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Minimizing irrigation water losses in flooded paddy using low cost sensor unit

B. ASHWIN KUMAR, A. RAMA RAO, M. SRINIVASULU AND **H.V. HEMA KUMAR**

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See end of the Paper for authors' affiliation

Correspondence to :

B. ASHWIN KUMAR
Department of Agricultural Engineering, Farm Implements and Machinery, Acharya N.G. Ranga Agricultural University, HYDERABAD (A.P.) INDIA

ABSTRACT : Optimum development and efficient utilization of water resources, assumes great significance research in water management in the developed countries is progressing towards real time irrigation, decision support systems and expert systems. As the farm holdings are not large enough in India and also high cost of automation cannot be realized in India ,low cost auto irrigation suitable to farmers ,if developed and can be made as technology, farmers can feel comfortable in view of the frequent power cuts and less power available in his form. To apply simple electronic circuit principles in irrigation, an attempt has been made to develop low cost auto irrigation based on soil moisture or timer. The device tested in the lab conditions has proved successful and can be very well adapted to paddy fields by slight modifications ensuring no time lag in the reduction of water level in the burette and surrounding water level in the fields. With low cost metal cylinders with sufficient openings and sensors fixed at recommend water levels, without time lag could also be easily made successful.

KEY WORDS : Water loss, Irrigation, Flooded paddy, Low cost, Sensor unit

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Auto irrigation is the method of application of precious amount of water automatically as per crop requirement through saving resources like water, power and fertilizer. The rapid advance electronics and its successful using developing auto - irrigation system has made it possible to practice efficient irrigation. Recent trends in research towards an integrated real time irrigation scheduling system lead for developing some recommendations for typical crop and irrigation management conditions in south eastern Australia. The system comprises three main elements namely a)Soil moisture monitoring device cable of measuring soil moisture level on a continued basis. b) Medium term weather forecast. c) Decision support system to assist irrigators in making irrigation scheduling on water ordering decisions. A surface irrigation management decision support system (SIMDSS) was also developed and its general architecture is described. Irrigation scheduling in surface irrigated forms required additional knowledge to predict the performance (time, quantity, uniformity of application) of any event.

Traditionally irrigation scheduling is considered as a decision making process used by irrigates to decide went to irrigate their crops and determine the appropriate quantity of water to apply. This concept has proved to be adequate for pressurized irrigation system in general (Spray and Drip) in adequate for surface irrigation is for less controllable. Although irrigation scheduling has been widely used by "irrigation experts", farm operators (indented users of the systems) don't regularly use them. An expert system is software that attempts to provide an answer to a problem, or clarify uncertainties where normally one or more human experts would need to be consulted. The expert systems are designed to emulate the logic and reasoning process that an expert would use to solve a problem in his / her field for expertise, using artificial intelligence technology. These are software programs, which typically fit into the category of decision support tools. The decision support program imitates and expert by involving a client in a problem solving situation, often providing a recommendation in response to clients request, and is highly interactive. Hence, an expert system intends to help the farmers to make as better decision and provide a useful advice, thus files the knowledge gap between the expert and user.

Auto irrigation can be done based using some sensor controllers and sample circuits connected to the starter of the pump set based on soil moisture or pre fixed time interval. The coastal areas of Andhra Pradesh, the single phase ac motors of 1-5 HP are common for irrigation and with considerations are the same, it is proposed to apply a commercially already available water tank sensor unit sold out extensively in city apartment water tanks for flooded paddy fields.

METHODOLOGY

College of Agricultural Engineering is located in Karlapalem Road, Bapatla which is surrounded by paddy fields and lies 9 km away from Bay of Bengal. Because of the availability of fresh water from traditional Doruvus, so made to collect the top fresh water for irrigating the paddy is the main source of irrigation water. The farmers still adapt flooding the paddy lands though SRI cultivation is gaining its momentum elsewhere. However, the losses and time of pump sets thereby power consumption could be greatly reduced if low cost sensor units are used for the pump sets. An attempt was made to apply a commercially available apartment water tank sensor unit for agricultural pump set in the farmer fields. The description of the unit used is described in this section.

Aqamon single phase auto cutoff and auto cut on circuit:

Aqamon single phase auto cutoff and auto cut on circuit board fixed in a box along with sensors which was designed for keeping in the water tanks of domestic houses and apartments for single phase motor pump sets was used for auto irrigation. The simple circuit used in the box is presented in Fig. A. A copper wire of 18 gauge with total length of 5 m has been purchased locally, cut into three equal pieces and connected to the circuit board and sensors to facilitate the variable depths of water levels in the burette and ceramic tip device. This circuit automatically controls the water pump motor. The motor gets automatically switched on when water level in the tensiometer falls below the irrigation starting point due to soil suction and gets switched off when the water level in the tensiometer reaches to field capacity point due to irrigation. The irrigation starting point and field capacity points are pre fixed according to the type of the soil.

