AUTOMATION IN DRIP IRRIGATION SYSTEM FOR COTTON GROWING ON LARGE SCALE - A CASE STUDY

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ABSTRACT

Micro Irrigation technology concept is now accepted by most of the farmers in Maharashtra. It's adoption started in grapes a decade back and has since then spread in to a large number of crops. Drip irrigation however had not been adopted in cotton crop until as recently as four to five years ago. This was primarily because cotton has a large plant population. Adequate research recommendations are not available regarding net water requirement, plant population, plant to plant and row to row spacing, distance between emitters, emitters discharge in black cotton and light soils etc. However, a progressive farmers tried drip irrigation in cotton with remarkable success. Fertigation through drip is yet to be given a genunine attempt. An integrated pest management approach to plant protection in cotton is a recent attempt in organized scale cluster demonstration and farmer's field school. Drip irrigation offers additional advantages in cotton growing such as application of controlled quantity of water at the initial stages of plant propogation in order to increase flowering, earl in flowering and thus higher yields and at source fertigation. Water saving of 60 percent increase in the irrigated area, and reduces the cost of fertigation, weeding, etc. This paper deals with the irrigation system equipment, design layout, computer control, field communication systems and water requirements.

INTRODUCTION

India is a major cotton producing country in the world with more than 7.5 million hectare in production. Maharashtra with 3 million hectares, accounts for 40 percent of the total cotton area in the country. In terms of per hectare productivity Maharashtra ranks eight in the country with 180 kg lint per hectare compared to the national average of 248 kg by comparison. Punjab has a

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productivity of more than 500 kg lint per hectare. However, Israel with the help of drip irrigation and fertigation through drip has been able to harvest 1900 kg lint per hectare. Therefore, they have attracted world wide attention for development and adoption of modern technology to overcome natural constraints to successful agriculture with limited water resources. Adoption of micro irrigation technology has helped them overcome this constraint successfully. Replication of this technology in cotton in Maharashtra would positively help in increasing yield. Therefore, cotton growing on a large scale with fully computerized drip irrigation systems has been implemented.

Installation Details of the Most Extensive Cotton Growing Project

The installation of the drip irrigation system spread over an area of 200 hectares (80 ha. at Central Research Station and 120 ha at Central Demonstration Farm) was a challenging task which involved detailed planning, procurement, co-ordination and management. The size of the project can be realised from the amount of overall material utilised in the project. Pressure compensating Drippers, numbered 22,000,00 (Twenty two lakh) and there was 11,000,00 (Eleven lakh) meters of LLDPE lateral with a 16 mm diameter. Twenty six thousand meters of PVC pipe line ranging from 63 mm to 280 mm diameter with 6 kg/cm2 pressure were used. About 18 kms of trenching was done to lay these pipes. The EBS Filter with a 400 m^3 /hr flow rate was electrically at operated. One hundred ten Bermad hydraulic valves were installed. Plastro in India (Pune) supplied the drip line with preinserted-drippers at specified spacings of 0.5 m .

Layout of the Irrigation System

The area of the project has been subdivided into plots with an average size of 2 ha. Each plot has a length of 200 m - 250 m and a width of 80 - 100 m according to the nature of the area. Each group of eight plots will have a secondary filtration head. The area has been so sub-divided so as to facilitate the work from the aspect of plot cultivation and the work of the irrigation operators and to facilitate flexible control over the water supply and irrigation system. The automation field layouts for drip irrigation systems for Central Research Station, (CRS), Akola and of Central Demonstration Farm (CDF), are given in Fig. 1 and 2 respectively.

The water from the main control head is delivered by a PVC pipeline to the secondary filter heads in the plots and to the operating heads. The PVC pipe having a diameter ranging from 280 mm to 90 mm and to a 75 mm and a working pressure rating of 6 Kg/cm^2. The PVC pipes has been laid in a trench, with the submain at 80 cm depth and the main pipeline at 1.2 m depth. Concrete anchors were constructed as necessary.

