5-176

CONSERVATION INNOVATION GRANTS

Final Report

December 28, 2007

Grantee Name: Flint River Soil and Water Conservation District	
Project Title: Flint River Irrigation and Crop Management Technology Integration Program NRCS 68 – 3A75 – 5 – 176	
Project Director: David Reckford	
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Period Covered by Report: September 28, 2005 – September 28, 2007	
Project End Date: September 28, 2007	

SUMMARY:

This conservation innovation grant provided producers in the Lower Flint River Basin with the ability to monitor soil moisture data and center pivot activity via the Internet on a 'near' real time basis during the 2005 and 2006 crop seasons. This data informed irrigation water management on 2,467 acres and resulted in estimated water savings of up to 15% due to improved irrigation scheduling.

Producers also benefited from access to the Internet at their home and/or office via the wireless broadband network. Additional benefits to the producer beyond irrigation water management was the increased integration of available technology to monitor and track the use of fertilizers, pesticides, and other agricultural inputs. This improved the profitability of each of the participants' agricultural operation.

The goal of the Conservation Innovation Grant – NRCS 68-3A75-5-176 as stated in the grant agreement was to "set up a telemetry network to transmit soil moisture data from the field to the Internet via a wireless network" so that "farmers will have the ability to read irrigation scheduling reports, pivot location, and other crop management information from a handheld computer in the field without having to return to the office." This goal was achieved during the grant period between September 28, 2005 and September 28, 2007.

INTRODUCTION:

With more than 6000 center pivot irrigation systems irrigating approximately 650,000 acres, the Flint River Basin's ground and surface water resources are challenged yearly to sustain economic yield without sacrificing the biodiversity of the Flint River and its tributaries. With changing weather patterns, droughts, and low market prices, agricultural producers are required now more than ever to sustain high yields with less money. Normally they resort to using more irrigation water to produce a higher yield. This helps mediate low market prices and/or dry weather conditions by providing additional revenue from yield increases. Producers cannot afford to risk economic stability by using less water unless they have some means to communicate that they are applying sufficient water. Constantly faced with this irrigation scheduling battle, producers are in need of a system that will inform them when to irrigate and if their irrigation equipment is functioning properly. With soil moisture content, rainfall, and soil temperature readings at hand, producers are better equipped to determine when and how much to irrigate their crops. Getting this information to the producer in a timely manner was the primary objective of this project.

This conservation innovation grant funded the deployment of a telemetry network able to receive data from the field and transfer that data onto the Internet. At the time of deployment, cellular solutions did exist, but they lacked the coverage area needed. They were also limited to the amount of data they could transmit through a single transmission; they simply did not have the bandwidth necessary to transmit all the data in a timely fashion. Satellite solutions also existed, but they were limited to a fixed location for data retrieval. They were also priced by the amount of data transmitted. Soil moisture monitoring requires a great deal of data transmission, which in turn would have resulted in very expensive monthly charges. The deployed wireless broadband telemetry network preserved data quantity, quality, and transmission speed while providing wireless Internet access over a 100 square mile area. The network provided a communication solution to agricultural producers enabling them to receive large amounts of data without being locked into a hardwired system. Producers were able to read irrigation scheduling reports, monitor pivot location, and access other crop management information from a handheld computer in the field via wireless technology.

PROJECT DESCRIPTION:

The telemetry network installed and maintained by the Flint River Soil and Water Conservation District in Lower Flint River Basin provided participating farmers with the ability to monitor soil moisture data and center pivot activity via the Internet on a 'near' real time basis during the 2005 and 2006 crop seasons. This data informed irrigation water management on 2,467 planted acres and resulted in estimated water savings of up to 15% due to improved irrigation scheduling. The telemetry network serviced seventeen center pivot irrigation systems owned and operated by nine participating farmers. The telemetry network consisted of four primary components: a base station tower with a centralized server to gather and distribute information connected directly to the Internet via an Ethernet cable; four relay towers each equipped with a mini – repeater to boost signal strength; six 50' mini towers with antenna to extend the signal; seventeen 'hotspots' equipped with a router, amplifier, mini – repeater, and antenna located at each center pivot to receive the Internet signal and transmit data from the soil probes to the relay towers; and, thirty – four soil probes each with three sensors, placed at varying depths of 8", 16", and 24", a rain gauge, data collector, solar array, radio transmitter, and soil temperature monitor.

The telemetry network operated as follows. The base station tower transmitted and collected information from the four relay towers over a 900 MHz frequency. The four relay towers connected wirelessly to the seventeen 'hotspots' installed at each center pivot. The 'hotspots' received soil moisture data from two soil moisture probes installed in each crop area. WIFI digital video camera transmissions of pivot activity were also received at the seventeen 'hotspots.' Data was then relayed from the 'hotspots' via a Linksys router with amplifier and antenna to one of the four relay towers. The relay tower then 'relayed' the information to the base station tower where the centralized server transferred the data onto the Internet via a designated web address. The participating farmer could then access the soil moisture data and camera images at any Internet connection point. The seventeen 'hotspots' provided Internet connectivity so that the participating farmer would be able to access the Internet via a 802.11b IP address when within range of the 'hotspot' so as to review soil moisture data, compare readings to field observations, and decide whether to irrigate or not. Due to the extended range of the 900 MHz broadband cloud, farmers often benefited from access to the Internet at their home and/or office, improving overall farm operations and communications capability.

Although the program did succeed in providing participating farmers with access to soil moisture data via the Internet, limitations of existing technology at the time of network installation reduced the ability of the system to provide data in 'real' time. The telemetry network, as originally envisioned, utilized a 900 MHz frequency to send and receive information. However, the soil probes provided by AgriLink for installation were not WIFI ready and therefore incapable of transmitting at the 900MHz frequency. The availability of WIFI ready soil probes was delayed due to technical difficulties encountered by the manufacturer. This required a reconfiguration of the network to employ a 450 MHz frequency radio to transmit data from the soil probes to the base station tower via a series of 450 MHz mini – repeaters to boost signal strength at each 'hotspot' and relay tower. The use of the relay towers was necessary due to non line of sight distance limitations. Between each relay tower and the main tower, data was transferred via line of sight which allowed for increased distances between towers. Line of sight was not possible to each 'hotspot' due to obstructions such as trees and buildings. Reliable connectivity required the use of the 450 MHz mini – repeaters to transmit data across the network. However, the mini – repeaters were prone to mechanical failure which decreased the ability of the telemetry network to provide 'real' time data.

For example, to stretch the range of communications, we employed an omni – directional circle antenna which provided three times the power of a traditional antenna to reach distant site locations. However, commercial broadband systems employ a 'sectorized' antenna array which is heavier and requires a built tower for transmission. Finances required that we adapt to existing conditions at each site, using various buildings and structures, such as a grain silo in one instance, to mount the omni – directional antenna, a lighter product than the 'sectorized' antenna. The omni – directional antenna was limited to a range of 3 miles non line of sight, 6 miles limited line of sight, and 12 miles line of sight on the 900 MHz frequency. At the 450 MHz frequency range improved due to increased wattage. This enhanced the communication range of the network, but was reliant on the mini – repeaters to boost signal strength. Lightening strikes on the towers, even though they were grounded, would disable the mini – repeaters. This would sever communications and was costly to fix. The replacement cost of a mini – repeater is approx. $2,400.00.