The circuit works by using NAND gate IC (CD4011), the circuit is simple, compact and economical. It works of a 12 volts DC power supply it is given through a step down transformer and on turn a very inlet power. In the circuit diagram, "A" is the irrigation starting point and "B" is the field capacity point. The 12 volts power supply is given common electrode "C", which is limit for minimum water in the tensiometer tube. The irrigation starting point electrode "A" is connected to base of transistor T1 (B547), the collector of which is connected to 12 volts power supply and the emitter

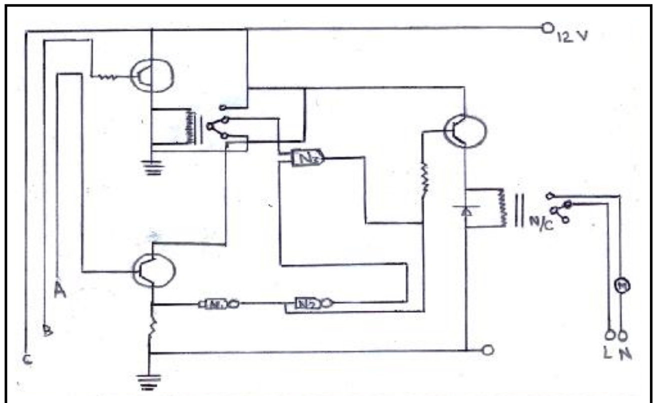

Fig. A : Circuit diagram of auto start and cutoff device for irrigation

is connected to relay RL 1. Relay RL 1 is connected to pin 13 of NAND get N3. The field capacity electrode "B" is connected to the base of transistor T2 (BC547), the collector of which is connected to the 12 volts power supply and emitter is connected to pin 1 and pin 2 of NAND gate Nl and ground via resistor R3. The output pin 4 of NAND gate N2 is connected to pin 12 of NAND gate N3.

The output ofN3 is connected to input pin 6 ofN2 and the base transistor T3 via resistor R4. Relay RL2 connected to the emitter of transistor T3 is used to drive the motor. If the water level in the tensiometer reaches below the irrigation starting point "A", transistors Tl and T2 do not conduct and the output of N3 goes high. This high output energizes relay RL2 to drive the motor.

When the water level in the tensiometer reaches above the irrigation starting point "A" but below the field capacity "B", water inside the tensiometer provides base voltage to drive transistor Tl and relay RLI energizes to make pin 13 of gate N3 high. However, water inside the tensiometer does not provide base voltage to transistor T2, so it does not conduct and logic built around NAND gates N 1 andN2 outputs low to pin 12 of gate N3. The net effect is that the output of N3 remains high and the motor continues working. When the water level in the tensiometer reaches the field capacity point "B", water inside the tank still provides base voltage to transistor Tl and relay RLl energizes to make pin 13 of gate N3 high. At the same time, water inside the tensiometer also provide base voltage to drive transistor T2 and the logic built around NAND gates Nl and N2 outputs high to pin 12 of gate N3. The net effect is that the output at pin 11 of N3 goes low and the motor stops working. When water level falls below field capacity point "B" but above irrigation starting point "A", water inside tensiometer still provides base voltage to transistor Tl and relay RLl remain energized to make pine 13 of gate N3 high. However, transistor T2 doesn't conduct and the logic built around NAND gates Nl and N2 outputs high in pin 12 ofN3,

Table 1 : List of components and unit costs of individual components of the circuit board

Sr. No	Name of part	Specification	No. of units	Price per unit(Rs)	Total price(Rs)
1.	Transformer	0-12V	1	35	35
2.	Diode	4007	4	2	8
3.	Capacitor	1000 μfd	1	15	15
4.	Capacitor	100 μfd	1	5	5
5.	Capacitor	22 μfd	1	3	3
6.	I.C (integrated circuit)	CD4011	2	50	100
7.	Regulator	12V-L7812	1	15	15
8.	Capacitors	0.22pfd	4	2	8
9.	Resistors		13	1	13
10.	Transistor	547	1	5	5
11.	Electromagnetic relay	12V	1	70	70
12.	On-off switch	6Am	1	10	10
13.	Pressing switch	5Am	1	10	10
14.	Led indicator		2	2	4
15.	I.C. base		2	10	20
16.	Flexible wire		1 packet	10	10
17.	Connectors or sockets	Plastic	2	5	10
18.	Soldering lead	West-X	1 bundle	5	5
19.	Paste		1bottle	5	5
20.	Solder iron	35w(tone)	1	35	35
21.	Converging box	Plastic	1	50	50
22.	Electrodes	Insulated cu wire	1m	5	5
23.	Servicing charges	-------	------	-------	50
	Grand Total				497/-

as a result the output ofN3 remains low and motor remains stopped. When water level falls below the irrigation starting point "A" both transistor Tl and T2 do not conduct electricity and NAND gate N3 gives a high output to dive relay RL2 and the motor restarts pumping water. The various components and their details are presented in Table 1.

As the circuit board is successful for the domestic water supply to tanks, the same concept is felt acceptable to study for the paddy field flood irrigation which is most popular in the coastal areas. A study has been conducted by connecting the starter of the single phase Kumar piston pump in farmers' fields for irrigating the paddy crop. The experiment of automation has been carried out by placing the cutoff depth of ponding water with 5 sets, namely 5cm, 6cm, 7cm, 8cm and 9cm depth of ponding. Taking different intervals for deep percolation arid evaporation losses. The pump responded well *i.e.* at the lowest position *i.e.* placed little above the ground surface for starting up and highest position of the sensor at the top level chosen. The sensors were placed in a PVC ring of 2ft dia so made for this purpose and kept in the paddy field submerged near to the pump set. As the timer based pump sets need some constant power supply and in the mean time, some percolation losses may be encountered, the authors did not recommend the timer based sensor unit for such flooding paddy situation.

Conclusion:

Low cost commercially available sensors could be better be used for pump sets for irrigating the paddy fields. Enormous savings could be foreseen with low cost units which are easy to connect to the pump sets village electricians. Further as the cost is considerably low when compared to the automation of drip irrigation systems, this type of sensors could be used extensively by adopting durable spares which could sustain for even saline water conditions too. Though the timer based sensor units possess ease in operation and maintenance, they are not feasible for paddy fields in view of frequent power cuts in the present day context particularly in South India.

Authors' affiliations:
A. RAMA RAO, M. SRINIVASULU AND H.V. HEMA KUMAR, Department of Soil and Water Engineering, College of Agricultural Engineering, BAPTLA (A.P.) INDIA

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