The Operating Heads

Each field plot have an operating head commanded by the control computer according to the operating program. The average application is 4 mm/day on the basis of six irrigation days in a week. The daily amount of water to be returned to the soil is 4.7 mm. Approximately 2 hours irrigation is required daily to apply this dosage. Therefore according to the operating program of eight sectors per day, the irrigation system is operating about 16 hours per day. The design and other details are given in Table 1, and water requirements of cotton during May to November is given in Table 2.

The drip laterals are connected to the sub main by means of saddles installed with 25 mm flexible pipes and the other end rises above ground level. A six way fitting is connected to the riser above the ground which enables connection of six drip laterals, three to each side. The outlets are spaced along the sub main at a distance of 5.8 meter. The drip laterals are laid out in the plots at the beginning of each season and rolled up at the end of each irrigation season.

Control and Automation

The irrigation systems at both places (CRS and CDF) are commanded and controlled by a central computer. Single electrical NYY cable is connected to the remote terminal units (R.T.U.) which are fixed on every valves in the field. The electronic coding to the valves is possible due to circuits cards and numbering of every individual valve. Accordingly these valves were operated with the help of computer and the data of operation is recorded. Both the irrigation systems at CRS and CDF for cotton growing are identical and have the same operating regime they have operated satisfactorily since installation in the year 1997.

Single Cable Field Communication System Overview

The single cable (SC) module is a microcontroller based module. The module operates up to 126 remote terminal units divided into two lines with each line controlling 63 RTU's . Each SC line is based on a communication cable, which transfers about 40 V A.C. feed power and command / report communication to the RTU's on site. Each RTU is comprised of an electronic circuit board and latching solenoid. When an RTU receives a command signal, its circuit board decodes the command signal and energizes the latching solenoid, thus controlling a hydraulic valve. The RTU can be connected to two back indication sensors (watermeter, pressure gauge and other type of dry contact connections). One single cable module is capable of serving up to 126 output and 252 input stations and the system can be protected against lightning surges by line protection units connected to the communication cables.

Operation

When the IRRINET unit is reporting to a central irrigation computer, an alarm report will be sent to the irrigation computer in case of failure of the 40 V mode and CLK. The physical connection table in the system defines the in and out connections to the logical stations and inputs. For each connection module / remote number, the input / output number is specified . The single cable module has 126 output and 252 input positions, which are divided into two communications lines with 63 RTU's on each line Therefore, when you need to physically connect a logical output or input to a SC module, you have to refer to one of the 126 output or 252 inputs. The RTU's can be checked through software by performing general operation diagnostics using the manual operation and the input status tables. Such unique field communication systems are installed on the large farms of the university. On 120 ha area there are 79 output positions with 43 output positions in module no. 1 and 36 in module no. 2 and 4 positions. Out of 4 input positions, 2 input positions are for main valves (hydrometers) and 2 are for fertigation pumps at Central Demonstration Farm (C.D.F.) at Wani Rambhapur and on a 80 ha area with 40 output positions in module one and 2 input positions in module no. 3 at Central Research Station, Akola (Table 3).

Maintenance

In order to ensure proper operation of the single cable system , periodic checking as mentioned below is necessary.

i. Proper electrical connection of the communications cables and the IRRINET unit. Also remove all the RTU's and LPU's cylinder covers and check for proper wire connections, remove dump residues and check the condition of the LPU's fuses.
ii. All grounding rods should be inserted properly in the ground and have a good cable connection
iii. The communication cables should be in the ground or properly routed indoors.

Remedies for Malfunctioning.

The following steps should be taken when malfunctions are detected.

When SC line fails to function

i. Check main power
ii. Check line connector on the SC module front panel for a good connection and no loose wires
iii. Inspect the SC module front panel for the illumination of the 40 V, MOD and CLK.
iv. Check all software implementation regarding specific line operation.

v. Check fuses F_1 and F_2 in the LPU's.
vi. Check all electrical wires on the RTU board are connected properly.
vii. Only use the fuses of specified type and ratings to avoid risk of fire and thereby damaging to equipment or other property.

