/animal problems

					Initial purchase cost
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**Page 3 – Grower Survey**

Optional

For farmers who already have Drip/Micro Irrigation

*What advice can you give farmers who are just starting with drip/micro?*

1. What are typical mistaken perceptions?
2. What problems did you have that you did not foresee?
3. For people in DEID who are planning to start with drip, what can you recommend regarding the following:
  - Best soil type
  - Best crop age (at planting, at 2 years, etc.)?
  - What major problems should they avoid and how can they avoid them?
  - What cautionary advice would you offer?
1. For people in DEID first starting drip, what situation should they avoid?
  - Soil type
  - Crop age
  - Other.

## Appendix B

### Responses of the Farmers Who Already Have Drip/Micro (Group 1)

(% of answers to each question)

<b>IS THE STATEMENT BELOW TRUE OR FALSE?</b>	Yes, True	True Most of the Time	Neutral	False sometimes	Definitely False	Don't Know
Yield will increase	24	43	24	5	0	5
Crop quality will improve	33	24	33	0	0	10
Less water will be applied	52	19	10	5	14	0
Less electricity will be used for pumping	14	5	14	10	57	0
Overall farming will be easier	48	29	14	5	5	0
There will be less weeds, or easier to control	33	29	24	5	10	0
Drip/micro systems require more sophisticated labor	24	29	14	5	29	0
Labor cost will decrease	29	10	24	10	29	0
Irrigating will be easier	48	29	14	5	5	0
More dependent on well water and less on DEID	0	5	15	10	70	0
Reservoir is necessary at the DEID turnout	33	10	10	14	29	5
Insects damage will be less, or easier to control	14	10	33	5	24	14
Disease/fungus damage will be less, or easier to control	14	19	33	10	14	10
Rodent/animal problems will be significantly less	0	0	19	19	48	14
\$\$ payback justifies the investment	52	43	5	0	0	0

How important are these factors in deciding to convert to drip/micro irrigation?  
 (Responses of the farmers with drip/micro at present)

<b>FACTOR</b>	Very Positive	Minor Positive	Not a Factor	Minor Negative	Very Negative
<b>Yield</b> will change	52	33	14	0	0
<b>Crop quality</b> will change	52	38	10	0	0
Less <b>water</b> will be applied	48	38	5	0	10
Less <b>electricity</b> will be used for pumping	24	19	10	29	19
Overall <b>farming</b> ease will change	71	10	19	0	0
<b>Weed</b> control	19	33	33	14	0
Degree of <b>labor</b> sophistication	10	14	52	19	5
<b>Labor costs</b>	24	19	48	10	0
<b>Irrigating</b> ease	62	14	24	0	0
Depend more on <b>well water</b> and less on DEID	0	0	52	19	29
<b>Reservoir</b> is necessary at the DEID turnout	20	5	40	20	15
<b>Insects</b> problems/control	5	29	62	5	0
<b>Diseases</b> /fungus problems/control	14	33	48	5	0
<b>Rodent</b> /animal problems	5	19	52	14	10
<b>Payback period</b>	38	29	14	14	5
Initial <b>purchase cost</b>	14	14	5	29	38

## Appendix C

### Responses of Farmers Who Do Not Currently Have Drip/Micro, But Who Plan to Convert Some/All Fields (Group 2)

(% of answers to each question)

<b>IS THE STATEMENT BELOW TRUE OR FALSE?</b>	Yes, True	True Most of the Time	Neutral	False sometimes	Definitely False	Don't Know
Yield will increase	33	33	0	11	11	11
Crop quality will improve	33	22	11	11	11	11
Less water will be applied	33	22	33	0	11	0
Less electricity will be used for pumping	0	13	13	13	38	25
Overall farming will be easier	11	33	22	0	11	22
There will be less weeds, or easier to control	0	22	22	11	22	22
Drip/micro systems require more sophisticated labor	0	56	11	0	11	22
Labor cost will decrease	13	0	38	25	13	13
Irrigating will be easier	11	44	11	11	11	11
More dependent on well water and less on DEID	11	0	33	22	22	11
Reservoir is necessary at the DEID turnout	11	22	11	11	22	22
Insects damage will be less, or easier to control	11	22	22	0	22	22
Disease/fungus damage will be less, or easier to control	11	22	0	11	33	22
Rodent/animal problems will be significantly less	0	0	11	11	44	33
\$\$ payback justifies the investment	11	22	22	0	22	22

How important are these factors in deciding to convert to drip/micro irrigation?