The telemetry network as installed and operated over the course of the project's duration did however allow for 'near' real time access to soil moisture data. Project sites located close to the base station tower performed best due to the omission of the mini – repeaters. Under these conditions, data was often available within 24 hours of collection which confirmed the potential of 'real' time soil moisture monitoring.

Project sites located further away from the base station tower performed more erratically with data lag times approaching several days to several weeks. This dilemma was a direct result of the Flint River Soil and Water Conservation's intention to service as many farmers as possible under significant cost restraints. However, in order to maintain the accuracy of the irrigation scheduling reports, each 'hotspot' was outfitted with a handheld computer component which allowed each participating producer to drive to the field and download recorded irrigation scheduling data stored by the data logger. This guaranteed the collection of irrigation scheduling data even when data transmission over the telemetry network failed.

Another problem encountered was the lack of an isolated power source for each of the seventeen 'hotspots.' Since it was not economically feasible to install an isolated power source at each pivot, 'hotspots' were powered by the same power source as used by the pivot. If the pivot was powered by a diesel generator, the system was able to transmit data and receive the Internet signal over the 900 MHz frequency only when the diesel generator was running. At sites hardwired into the electrical grid, power was continuous to both the pivot and 'hotspot.' Additional component failures occurred at the soil probe level. Each soil probe was powered by low voltage rechargeable batteries which limited range and reliability. Solar base packs were positioned at the top of each probe to charge the battery and power the 450MHz transmitter and data collector. Faulty batteries, solar panels, and radio transmitters reduced the reliability of the telemetry network. This project utilized available off the shelf technology. To improve reliability, components could be customized for field application. Some equipment failure however is to be expected.

In conclusion, although the telemetry network project experienced setbacks due to its 'innovative' nature, the result is continued broadband coverage that has been maintained since project installation, and is now equipped for the integration of WIFI ready soil probes. The project over its two year duration has succeeded in progressing a useful and innovative irrigation best management practice from a conceptual to a 'real' time model. The project has also illustrated the ability of the Internet to function as an access point for monitoring soil moisture data to improve irrigation scheduling without advanced irrigation software.

RESULTS SUMMARY:

Water savings from this project were estimated by the project director with the assistance of research faculty at the University of Georgia National Environmentally Sound Production Agriculture Laboratory.

Reductions in labor, mileage, and fuel were achieved by minimizing trips to the field to gather soil moisture and temperature data. Another benefit to producers was the ability to monitor center pivot activity remotely via the WIFI camera. The system also provided 'near' real time irrigation scheduling data that informed producers as to when to irrigate their crops thereby reducing over watering which can lead to soil erosion, decreased crop yields, added expense of irrigation cycles, disease, and possible water contamination.

An additional success of the program was achieved via numerous outreach and education opportunities provided to farmers in southwest GA as to the potential of integrating broadband technology into traditional agriculture. For example, the 2006 Farm Expo in Moultrie, GA employed a small scale version of the broadband system funded in a joint effort by the Flint River Soil and Water Conservation District and NRCS. Presentations were provided at the Expo to farmers about the potential of 'real' time soil moisture monitoring. The Flint River Soil and Water Conservation District also hosted several field days and workshops on the telemetry network. In addition, the project brought together a wide range of participants including the Natural Resources Conservation Service, The Nature Conservancy, GA Soil and Water Conservation Commission, UGA NESPAL, and the USDA – ARS National Peanut Laboratory.

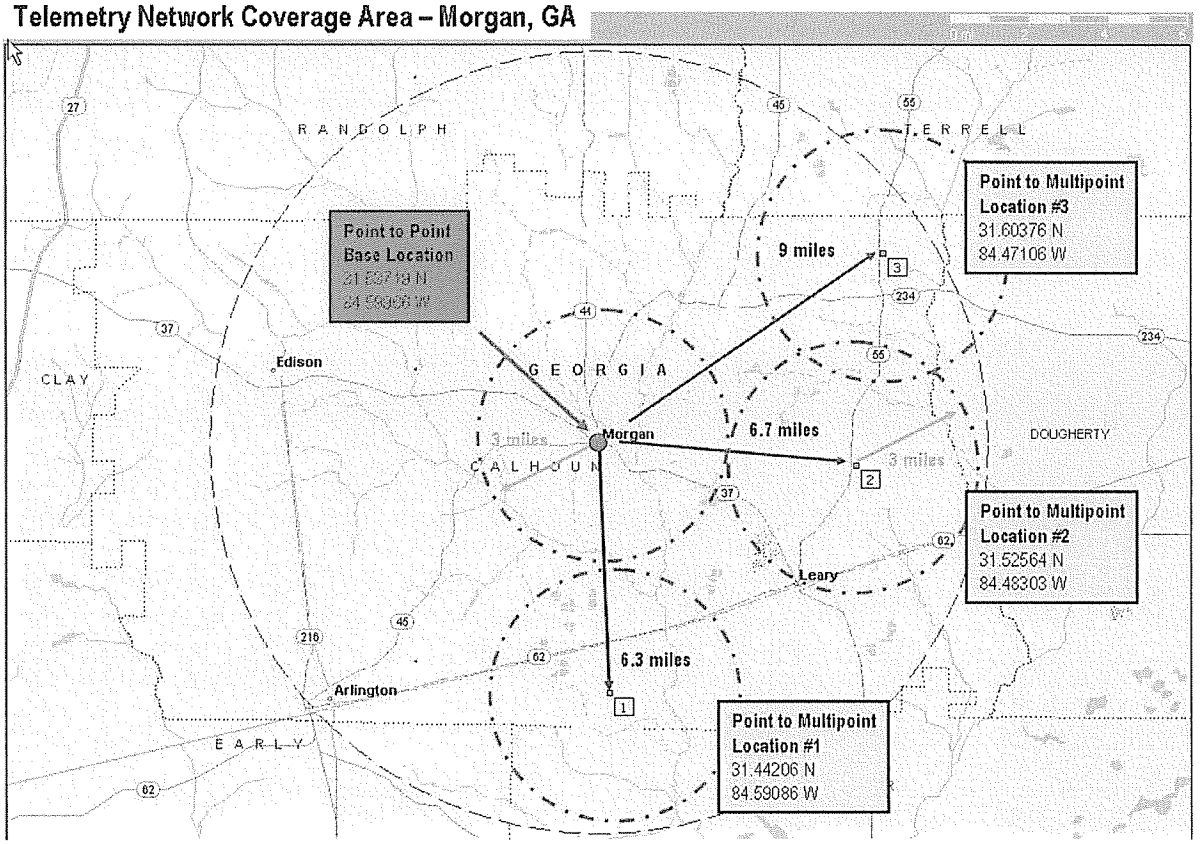
Future applications of broadband technology in agriculture are many. Research is currently underway to remotely monitor pest infestations and fertility content. This will help eliminate human error in pest infestation reporting. It will also help producers to determine how much nitrogen and phosphorus are needed throughout the growing season. Producers are currently limited to a single report at the beginning of the growing season. Research is also being conducted on remote monitoring of equipment, livestock, and water quality. These are all possible avenues that need further development and testing. With broadband access in rural areas, such avenues can become 'on the ground' realities in years to come.

