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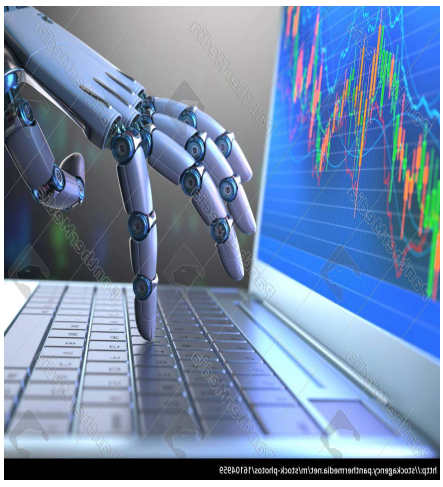
# Automation in agriculture

**Lakshmi Poojitha Challa**
ICAR- Central Institute of Agricultural Engineering, Bholpal (M.P.) India

Water is a scarce resource in arid and semi-arid regions such as the Mediterranean basin. Agriculture is the world's largest consumer of the world's fresh water, accounting for irrigation. The increase of the water use efficiency (WUE) in agricultural systems, defined as the yield obtained per unit of water applied, it is possible with appropriate irrigation scheduling. This adequate irrigation scheduling will also reduce the environmental impacts associated with water losses by percolation and nutrient leaching. Automation in agriculture is the technical approach in which the farmers will be benefitted by automatic monitoring and real time operation. Automatic monitoring and control system will be substitute to traditional farming method in which farmer had to visit his field regularly to examine the parameters. Therefore, for overcome these problems and to increase water use efficiency and to minimize the water losses in irrigation, automation of irrigation is playing major role. Maximize the automation in agriculture concentrates on the irrigation part.

**Automation in irrigation:** Automation is the technology by which a process or procedure is performed with minimum human assistance. Automation involves the use of various control systems for the operation. It is a powerful tool for increasing efficiency and this requires technology. Automation of irrigation system refers to operation of the irrigation system with minimum or without manual intervention. It eliminates the manual opening and closing of valves. It starts and stops pump exactly as and when required thus optimizing the energy requirement. Irrigation system can be started at any desired time. There is a possibility to change frequency of irrigation and fertilizer application as per the crop need. There are some automated systems used in irrigation are discussed as follows.




**Types of automation system used in irrigation**

- Time based automated irrigation system
- Open loop systems
- Computer-based irrigation control systems
- wireless sensor network
- Artificial intelligence
- Volume based automated irrigation system
- Closed loop systems
- Sensor based irrigation system
- Internet of things

**Time based automated irrigation system:** In time based system, time is the basis of irrigation. Time of operation is calculated according to volume of water required and the average flow rate of water. The first thing to perform before programming for time-based system is to determine the duration of irrigation required for each section.

**Volume-based automated irrigation system**:In volume-based system, the pre-set amount of water can be applied in the field segments by using automatic volume controlled metering valves. Automation using volume-based systems is of two types. In first type of system, automatic metering valve with pulse output provides one pulse after completing one dial of the automatic metering valve. In second type of system, no controller is required. Automatic metering valves are positioned near each field segment.

**Open loop system:** In this system, operator makes the decision on the amount of water to be applied and the timing of the irrigation event. The controller is programmed correspondingly and the water is applied according to the desired schedule. Open loop controllers normally come with a clock that is used to start irrigation.

**Closed loop system:** In this system the operator develops a general control strategy. Once the general strategy is defined, the control system takes over and makes detailed decisions on irrigation scheduling and requires feedback from one or more sensors.

**Computer based irrigation system:** It consists of a combination of hardware and software that acts as a supervisor with the purpose of managing irrigation and other related practices such as fertigation and maintenance. The system is further divided into interactive system and fully automatic system

**Interactive system:** This system uses a micro-computer. The data is transmitted to control unit from sensors and then to central computer. In system, the field devices like valves, regulators, pumps etc., are fitted with electrically operated servo-device, which operates them and Controls the flow rate.

**Automatic system:** In this system person is completely avoided. Computer is programmed to perform automatic functions. With the help of control devices corrections can be done. In this system there is a facility to stop the function when there is a rainfall.

**Sensor based irrigation system:** There are two types of sensors for irrigation *i.e.,* soil based and plant based sensors.

**Soil moisture sensor:** Measuring and monitoring soil moisture helps determining when to irrigate, how much water to apply.

**Neutron probe:** Dielectric constant of soil is the function

**Soil- based sensors**

*Soil water content?based soil moisture sensors*

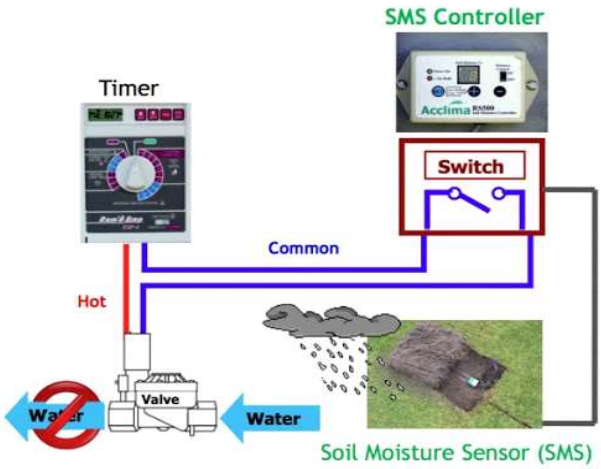
- Capacitance sensors (FDR)
- Neutron Probe
- Gypsum resistance
- Time domain reflectometry (TDR)