<b>FACTOR</b>	Very Positive	Minor Positive	Not a Factor	Minor Negative	Very Negative
Yield will change	22	33	33	11	0
Crop quality will change	33	11	56	0	0
Less water will be applied	33	22	44	0	0
Less electricity will be used for pumping	22	11	11	44	11
Overall farming ease will change	33	22	22	22	0
Weed control	22	22	33	22	0
Degree of labor sophistication	22	11	44	22	0
Labor costs	38	13	50	0	0
Irrigating ease	44	22	33	0	0
Depend more on well water and less on DEID	22	0	44	11	22
Reservoir is necessary at the DEID turnout	56	11	22	0	11
Insects problems/control	13	38	38	13	0
Diseases/fungus problems/control	25	38	25	13	0
Rodent/animal problems	25	0	25	25	25
Payback period	25	25	13	13	25
Initial purchase cost	38	0	0	0	63

## Appendix D

### Responses of Farmers Who Do Not Currently Have Drip/Micro and Who Do Not Have Plans to Install Drip/Micro in the Near Future (Group 3).

(% of answers to each question)

<b>IS THE STATEMENT BELOW TRUE OR FALSE?</b>	Yes, True	True Most of the Time	Neutral	False sometimes	Definitely False	Don't Know
Yield will increase	0	0	17	0	33	50
Crop quality will improve	0	0	17	0	33	50
Less water will be applied	33	33	0	0	0	33
Less electricity will be used for pumping	0	17	0	17	17	50
Overall farming will be easier	0	17	17	17	0	50
There will be less weeds, or easier to control	0	17	0	33	17	33
Drip/micro systems require more sophisticated labor	60	0	20	0	0	20
Labor cost will decrease	0	0	0	17	33	50
Irrigating will be easier	0	60	0	20	20	0
More dependent on well water and less on DEID	0	0	17	17	17	50
Reservoir is necessary at the DEID turnout	0	20	0	0	0	80
Insects damage will be less, or easier to control	0	17	0	17	33	33
Disease/fungus damage will be less, or easier to control	0	17	0	17	33	33
Rodent/animal problems will be significantly less	0	20	0	20	40	20
\$\$ payback justifies the investment	17	0	17	0	17	50

How important are these factors in deciding to convert to drip/micro irrigation?

<b>FACTOR</b>	Very Positive	Minor Positive	Not a Factor	Minor Negative	Very Negative
Yield will change	43	14	29	0	14
Crop quality will change	43	29	14	0	14
Less water will be applied	57	0	43	0	0
Less electricity will be used for pumping	33	17	33	17	0
Overall farming ease will change	29	14	43	14	0
Weed control	17	33	33	17	0
Degree of labor sophistication	20	20	20	40	0
Labor costs	60	0	0	40	0
Irrigating ease	60	0	20	0	20
Depend more on well water and less on DEID	0	17	33	50	0
Reservoir is necessary at the DEID turnout	0	17	50	17	17
Insects problems/control	17	33	33	17	0
Diseases/fungus problems/control	17	33	33	17	0
Rodent/animal problems	17	33	0	33	17
Payback period	50	0	17	0	33
Initial purchase cost	67	0	0	0	33



## Appendix E

### Chi-Square Statistical Analysis

**The Chi-Square test was used to find statistical differences between groups of answers. This is a test that finds differences between proportions.**

The first analysis was made between 3 groups. The 3 groups were:

1. Farmers with drip/micro
2. Farmers without drip/micro but who are planning to install drip/micro, and
3. Farmers with no drip/micro, and who are not planning to install drip/micro.

The Chi-Square test is set up as follows:

1. The table below has 3 columns – one for each of the groups listed above.
2. The first column is for group 1, the second column for group 2, etc.
3. The rows indicate the number of answers of each type, for question #1. Question #1 asked if the yield will increase when an orchard/vineyard is shifted to drip/micro.
  - a. The number “14” indicates that 14 persons gave an answer of “true”
  - b. The number “5” in the second row of the first column indicates that 5 persons answered “neutral” to the question.
  - c. The number “1” in the third row of the first column indicates that 1 person answered “False”
  - d. The number “1” in the fourth row of the first column indicates that 1 person answered “I don’t know”
  - e. The number “1” in the fifth row of the first column indicates that 1 person did not respond to the question.
  - f. For the same question and the group w/o drip and with intentions to change the column would be 6, 0, 2, 1 and 3. And for the group w/o drip and w/o intentions to change the column would be 0, 1, 3, 2 and 5.