Due in part to the demonstrated success of this project in improving agriculture operations, funding has been allocated for the deployment of a five county broadband expansion in the Lower Flint River Basin. The broadband expansion will be implemented over the next two years. This project and its results were instrumental in expressing the need for such a system which will have long term impacts on both irrigation water management as well as improved farm management and efficiency in the Lower Flint River Basin.

THE TELEMETRY NETWORK:

The critical component of this project was the wireless 803.11b telemetry network. The network provided a wireless cloud above the demonstration sites that was capable of relaying high volumes of data on a 'near' real time basis. The base connection was located in Morgan, GA. This base location served as the Internet access point for a network of rural "hotspot" relay towers located within a 10 – 14 mile radius of Morgan. Due to shorter communications distance (approximately 300 feet), sensors equipped with 802.11b radios required the 450 MHz mini – repeaters to relay data from the point to multipoint locations.

Telemetry Network Coverage Area – Morgan, GA



Point to Point Base Location – Connection to the Internet for the entire network. Approximate range point to point 10 – 14 miles. This site serves as a "hotspot" for a 3 mile radius.

Point to Multipoint Locations – Relays information to and from the base location. Equipped with a 450 MHz mini – repeater. This site serves as a "hotspot" for a 3 mile radius.

THE EQUIPMENT:

This project utilized off the shelf technology available for agricultural use in the United States. Rural broadband deployment is however expensive. Resources outside of the funding provided by this conservation innovation grant were leveraged to increase coverage and reliability. However, when rural broadband access is available at a commercial level, 'real' time soil moisture monitoring and data gathering is a viable irrigation water management solution for agricultural producers across the country. Much of the data gathering equipment used in this project is currently employed in agricultural applications. This project demonstrates that these data gathering systems can be adapted to work with available broadband technology. WIFI ready soil probes are also now available commercially. The use of WIFI ready soil probes would remove the necessity of transferring data over the 450 MHz frequency and omit the 450 MHz equipment altogether. This reconfiguration will improve reliability and efficiency of the telemetry network.

Below is the telemetry network equipment:

1. CISCO PIX 515
2. CISCO 2621XM w/ WVIC x 2T1 Card
3. HP 140 w/ 1G of Ram
4. CISCO Switch
5. Half Server Rack
6. APC Battery Backup
7. TripLite
8. Filler Panels
9. Ceragon Backhaul Radios
10. Motorola Canopy 2.4 Backhaul Radios w/ Reflectors Kits
11. Pivot NEMA Enclosures
12. WIFI AP/NEMA
13. WaveRider Backup CCU
14. WaveRider Modem Backups
15. WaveRider OMNI 12db Whip

Below is the data gathering equipment employed at each demonstration site:

1. 2 AgriLink Soil C-Probes v2.0.
2. 2 Solar Panels, 2 Rain Gauges, 2 A723RTU AgriLink Field Unit Radios.
3. 1 ST Soil Temperature Probe (only in years of peanut rotation).
4. 1 Digital 'Pan, Tilt, Zoom' Camera to monitor pivot operation.
5. 1 802.11B WIFI 'hotspot' at center pivot field location.

SAMPLE DATA:

Producer:

Field ID:

Crop: Peanuts

Year: 2006

Planting Date: May 28, 2006

Date	Rainfall	Irrigation	Maximum Ground Temperature	Minimum Ground Temperature
6/22/2006	0.2	0.8	0	0
6/24/2006	0.2	0	0	0
6/26/2006	0.7	0	0	0
7/5/2006	0	0	90	74
7/6/2006	0.8	0	0	0
7/7/2006	0	0	89	75
7/12/2006	0	0.55	84	73
7/13/2006	0	0	84	77
7/14/2006	0	0.8	0	0
7/16/2006	0	0.8	0	0
7/17/2006	1.2	0	0	0
7/18/2006	0	0	85	77
7/21/2006	0	0	88	76
7/23/2006	0.3	0	0	0
7/24/2006	0.2	0	0	0
7/25/2006	1.1	0	0	0
7/26/2006	0	0	84	75
7/28/2006	0	0	83	76
8/1/2006	0	0.55	84	75
8/4/2006	1.2	0	84	77
8/5/2006	0	0.6	82	75
8/7/2006	0.1	0	0	0

8/8/2006	1.8	0	83	76
8/10/2006	0	0	83	75
8/14/2006	0	0	83	76
8/17/2006	0	0.3	83	76
8/19/2006	0	0.5	0	0
8/20/2006	0	0	82	75
8/24/2006	0	0	83	76
8/26/2006	0	0.7	0	0
8/27/2006	0	0	82	74
8/29/2006	0	0.6	0	0
8/30/2006	2.5	0	83	75
9/1/2006	0.2	0	0	0
9/3/2006	0	0	83	74
9/7/2006	0.1	0	0	0
9/8/2006	0	0	81	72
9/10/2006	2.3	0	79	71
9/13/2006	0.3	0	0	0
9/18/2006	0.3	0	81	71
9/19/2006	0.3	0	0	0
9/22/2006	0.8	0	80	64
9/24/2006	0.4	0	0	0
9/27/2006	0	0	81	64
10/4/2006	0	0	77	61
10/11/2006	0	0	77	62

Irrigation Water Management Report

Field	Track #	FSA #	Acres
4			162
6			140
11			240

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2005 Irrigation Water Management Report

Grower
Field
Track #
FSA #
Acres 240

	Totals	
Total Rain (in.)		Inches for growing season
Total Applied Irrigation (in.)	2.39	Inches for growing season
	2.39	

Plant Date Harvest Date

April-05

Date	Rain (in)	Irrigation Amount (in)
1-Apr-05	2.01	
2-Apr-05	0	
3-Apr-05	0	
4-Apr-05	0	
5-Apr-05	0	
6-Apr-05	0.01	
7-Apr-05	1.96	
8-Apr-05	0	
9-Apr-05	0	
10-Apr-05	0	
11-Apr-05	0	
12-Apr-05	0.11	
13-Apr-05	0	
14-Apr-05	0	
15-Apr-05	0	
16-Apr-05	0	
17-Apr-05	0	
18-Apr-05	0	
19-Apr-05	0	
20-Apr-05	0	
21-Apr-05	0.01	
22-Apr-05	0.55	
23-Apr-05	0.01	
24-Apr-05	0	
25-Apr-05	0.01	
26-Apr-05	1.14	
27-Apr-05	0	
28-Apr-05	0	
29-Apr-05	0	
30-Apr-05	1.89	
Monthly Totals	7.7	0

May-05

Date	Rain (in)	Irrigation Amount (in)
1-May-05	0	
2-May-05	0	
3-May-05	0	
4-May-05	0.15	
5-May-05	0.32	
6-May-05	0	
7-May-05	0	
8-May-05	0	
9-May-05	0	
10-May-05	0	
11-May-05	0.1	
12-May-05	0	
13-May-05	0	
14-May-05	0	
15-May-05	0.04	
16-May-05	0	
17-May-05	0	
18-May-05	0	
19-May-05	0	
20-May-05	1.21	
21-May-05	0.02	
22-May-05	0	
23-May-05	0	
24-May-05	0	
25-May-05	0	
26-May-05	0	
27-May-05	0	
28-May-05	0	
29-May-05	0	
30-May-05	0	
31-May-05	0.48	
	2.32	0