*Tension?based soil moisture sensors*

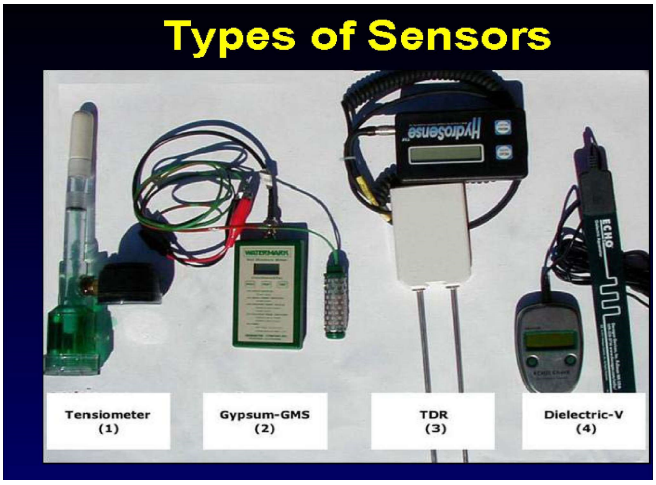
- Tensiometers

**Plant- based sensors**

- Thermocouple/ Temperature
- Dendrometer
- Sap flow sensor




Soil moisture sensors




Sensors used in irrigation

of content of moisture present in the soil. Travelling time of an electric magnetic wave changes as velocity of travelling wave is affected by the dielectric constant of soil.

**Frequency domain reflectometry (Capacitance sensors):** The electrical capacitance of a capacitor that uses the soil as a dielectric depends on the soil water content. When connecting this capacitor together with an oscillator to form an electronic circuit, changes in the circuit operating frequency detects the changes in soil moisture.

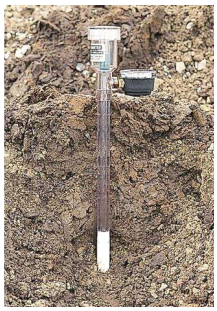
**Tensiometers:** A partial vacuum is created in a closed chamber when water moves out through a porous ceramic cup to the surrounding soil.

**Electrical resistance blocks:** Change in moisture content of a soil produces a change in electrical conductivity in a porous block placed in a soil, two electrodes embedded in it.

**Infrared thermocouples:** It is a sensor which measures leaf temperature**.** When it is compared to air temperature, it is used to predict the health status and transpiration activity of the plant. It works based on leaf-air temperature differential condition.

**Dendrometers:** These are linear variable displacement transducers (LVDTs)and linear motion potentiometers (LMP).These sensors measures daily shrinkage/swelling and radial growth of the stem and are successfully used to detect stress condition.

**Sap flow sensors:** Sap flow sensors are used to quantify whole plant-water use and dynamic plant water transport in trees and crops. By knowing plant- water use and plant water transport, we can schedule irrigation.



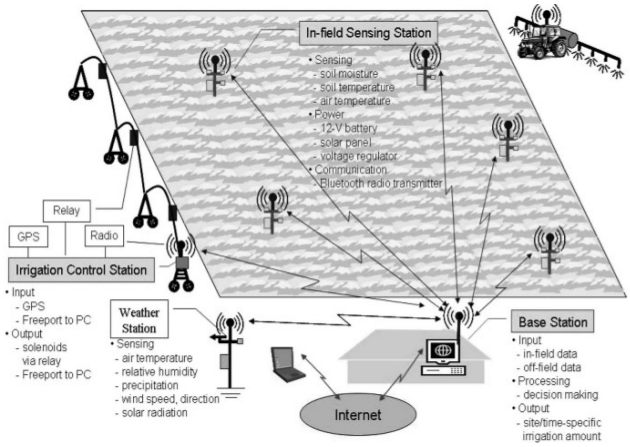
(a) Tensiometers

(b) Neutron probe


(c) Sap flow sensors

(d) FDR

**Wireless sensor network (WSN):** The WSN provides a more effective direct method of monitoring crop water use and need for irrigation on real time basis. But main limitation of this WSN is it works in a limited range. The advantages of using site specific real time soil moisture data, affected by site specific climatic conditions, for irrigation scheduling are:




Wireless sensor network

– No need to know the plant type and plant growth stage

– Avoid uncertainties (errors) when estimating evapotranspiration (ET) such as

Air temperature, relative humidity (RH), radiation, soil temperature and wind conditions.

**Internet of things (IoT):** IoT sensors can provide real-time updates on even the smallest fluctuation of moisture


Fig. Internet of things in agriculture

and subtle weather changes, altering the irrigation schedule. IoT systems transmit information by using wireless networks, connected to the regulator and other devices. Firstly, sensor data are transmitted to data processing center via a low-power network. The next step is to send data insights to farmer's dashboards on a laptop/ mobile, using these devices as controllers.

**Conclusions:** More scarcity of available water and also degradation of cultivable land are leading to improve farming trends. Rising population increases pressure on limited water resources are forcing us to think about viable options like automation of irrigation. Automation can help to maintain higher accuracy, timely operations as well as better yield. Besides increasing WUE and water productivity it can also be used for higher water application efficiency and also optimum crop growth can achieve.

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