So for one Chi-Square analysis of differences between the 3 groups, the columns to test are:

	With drip/micro	w/o drip/micro but planning to add it	No plans for drip/micro
True	<b>14</b>	<b>6</b>	<b>0</b>
Neutral	<b>5</b>	<b>0</b>	<b>1</b>
False	<b>1</b>	<b>2</b>	<b>3</b>
Don’t know	<b>1</b>	<b>1</b>	<b>2</b>
No ans.	<b>1</b>	<b>3</b>	<b>5</b>

The test gives a p value that must be checked with the significance level (risk considered). If the p value is below the significance number there are differences between groups at that probability level. For example, if the p value is 0.049, there are differences between groups of answers at the 0.05 significance level – the “.05 level” indicates that there is a 95% probability that the answers vary between groups



## Appendix F

### Detailed Farmer Answers to Questions

Farmer #		1	2	3	4	5	6	7	8	9	10	11	12	13
% of present acreage under drip/micro	Grapes	100				100		0	100	25		0	0	0
	Almonds							0			0			100
	Pistachios						65 ac							
	Apples													
	Cherries	100												
	Alfalfa			0										
	Prunes				0						0			
	Plums					0				100				
	Open					0								
	Olive										100			0
	Other												0	
	Field crops													
	Pecans													
	Citrus									100				
% of future plantings to be put under drip/micro	Grapes	100						0	100			0?	100	100
	Almonds							0				0?		100
	Pistachios						0							
	Apples													
	Cherries													
	Alfalfa			0										
	Prunes					100								
	Plums					100								
	Open					0								
	Olive													100
	Other												0	
	Field crops													
	Pecans													
	Citrus									100				
% of present furrow/flood acres to be converted to drip/micro	Grapes			100				0		30		0		40%
	Almonds							0			100			200 %
	Pistachios						0			100				
	Apples													
	Cherries													
	Alfalfa													
	Prunes					100								
	Plums					100								

Farmer #		1	2	3	4	5	6	7	8	9	10	11	12	13
	Open				0									
	Olive												100	
	Other											0?		
	Cotton													
	Soy Beans													
	Field crops													
	Pecans													
	Citrus													
Rank Statements in terms of TRUTH (1-6)	Yield	3			2	2		5	2	2	1	6		3
	Crop Quality	2			4	1		5	2	2	1	6		3
	Water	4			3	1		1	2	3	3	2		1
	Electricity	4			5	1		3	5	3	3	6		5
	Farming	2			3	1		3	4	2	2	2		1
	Weeds	3			2	1		4	3	2	3	2		1
	Labor Sophistication	2			2	3		4	2	2	2	1		5
	Labor Costs	2			3	3		3	5	2	4	6		1
	Irrigating	2			3	1		2	3	2	4	2		1
	Well Water	4			3	3		5	2-3	5	4	6		5
	Reservoir	2			4	6		4	1	2	2	6		3
	Insect	3			5	6		3	3	2	3	2		1
	Disease	3			5	3		3	3	2	2	2		2
	Rodent	4			5	3		3	4	6	3	2		3
	Payback	2			3	1		3	1	2	3	6		1
Importance in deciding to convert to drip/micro (1-5)	Yield	1			2	2		3	1	1	2	1		1
	Crop Quality	1			3	2		3	1	1	3	2		2
	Water	2			3	1		1	2	2	3	1		1
	Electricity	2			4	1		4	5	2	3	2		4
	Farming	1			4	1		3	3	1	3	2		1
	Weed	2			3	1		3	3	1	3	2		1
	Labor Sophistication	2			4	3		3	3	2	3	3		1
	Labor Costs	3			3	3		3	3	1	3	1		1
	Irrigating	2			3	1		2	3	1	3	1		1
	Well Water	3			4	3		4	4	3	5	4		4
	Reservoir	1			5	3			4	3	1	4		3
	Insect	3			3	3		3	3	1	3	2		2
	Disease	3			3	3		3	3	1	2	2		2
	Rodent	3			3	3		3	3	1	3	2		3
	Payback Period	2			4	1		3	4	1	2	1		1
Purchase Cost	2			5	1		5	4	1	1	1		1	

Farmer #		14	15	16	17	18	19	20	21	22	23	24	25	26
% of present acreage under drip/micro	Grapes	95	98		0	0				0			0	0
	Almonds	100	100		0	14							0	
	Pistachios				100							100	0	
	Apples				0								0	
	Cherries				0								0	
	Alfalfa													
	Prunes													
	Plums													
	Open													
	Olive			100										
	Other													
	Field crops													
	Pecans													
	Citrus	100	85				0	100				100		
% of future plantings to be put under drip/micro	Grapes	100	100			0				0			0	0
	Almonds	100	100		100	0							0	
	Pistachios				100							100	0	
	Apples												0	
	Cherries												0	
	Alfalfa													
	Prunes													
	Plums													
	Open													
	Olive			100										
	Other													
	Field crops													
	Pecans													
	Citrus	100	100				0					100		
% of present furrow/flood acres to be converted to drip/micro	Grapes % to convert	0	0			0			80 ac	0			100	100
	Almonds	0	0			0								
	Pistachios													
	Apples													
	Cherries													
	Alfalfa													
	Prunes													
	Plums													
	Open													
	Olive													
	Other													
	Cotton													100
	Soy Beans													100
	Field crops													
Pecans														