June-05

Date	Rain (in)	Irrigation Amount (in)
1-Jun-05	0.59	
2-Jun-05	0.38	
3-Jun-05	0.14	
4-Jun-05	0	
5-Jun-05	0	
6-Jun-05	0.16	
7-Jun-05	0.01	
8-Jun-05	2.99	
9-Jun-05	0.42	
10-Jun-05	0.09	
11-Jun-05	1.64	
12-Jun-05	0.06	
13-Jun-05	0.01	
14-Jun-05	0	
15-Jun-05	0	
16-Jun-05	0	
17-Jun-05	0.01	
18-Jun-05	0.14	
19-Jun-05	0	
20-Jun-05	0	
21-Jun-05	0	
22-Jun-05	0	
23-Jun-05	0	
24-Jun-05	0	
25-Jun-05	0.04	
26-Jun-05	0	
27-Jun-05	0	
28-Jun-05	0.21	
29-Jun-05	0.48	
30-Jun-05	0	
	7.37	0

July-05

Date	Rain (in)	Irrigation Amount (in)
1-Jul-05	0.02	
2-Jul-05	0.07	
3-Jul-05	0	
4-Jul-05	0	
5-Jul-05	0.11	
6-Jul-05	0.12	
7-Jul-05	0	
8-Jul-05	0	
9-Jul-05	0.52	
10-Jul-05	2.44	
11-Jul-05	1.67	
12-Jul-05	0.21	
13-Jul-05	0	
14-Jul-05	0.29	
15-Jul-05	0.3	
16-Jul-05	0	
17-Jul-05	0	
18-Jul-05	0.3	
19-Jul-05	0.03	
20-Jul-05	0.04	
21-Jul-05	0	
22-Jul-05	0	
23-Jul-05	0	
24-Jul-05	0	
25-Jul-05	0	
26-Jul-05	0	
27-Jul-05	0	
28-Jul-05	0	
29-Jul-05	0.39	
30-Jul-05	0.44	
31-Jul-05	0.54	
	7.49	0

August-05

Date	Rain (in)	Irrigation Amount (in)
1-Aug-05	0.67	
2-Aug-05	0.01	
3-Aug-05	0.07	
4-Aug-05	0	
5-Aug-05	0.47	
6-Aug-05	0.31	
7-Aug-05	0	
8-Aug-05	0	
9-Aug-05	0.54	
10-Aug-05	0.36	1.1
11-Aug-05	0	
12-Aug-05	0	
13-Aug-05	0	
14-Aug-05	0	
15-Aug-05	0.63	
16-Aug-05	0.01	
17-Aug-05	0	
18-Aug-05	0	
19-Aug-05	0	0.69
20-Aug-05	0.3	
21-Aug-05	0.19	0.6
22-Aug-05	0	
23-Aug-05	0	
24-Aug-05	0.02	
25-Aug-05	0.02	
26-Aug-05	0	
27-Aug-05	0.02	
28-Aug-05	0.33	
29-Aug-05	2.21	
30-Aug-05	0.26	
31-Aug-05	0.06	
Monthly Totals	6.48	2.39

September-05

Date	Rain (in)	Irrigation Amount (in)
1-Sep-05	0	
2-Sep-05	0	
3-Sep-05	0	
4-Sep-05	0	
5-Sep-05	0	
6-Sep-05	0	
7-Sep-05	0	
8-Sep-05	0	
9-Sep-05	0	
10-Sep-05	0	
11-Sep-05	0	
12-Sep-05	0	
13-Sep-05	0	
14-Sep-05	0	
15-Sep-05	0	
16-Sep-05	0	
17-Sep-05	0	
18-Sep-05	0	
19-Sep-05	0	
20-Sep-05	0	
21-Sep-05	0	
22-Sep-05	0	
23-Sep-05	0.11	
24-Sep-05	0.01	
25-Sep-05	0	
26-Sep-05	0.08	
27-Sep-05	0.4	
28-Sep-05	0.1	
29-Sep-05	0	
30-Sep-05	0	
	0.7	0

October-05

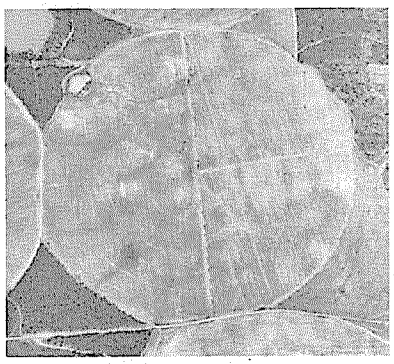
Date	Rain (in)	Irrigation Amount (in)
1-Oct-05	0	
2-Oct-05	0.22	
3-Oct-05	0	
4-Oct-05	0	
5-Oct-05	0.04	
6-Oct-05	0.11	
7-Oct-05	0.27	
8-Oct-05	0	
9-Oct-05	0	
10-Oct-05	0	
11-Oct-05	0	
12-Oct-05	0	
13-Oct-05	0	
14-Oct-05	0	
15-Oct-05	0	
16-Oct-05	0	
17-Oct-05	0	
18-Oct-05	0	
19-Oct-05	0	
20-Oct-05	0.04	
21-Oct-05	0.01	
22-Oct-05	0	
23-Oct-05	0	
24-Oct-05	0	
25-Oct-05	0	
26-Oct-05	0	
27-Oct-05	0	
28-Oct-05	0	
29-Oct-05	0	
30-Oct-05	0	
31-Oct-05	0	
	0.69	0