When a single RTU fails to function.

i. Check all software implementation regarding the specific RTU operation.
ii. Recheck the address jumper setting of the RTU board and electrical wire connections
iii. Check for proper mechanical function of the RTU by using the manual operation knob.

Transfer of technology

About 1 lakh farmers have visited the project at the various stages of the cotton crop during last year and demonstrated the technology with effective and efficient water management practices. Training was provided to the Government Extension, Village Development, and Agricultural Officers, as well as to the social workers of non government organisations and farmers to improve the cotton growing technology in the State. Department of Agricultural Govt. of Maharashtra and Agricultural Universities have jointly under taken the need base technology demonstration programme for small farmers on 1, 2 3 and 4 hectares area at various Government and University farms in the region. This will transfer the technology at root level with proper soil, water and fertilizer management practices through Drip Irrigation.

CONCLUSIONS

1. The system works efficiently if logical monitoring, careful operation and timely and wise maintenance is carried out.
2. Frequent failures of the RTU's circuit cards are due to the humidity and mishandling.
3. Entry of water or moist conditions inside the RTU box is strictly prohibited.
4. Position of the RTU box in the field or at the bank of the stream should be sufficiently above the surface heading during rainy season.
5. At the time of installation of the cable, care should be taken to avoid cable damage due to the soil clods or stones etc. during filling of the trenches.
6. Cable jointing should be fully water tight.

REFERENCES

Project report submitted by Agricultural Development Company, Israel to the Govt. of Maharashtra, 1997.

Project report submitted by the Dr. Panjabrao Deshmukh Agricultural University, Akola to the Govt. of Maharashtra and Agricultural Development Company, ISRAEL (1997).

Irrigation Engineering, Sprinklers, Trickle, Surface Irrigation, Principles, Design and Agricultural Practices, (1995). By A. Benami and A Ofen. AGRIPRO, Jeruselum, Israel.

Literature published by the Plastro (India), Bermad, Amiad, ARI Air valves, Motorola, etc. pertains to their products provided in the project.

LIST OF ABBREVIATIONS

cm	centimeter
Doz	Dozen
ha.	hectare
Irri.	Irrigation
Kg.	Kilograms
l	liter
LDPE	Low Density Polyethylene
m	meter
MS	Maharashtra State
No.	Number
Q	Quintal
Rs.	Rupees
Spr.	Sprinkler
Sur.	Surface
T	Tones
UAS	University of Agricultural Sciences

Table 1. Design Details And Irrigation Data

Design / irrigation parameters	Units	C.D.F.	C.R.S.
Crop		Cotton	Cotton
Irrigation area (net)	Ha	120	80
Water source type		Tank	Tank
Crop spacing	m	1.96	1.96
Type of irrigation system		Drip	Drip
Emitter type		Katif	Katif
Emitter flow rate	l/h	2.3	2.3
Emitter spacing	m	0.5	0.5
Lateral spacing	m	1.93	1.93
Number of laterals per bed	-	1.00	1.00
Irrigation rate	mm/h	2.4	2.4
Average peak consumptive use	mm	4.66	4.66
Irrigation interval	days	6 days out of 7	6 days out of 7
Water application per irrigation	mm	4.66	4.66
Time of irrigation per operation	h	1.94	1.94
Number of operations per cycle		8	8
Max. discharge per operation	m^3/h	376	395
Min. discharge per operation	m^3/h	352	280
Max. total irrigation time per cycle	h	16	16
Min. required emitter pressure head	m	8	8
Elevation (up+, down -)	m	-	-
Required pressure head at water source (outlet)	m	60	60

Table 2. Water Requirements of Cotton During May to November

Item	May	June	July	Aug	Sept.	Oct.	Nov.	Total
Class A pan evaporation, mm/day	17	7-14	5.7	4.3	5.2	5.6	5.0	
Crop evapotrans-piration factor			0.4	0.6	0.8	0.4		
Monthly water demand, mm	35		88	80	125	140	60	508
Rainfall, mm/month	15	183	251	179	101	53	9	791
Balance, mm/month	-20	183	163	99	-24	-87	-51	283

Table 3. Input and output connections for the field communication system.