Farmer #		14	15	16	17	18	19	20	21	22	23	24	25	26
	Citrus	0	0				100							
Rank Statements in terms of TRUTH (1-6)	Yield	1	2	3	1	1	2	6	1-2		2	1		4
	Crop Quality	1	2	3	1	6	2	6	1		2	1		3
	Water	1	5	1	1	1	2	2	1		1	1		1
	Electricity	4	5	3	5	5	4	3			1	5		5
	Farming	3	3	3	5	1	2	1	6		1	1		1
	Weeds	5	5	3	1	1	4	2	6		2	1		3
	Labor Sophistication	3	1	2	5	5	3	2	6		2	1		2
	Labor Costs	1	3	5	5	1	3	1	6		5	1		1
	Irrigating	1	3	4	5	1	2	1	6		1	1		1
	Well Water	5	2	5	5	5	3	5	1		5	5		5
	Reservoir	1	1	5	5	1	3	5	6		5	1		2
	Insect	5	3	3	5	6	2	6	6		3	5		1
	Disease	5	3	3	1	6	4	6	6		3	1		1
	Rodent	5	5	4	5	6	4	6	6		3	5		5
	Payback	1	2	2	1	1	2	1	6		1	1		1
Importance in deciding to convert to drip/micro (1-5)	Yield	1	2	3	1	2	2	2	3		1	1		4
	Crop Quality	1	1	3	1	2	2	2	3		2	1		1
	Water	1	5	1	2	1	2	1	3		1	1		1
	Electricity	4	5	1	3	3	4	1	2		1	4		4
	Farming	2	3	1	3	1	3	1	1		1	1		1
	Weed	4	4	2	3	2	4	2	1		2	1		3
	Labor Sophistication	4	5	3	3	3	3	2	1		4	1		2
	Labor Costs	2	3	3	3	2		1	1		4	1		2
	Irrigating	1	3	3	3	1	2	1	1		2	1		1
	Well Water	5	4	4	3	5	3	5	1		3	3		5
	Reservoir	1		3	1	2	3	5	1		3	5		1
	Insect	4	3	3	3	2	3	3	2		3	3		2
	Disease	3	3	3	1	2	3	3	1		3	1		2
	Rodent	4	4	3	3	2	4	3	1		3	3		5
	Payback Period	1	1	3	1	2	2	2	1		2	1		3
	Purchase Cost	4	5	3	4	2	5	4	1		4	5		5

Farmer #		27	28	29	30	31	32	33	34	35	36	37	38
% of present acreage under drip/micro	Grapes	100	0					88	0	0	0		
	Almonds						59.8	56				0	100
	Pistachios												
	Apples												
	Cherries												
	Alfalfa												
	Prunes												
	Plums												
	Open												
	Olive												
	Other			0									
	Field crops				0								
	Pecans											0	
	Citrus												
% of future plantings to be put under drip/micro	Grapes	100	80						50	0	0		
	Almonds						100					25	
	Pistachios												
	Apples												
	Cherries												
	Alfalfa												
	Prunes												
	Plums												
	Open												
	Olive												
	Other			0									
	Field crops				0								
	Pecans											0	
	Citrus												
% of present furrow/flood acres to be converted to drip/micro	Grapes % to convert	0	0					12	80	0	0		
	Almonds						0	44				0	
	Pistachios												
	Applies												
	Cherries												
	Alfalfa												
	Prunes												
	Plums												
	Open												
	Olive												
	Other			0									
	Cotton												
	Soy Beans												
	Field crops				0								
Pecans											0		