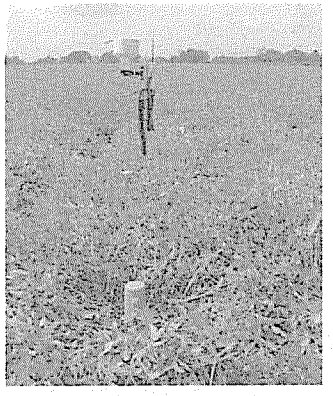
November-05

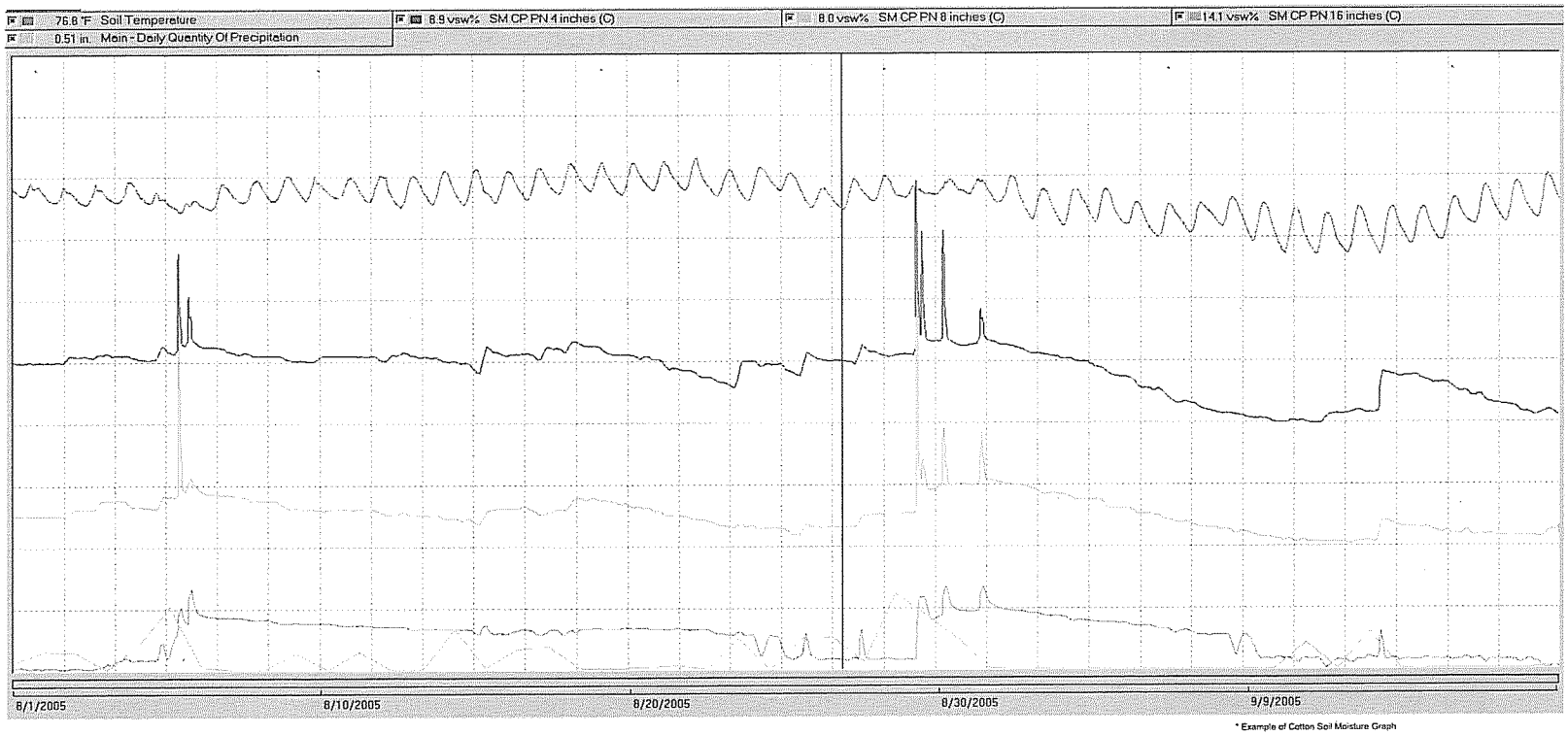
Date	Rain (in)	Irrigation Amount (in)
1-Nov-05	0.22	
2-Nov-05	0.04	
3-Nov-05	0	
4-Nov-05	0	
5-Nov-05	0	
6-Nov-05	0	
7-Nov-05	0	
8-Nov-05	0	
9-Nov-05	0	
10-Nov-05	0	
11-Nov-05	0	
12-Nov-05	0	
13-Nov-05	0	
14-Nov-05	0	
15-Nov-05	0	
16-Nov-05	0.01	
17-Nov-05	0	
18-Nov-05	0	
19-Nov-05	0	
20-Nov-05	1.26	
21-Nov-05	0.34	
22-Nov-05	0	
23-Nov-05	0	
24-Nov-05	0	
25-Nov-05	0	
26-Nov-05	0	
27-Nov-05	0.16	
28-Nov-05	1.09	
29-Nov-05	0.1	
30-Nov-05	0	
	3.22	0

2005 Irrigation Water Management Report

Grower
Field
Track #
FSA #
Acres 140







* Example of Cotton Soil Moisture Graph

ENVIRONMENTAL
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Bringing Your World To You, Wherever You Are

2005 Irrigation Water Management Report

Grower
Field
Track #
FSA #
Acres 140

Total Rai
Total Applied Irrigation (in.)
Totals

Totals	
	inches for growing season
3.13	inches for growing season
3.13	

Plant Date Harvest Date

April-05

Date	Rain (in)	Irrigation Amount (in)
1-Apr-05	2.01	
2-Apr-05	0	
3-Apr-05	0	
4-Apr-05	0	
5-Apr-05	0	
6-Apr-05	0.01	
7-Apr-05	1.96	
8-Apr-05	0	
9-Apr-05	0	
10-Apr-05	0	
11-Apr-05	0	
12-Apr-05	0.11	
13-Apr-05	0	
14-Apr-05	0	
15-Apr-05	0	
16-Apr-05	0	
17-Apr-05	0	
18-Apr-05	0	
19-Apr-05	0	
20-Apr-05	0	
21-Apr-05	0.01	
22-Apr-05	0.55	
23-Apr-05	0.01	
24-Apr-05	0	
25-Apr-05	0.01	
26-Apr-05	1.14	
27-Apr-05	0	
28-Apr-05	0	
29-Apr-05	0	
30-Apr-05	1.89	
Monthly Totals	7.7	0

May-05

Date	Rain (in)	Irrigation Amount (in)
1-May-05	0	
2-May-05	0	
3-May-05	0	
4-May-05	0.15	
5-May-05	0.32	
6-May-05	0	
7-May-05	0	
8-May-05	0	
9-May-05	0	
10-May-05	0	
11-May-05	0.1	
12-May-05	0	
13-May-05	0	
14-May-05	0	
15-May-05	0.04	
16-May-05	0	
17-May-05	0	
18-May-05	0	
19-May-05	0	
20-May-05	1.21	
21-May-05	0.02	
22-May-05	0	
23-May-05	0	
24-May-05	0	
25-May-05	0	
26-May-05	0	
27-May-05	0	
28-May-05	0	
29-May-05	0	
30-May-05	0	
31-May-05	0.48	
	2.32	0

June-05

Date	Rain (in)	Irrigation Amount (in)
1-Jun-05	0.59	
2-Jun-05	0.38	
3-Jun-05	0.14	
4-Jun-05	0	
5-Jun-05	0	
6-Jun-05	0.16	
7-Jun-05	0.01	
8-Jun-05	2.99	
9-Jun-05	0.42	
10-Jun-05	0.09	
11-Jun-05	1.64	
12-Jun-05	0.06	
13-Jun-05	0.01	
14-Jun-05	0	
15-Jun-05	0	
16-Jun-05	0	
17-Jun-05	0.01	
18-Jun-05	0.14	
19-Jun-05	0	
20-Jun-05	0	
21-Jun-05	0	
22-Jun-05	0	
23-Jun-05	0	
24-Jun-05	0	
25-Jun-05	0.04	
26-Jun-05	0	
27-Jun-05	0	
28-Jun-05	0.21	
29-Jun-05	0.48	
30-Jun-05	0	
	7.37	0

July-05

Date	Rain (in)	Irrigation Amount (in)
1-Jul-05	0.02	
2-Jul-05	0.07	
3-Jul-05	0	
4-Jul-05	0	
5-Jul-05	0.11	
6-Jul-05	0.12	
7-Jul-05	0	
8-Jul-05	0	
9-Jul-05	0.52	
10-Jul-05	2.44	
11-Jul-05	1.67	
12-Jul-05	0.21	
13-Jul-05	0	
14-Jul-05	0.29	
15-Jul-05	0.3	
16-Jul-05	0	
17-Jul-05	0	
18-Jul-05	0.3	
19-Jul-05	0.03	
20-Jul-05	0.04	
21-Jul-05	0	
22-Jul-05	0	
23-Jul-05	0	
24-Jul-05	0	
25-Jul-05	0	
26-Jul-05	0	
27-Jul-05	0	
28-Jul-05	0	
29-Jul-05	0.39	
30-Jul-05	0.44	
31-Jul-05	0.54	
	7.49	0