Sr. No	System valve details	Output connections		Input connections	
		Module	Out put	Module	Input
Central Demonstration Farm Wani-Rambhapur (120 ha)					
1	Line I control valve no. 1 to 43	1	1 to 43	-	-
2	Main control valve, no. 44	3	1	3	1
3	Fertilizer injection pump, no. 45	3	2	3	2
4	Line II control valve no. 46 to 81	2	1 to 36	-	-
5	Main control valve, no. 82	3	3	3	3
6	Fertilizer injection, valve no. 83	3	4	3	4
Central Research Station, Akola (80 ha)					
1	Control valve no. 1 to 40	1	1 to 40	-	-
2	Main control valve, No. 41	3	1	3	1
3	Fertilizer Injection pump valve no. 42	3	2	3	2

Figure 1. Automation field layout of Drip Irrigation System for Center Research Station (CRS), Akola

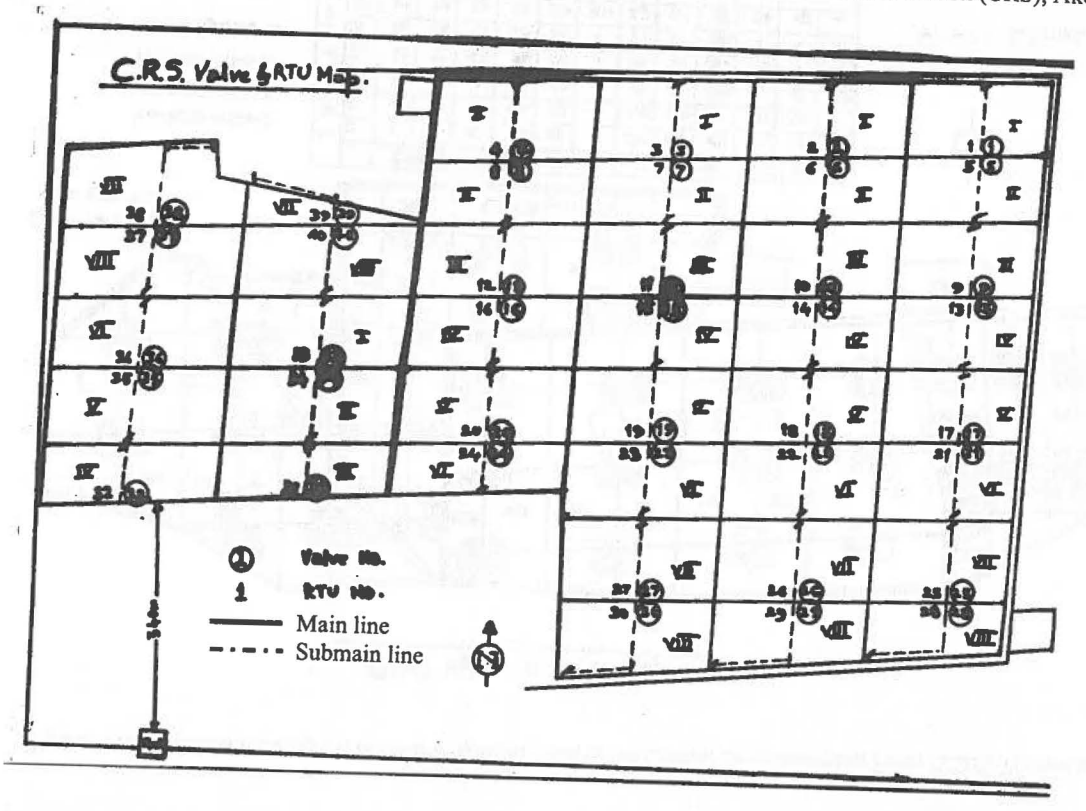

Figure 2. Automation field layout of Drip Irrigation System for Central Demonstration Farm (CDF) Wanirambhapur