Farmer #		27	28	29	30	31	32	33	34	35	36	37	38
	Citrus												
Rank Statements in terms of TRUTH (1-6)	Yield	3	6		5		2	4	2	6	5	1	1
	Crop Quality	3	6		5		3	3	2	6	5	1	1
	Water	1	2		6		1	2	1	6	1	3	3
	Electricity	5	6		5		2	1	2	2	6	6	5
	Farming	1	6		6		2	1	3	3	6	2	2
	Weeds	3	6		5		2	1	5	4	6	2	2
	Labor Sophistication	1	6				3	5	2	3	1	2	1
	Labor Costs	3			5		3	5	3	6	4	4	4
	Irrigating	1	2				3	2	2	4	5	2	2
	Well Water	5	6		5		4	5	4	3	6	3	3
	Reservoir	3	6				4	1	5	6	6	1	1
	Insect	1	6		5		5	4	2	4	6	3	3
	Disease	1	6		5		4	4	5	4	6	2	2
	Rodent	3	6				5	5	5	4	5	6	5
Payback	1	6		6		3	2	5	1	5	2	2	
Importance in deciding to convert to drip/micro (1-5)	Yield	2	3		3		1	3	3	1	5	1	1
	Crop Quality	2	3		3		2	2	3	1	5	1	1
	Water	1	1		3		2	2	2	1	1	3	2
	Electricity	2	1		3		2	1	4	1	3	5	5
	Farming	1	2		3		3	1	4	1	3	2	2
	Weed	3	2		4		3	3	4	1	3	2	2
	Labor Sophistication	3	3				3	3	3	1	4	4	4
	Labor Costs	1	1				3	3	3	1	4	3	3
	Irrigating	1	1				3	1	3	1	5	2	1
	Well Water	5	3		3		3	5	3	4	3	3	3
	Reservoir	5	3		5		4	3	2	3	3	1	1
	Insect	2			3		3	3	4	1	3	2	2
	Disease	2			3		4	3	4	1	3	2	2
	Rodent	2			4		3	4	4	1	5	5	5
Payback Period	2			5		3	4	5	1	5	5	5	
Purchase Cost	2			5		5	5	5	1	5	5	5	



Farmer #		39	40	41	42	43	44	45	46	47
% of present acreage under drip/micro	Grapes	0	0	0	12.5		0		70	
	Almonds							100		60
	Pistachios									
	Apples									
	Cherries									
	Alfalfa									
	Prunes									
	Plums									
	Open									
	Olive									
	Other	0								
	Field crops									
	Pecans									
	Citrus									
% of future plantings to be put under drip/micro	Grapes	0	0	0	100		0		100	
	Almonds							100		
	Pistachios								100	
	Apples									
	Cherries									
	Alfalfa									
	Prunes									
	Plums									
	Open									
	Olive									
	Other	0								
	Field crops									
	Pecans									
	Citrus									
% of present furrow/flood acres to be converted to drip/micro	Grapes % to convert	0	0	0	87.5	40 ac	0		67	
	Almonds									100
	Pistachios							100		
	Applies									
	Cherries									
	Alfalfa									
	Prunes									
	Plums									
	Open									
	Olive									
	Other	0								
	Cotton									
	Soy Beans									
	Field crops									
Pecans										

Farmer #		39	40	41	42	43	44	45	46	47	
	Citrus										
Rank Statements in terms of TRUTH (1-6)	Yield	3	6		2	5		2	3	2	
	Crop Quality	3	6		1	5		1	3	3	
	Water	2	1		5	5		5	1	2	
	Electricity	4	6		5	5		5	5	5	
	Farming	4	6		1	5		2	1	2	
	Weeds	4	6		2	5		3	1	4	
	Labor Sophistication	1	6		5	5		1	5	4	
	Labor Costs	5	6		3	5		5	1	4	
	Irrigating	2	2		1	5		2	1	2	
	Well Water	4	6		5	5		3	5	5	
	Reservoir	2	6		5	5		4	4	5	
	Insect	5	6		2	5		1	3	5	
	Disease	5	6		2	5		5	3	5	
	Rodent	5	6		4	5		5	5	5	
	Payback	3	6		1	5		2	2	2	
	Importance in deciding to convert to drip/micro (1-5)	Yield	2	1	3	2	1		2	3	1
		Crop Quality	2	1	1	1	1		1	3	1
Water		3	1	3	5	1		3	2	1	
Electricity		4	1		4	1		4	5	4	
Farming		4	1	3	1	1		1	1	1	
Weed		3	2		3	1		3	2	4	
Labor Sophistication		4	2		3	1		4	3	3	
Labor Costs		4	1		2	1		4	2	3	
Irrigating		3	1		1	1		1	2	1	
Well Water		4	2		3	1		3	5	3	
Reservoir		3	2		4	1		4	3	3	
Insect		4	2		2	1		2	3	3	
Disease		4	2		2	1		2	2	3	
Rodent		4	2		2	1		5	3	2	
Payback Period		3	1		4	1		3	2	1	
Purchase Cost		1	1		5	1		5	4	5	