August-05

Date	Rain (in)	Irrigation Amount (in)
1-Aug-05	0.67	
2-Aug-05	0.01	
3-Aug-05	0.07	
4-Aug-05	0	
5-Aug-05	0.47	
6-Aug-05	0.31	
7-Aug-05	0	
8-Aug-05	0	
9-Aug-05	0.54	
10-Aug-05	0.36	
11-Aug-05	0	
12-Aug-05	0	0.3
13-Aug-05	0	
14-Aug-05	0	
15-Aug-05	0.63	
16-Aug-05	0.01	
17-Aug-05	0	0.35
18-Aug-05	0	0.35
19-Aug-05	0	
20-Aug-05	0.3	
21-Aug-05	0.19	
22-Aug-05	0	
23-Aug-05	0	0.5
24-Aug-05	0.02	
25-Aug-05	0.02	
26-Aug-05	0	
27-Aug-05	0.02	0.5
28-Aug-05	0.33	
29-Aug-05	2.21	
30-Aug-05	0.26	
31-Aug-05	0.06	
Monthly Totals	6.48	2

September-05

Date	Rain (in)	Irrigation Amount (in)
1-Sep-05	0	
2-Sep-05	0	
3-Sep-05	0	
4-Sep-05	0	
5-Sep-05	0	
6-Sep-05	0	
7-Sep-05	0	
8-Sep-05	0	
9-Sep-05	0	
10-Sep-05	0	
11-Sep-05	0	0.55
12-Sep-05	0	
13-Sep-05	0	
14-Sep-05	0	0.58
15-Sep-05	0	
16-Sep-05	0	
17-Sep-05	0	
18-Sep-05	0	
19-Sep-05	0	
20-Sep-05	0	
21-Sep-05	0	
22-Sep-05	0	
23-Sep-05	0.11	
24-Sep-05	0.01	
25-Sep-05	0	
26-Sep-05	0.08	
27-Sep-05	0.4	
28-Sep-05	0.1	
29-Sep-05	0	
30-Sep-05	0	
	0.7	1.13

October-05

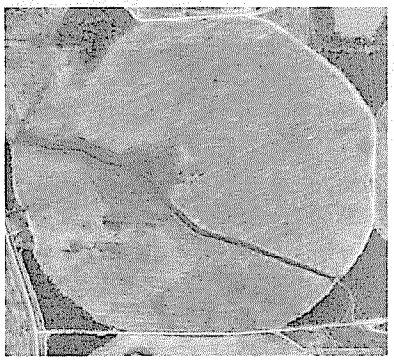
Date	Rain (in)	Irrigation Amount (in)
1-Oct-05	0	
2-Oct-05	0.22	
3-Oct-05	0	
4-Oct-05	0	
5-Oct-05	0.04	
6-Oct-05	0.11	
7-Oct-05	0.27	
8-Oct-05	0	
9-Oct-05	0	
10-Oct-05	0	
11-Oct-05	0	
12-Oct-05	0	
13-Oct-05	0	
14-Oct-05	0	
15-Oct-05	0	
16-Oct-05	0	
17-Oct-05	0	
18-Oct-05	0	
19-Oct-05	0	
20-Oct-05	0.04	
21-Oct-05	0.01	
22-Oct-05	0	
23-Oct-05	0	
24-Oct-05	0	
25-Oct-05	0	
26-Oct-05	0	
27-Oct-05	0	
28-Oct-05	0	
29-Oct-05	0	
30-Oct-05	0	
31-Oct-05	0	
	0.69	0

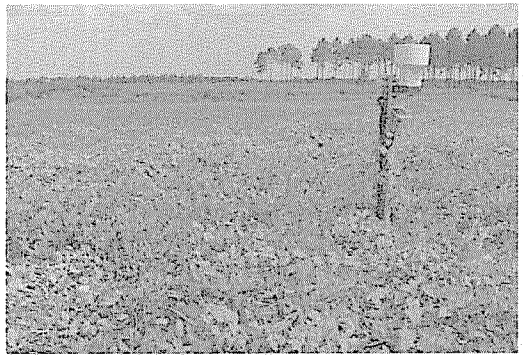
November-05

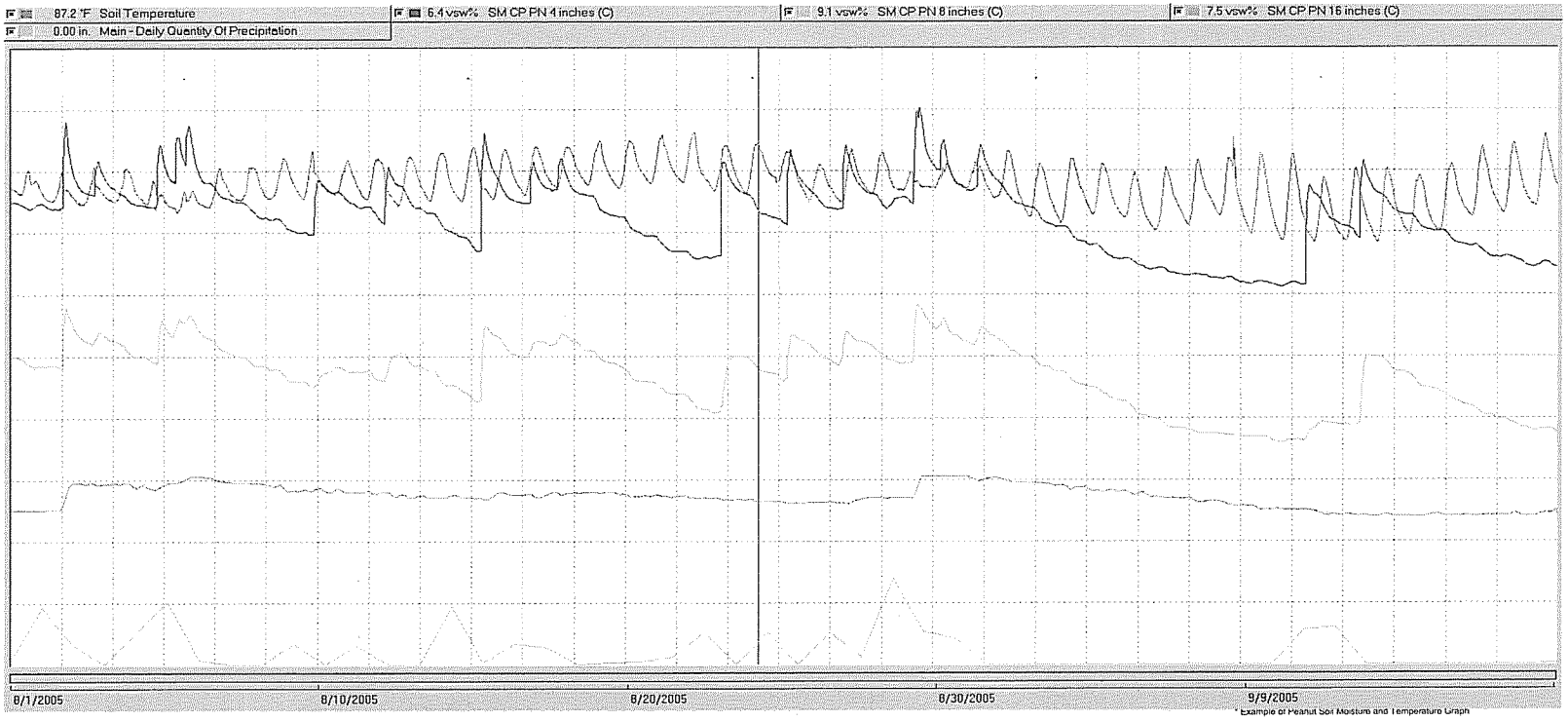
Date	Rain (in)	Irrigation Amount (in)
1-Nov-05	0.22	
2-Nov-05	0.04	
3-Nov-05	0	
4-Nov-05	0	
5-Nov-05	0	
6-Nov-05	0	
7-Nov-05	0	
8-Nov-05	0	
9-Nov-05	0	
10-Nov-05	0	
11-Nov-05	0	
12-Nov-05	0	
13-Nov-05	0	
14-Nov-05	0	
15-Nov-05	0	
16-Nov-05	0.01	
17-Nov-05	0	
18-Nov-05	0	
19-Nov-05	0	
20-Nov-05	1.26	
21-Nov-05	0.34	
22-Nov-05	0	
23-Nov-05	0	
24-Nov-05	0	
25-Nov-05	0	
26-Nov-05	0	
27-Nov-05	0.16	
28-Nov-05	1.09	
29-Nov-05	0.1	
30-Nov-05	0	
	3.22	0

2005 Irrigation Water Management Report

Grower
Field
FSA #
Acres 162







* Example of Peanut Soil Moisture and Temperature Graph

ENVIRONMENTAL
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2005 Irrigation Water Management Report

Grower
Field
Track #
FSA # 1619
Acres 162

Totals	
Total Rain (in.)	Inches for growing season
Total Applied Irrigation (in.	3.15 inches for grfor growing season
Total	3.15

Plant Date Harvest Date

April-05

Date	Rain (in)	Irrigation Amount (in)
1-Apr-05	2.01	
2-Apr-05	0	
3-Apr-05	0	
4-Apr-05	0	
5-Apr-05	0	
6-Apr-05	0.01	
7-Apr-05	1.96	
8-Apr-05	0	
9-Apr-05	0	
10-Apr-05	0	
11-Apr-05	0	
12-Apr-05	0.11	
13-Apr-05	0	
14-Apr-05	0	
15-Apr-05	0	
16-Apr-05	0	
17-Apr-05	0	
18-Apr-05	0	
19-Apr-05	0	
20-Apr-05	0	
21-Apr-05	0.01	
22-Apr-05	0.55	
23-Apr-05	0.01	
24-Apr-05	0	
25-Apr-05	0.01	
26-Apr-05	1.14	
27-Apr-05	0	
28-Apr-05	0	
29-Apr-05	0	
30-Apr-05	1.89	
Monthly Totals	7.7	0

May-05

Date	Rain (in)	Irrigation Amount (in)
1-May-05	0	
2-May-05	0	
3-May-05	0	
4-May-05	0.15	
5-May-05	0.32	
6-May-05	0	
7-May-05	0	
8-May-05	0	
9-May-05	0	
10-May-05	0	
11-May-05	0.1	
12-May-05	0	
13-May-05	0	
14-May-05	0	
15-May-05	0.04	
16-May-05	0	
17-May-05	0	
18-May-05	0	
19-May-05	0	
20-May-05	1.21	
21-May-05	0.02	
22-May-05	0	
23-May-05	0	
24-May-05	0	
25-May-05	0	
26-May-05	0	
27-May-05	0	
28-May-05	0	
29-May-05	0	
30-May-05	0	
31-May-05	0.48	
	2.32	0

June-05

Date	Rain (in)	Irrigation Amount (in)
1-Jun-05	0.59	
2-Jun-05	0.38	
3-Jun-05	0.14	
4-Jun-05	0	
5-Jun-05	0	
6-Jun-05	0.16	
7-Jun-05	0.01	
8-Jun-05	2.99	
9-Jun-05	0.42	
10-Jun-05	0.09	
11-Jun-05	1.64	
12-Jun-05	0.06	
13-Jun-05	0.01	
14-Jun-05	0	
15-Jun-05	0	
16-Jun-05	0	
17-Jun-05	0.01	
18-Jun-05	0.14	
19-Jun-05	0	
20-Jun-05	0	
21-Jun-05	0	
22-Jun-05	0	
23-Jun-05	0	
24-Jun-05	0	
25-Jun-05	0.04	
26-Jun-05	0	
27-Jun-05	0	
28-Jun-05	0.21	
29-Jun-05	0.48	
30-Jun-05	0	
	7.37	0

July-05

Date	Rain (in)	Irrigation Amount (in)
1-Jul-05	0.02	
2-Jul-05	0.07	
3-Jul-05	0	
4-Jul-05	0	
5-Jul-05	0.11	
6-Jul-05	0.12	
7-Jul-05	0	
8-Jul-05	0	
9-Jul-05	0.52	
10-Jul-05	2.44	
11-Jul-05	1.67	
12-Jul-05	0.21	
13-Jul-05	0	
14-Jul-05	0.29	
15-Jul-05	0.3	
16-Jul-05	0	
17-Jul-05	0	
18-Jul-05	0.3	
19-Jul-05	0.03	
20-Jul-05	0.04	
21-Jul-05	0	
22-Jul-05	0	
23-Jul-05	0	
24-Jul-05	0	
25-Jul-05	0	
26-Jul-05	0	
27-Jul-05	0	
28-Jul-05	0	
29-Jul-05	0.39	
30-Jul-05	0.44	
31-Jul-05	0.54	
	7.49	0

August-05

Date	Rain (in)	Irrigation Amount (in)
1-Aug-05	0.67	
2-Aug-05	0.01	
3-Aug-05	0.07	
4-Aug-05	0	
5-Aug-05	0.47	
6-Aug-05	0.31	
7-Aug-05	0	
8-Aug-05	0	
9-Aug-05	0.54	
10-Aug-05	0.36	
11-Aug-05	0	
12-Aug-05	0	0.28
13-Aug-05	0	
14-Aug-05	0	
15-Aug-05	0.63	
16-Aug-05	0.01	
17-Aug-05	0	0.32
18-Aug-05	0	0.35
19-Aug-05	0	
20-Aug-05	0.3	
21-Aug-05	0.19	
22-Aug-05	0	0.09
23-Aug-05	0	0.5
24-Aug-05	0.02	
25-Aug-05	0.02	
26-Aug-05	0	0.48
27-Aug-05	0.02	
28-Aug-05	0.33	
29-Aug-05	2.21	
30-Aug-05	0.26	
31-Aug-05	0.06	
Monthly Totals	6.48	2.02

September-05

Date	Rain (in)	Irrigation Amount (in)
1-Sep-05	0	
2-Sep-05	0	
3-Sep-05	0	
4-Sep-05	0	
5-Sep-05	0	
6-Sep-05	0	
7-Sep-05	0	
8-Sep-05	0	
9-Sep-05	0	
10-Sep-05	0	
11-Sep-05	0	0.55
12-Sep-05	0	0.58
13-Sep-05	0	
14-Sep-05	0	
15-Sep-05	0	
16-Sep-05	0	
17-Sep-05	0	
18-Sep-05	0	
19-Sep-05	0	
20-Sep-05	0	
21-Sep-05	0	
22-Sep-05	0	
23-Sep-05	0.11	
24-Sep-05	0.01	
25-Sep-05	0	
26-Sep-05	.0.08	
27-Sep-05	0.4	
28-Sep-05	0.1	
29-Sep-05	0	
30-Sep-05	0	
	0.7	1.13

October-05

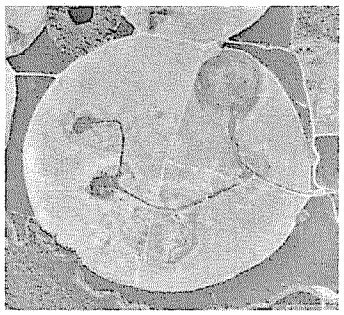
Date	Rain (in)	Irrigation Amount (in)
1-Oct-05	0	
2-Oct-05	0.22	
3-Oct-05	0	
4-Oct-05	0	
5-Oct-05	0.04	
6-Oct-05	0.11	
7-Oct-05	0.27	
8-Oct-05	0	
9-Oct-05	0	
10-Oct-05	0	
11-Oct-05	0	
12-Oct-05	0	
13-Oct-05	0	
14-Oct-05	0	
15-Oct-05	0	
16-Oct-05	0	
17-Oct-05	0	
18-Oct-05	0	
19-Oct-05	0	
20-Oct-05	0.04	
21-Oct-05	0.01	
22-Oct-05	0	
23-Oct-05	0	
24-Oct-05	0	
25-Oct-05	0	
26-Oct-05	0	
27-Oct-05	0	
28-Oct-05	0	
29-Oct-05	0	
30-Oct-05	0	
31-Oct-05	0	
	0.69	0

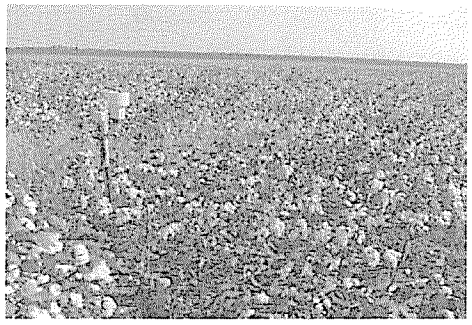
November-05

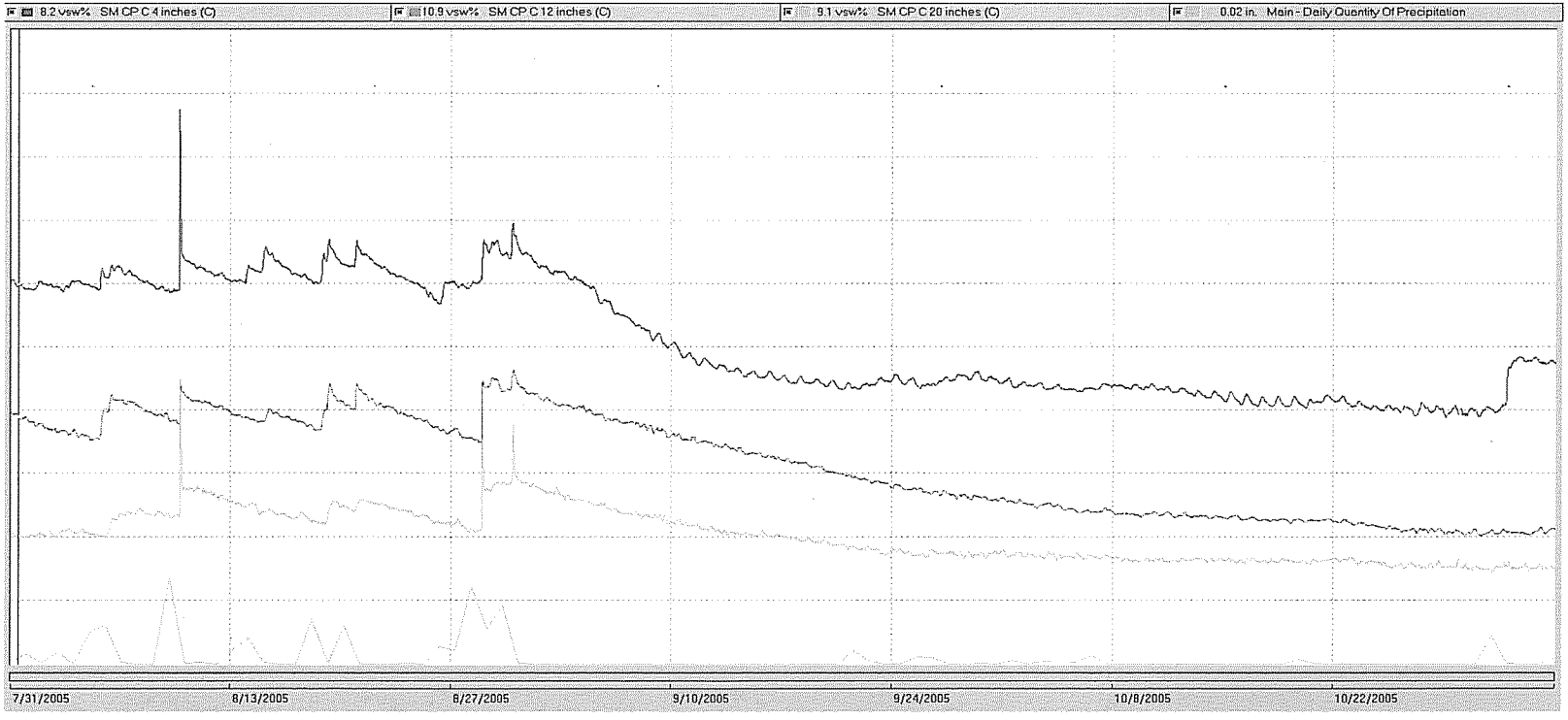
Date	Rain (in)	Irrigation Amount (in)
1-Nov-05	0.22	
2-Nov-05	0.04	
3-Nov-05	0	
4-Nov-05	0	
5-Nov-05	0	
6-Nov-05	0	
7-Nov-05	0	
8-Nov-05	0	
9-Nov-05	0	
10-Nov-05	0	
11-Nov-05	0	
12-Nov-05	0	
13-Nov-05	0	
14-Nov-05	0	
15-Nov-05	0	
16-Nov-05	0.01	
17-Nov-05	0	
18-Nov-05	0	
19-Nov-05	0	
20-Nov-05	1.26	
21-Nov-05	0.34	
22-Nov-05	0	
23-Nov-05	0	
24-Nov-05	0	
25-Nov-05	0	
26-Nov-05	0	
27-Nov-05	0.16	
28-Nov-05	1.09	
29-Nov-05	0.1	
30-Nov-05	0	
	3.22	0

2005 Irrigation Water Management Report

Grower
Field
Track #
FSA #
Acres 240







* Example of Cotton Soil Moisture Graph

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