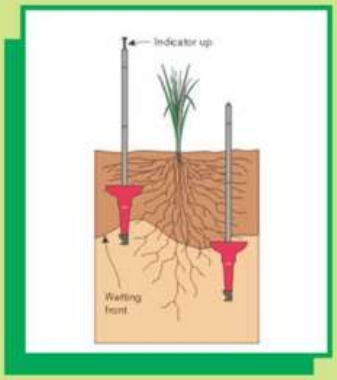
GOVERNMENT OF THE PUNJAB
Agriculture Department

TECHNICAL BRIEF
9

MODERN IRRIGATION TECHNOLOGIES AND PRACTICES



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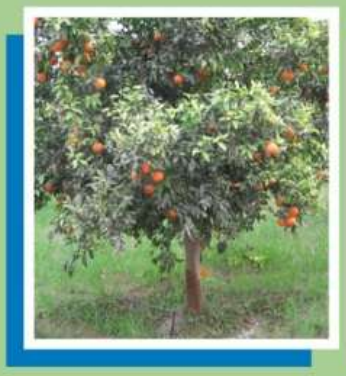


Directorate General Agriculture
(Water Management) Punjab

MODERN IRRIGATION TECHNOLOGIES AND PRACTICES

BACKGROUND

There has been modernization in every agricultural operation in Pakistan starting from tillage to threshing, except irrigation that is the most critical activity in crop production. The need for judicious and economical use of this scarce resource for sustainable agriculture is becoming increasingly important day by day due to constantly escalating water shortages. Contrarily, there is a huge gap in amount of water being applied and actual irrigation requirements that is required to be curtailed by scheduling the irrigation on scientific basis and modernizing application methods..

More importantly, orthodox guess work of plant and soil feel/appearance for irrigation is needed to be replaced with scientific measurement and monitoring of soil moisture for accurate determination of "*WHEN and HOW MUCH water to apply to a field*".Present practice of every time cutting bank of the earthen channel and creating a mud dike to divert water to the field is to be changed with more efficient and easy to operate low cost techniques. The irrigator should have control over irrigation interval, flow rate, and duration for maximizing crop productivity as well as water use efficiency.

IRRIGATION SCHEDULING BY SOIL MOISTURE MEASUREMENT

Soil moisture is a critical and potentially highly variable component of the soil environment in crop production. The feel and appearance is the only method presently employed for guessing soil moisture content for irrigation purposes. There are, however, a numerous instruments and tools available for its correct measurement. The use of these devices can remove the guess work in irrigation management by providing an accurate assessment of the soil water status. There are numerous such devices used for moisture measurement such as Weather Station, Tensiometers, Gypsum Blocks, Neutron Probes, Capacitance Devices, Soil Moisture Sensors, Time Domain Reflectometers, Time Delay Transmission Reflectometers, Wetting Front Detectors "Full Stop", Shovel/ Dig Sticks. A brief overview of commonly used low cost and farmer-friendly soil moisture monitoring tools is outlined at next page.

Time Domain Reflectometer

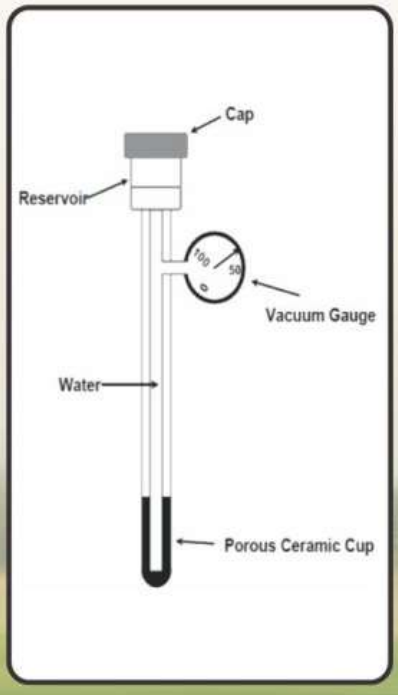
Time Domain Reflectometry (TRD) is a proven technology for quickly and accurately determining volumetric soilmoisture content. It is based on recording the propagation time of an electromagnetic pulse along measuring pins buried in the soil, which in turn is linked to soil moisture content. The meter's built-in data logger can automatically record readings from several sites as well as capture geo-referenced statistics that can be readily imported into software for full analysis mapping of relative water content at multiple sites.

ECHO Soil Moisture Sensors and Meters

The ECHO probe monitors soil moisture levels using the capacitance principle. It is comprised of low-cost sensors made of durable porous materials for measuring volumetric soil moisture content over a wide geographic area.

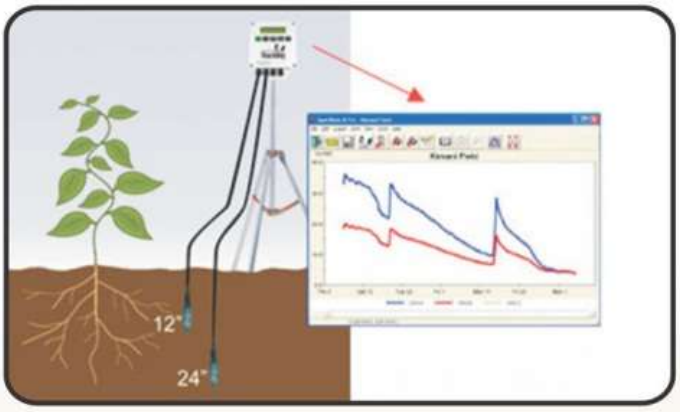
Tensiometers

A tension meter is a cylindrical pipe with a porous ceramic cup attached to one end and a vacuum gauge to the other with a reservoir located at the top. The tube is filled with water that is sealed tightly preventing air entry to ensure proper working. As soil dries, it tries to extract water through the ceramic tip that creates a vacuum within the tube indicating decrease in soil moisture content and vice versa. These phenomena are calibrated to represent soil moisture status and are measured on the dial attached to the tension meter.



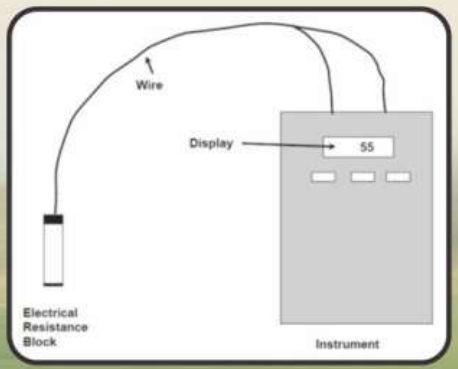
Soil Moisture Sensors

The soil moisture sensors combine affordability and accuracy. These are composed of two electrodes embedded in a suitable porous medium. Changes in electric current are detected by the sensors and correlated to the soil moisture content. These are compatible with data loggers and weather stations that enables information view in graphical and tabular form as well as run daily, monthly, and yearly reports customized to application.



Electrical Resistance Blocks

Electrical resistance or gypsum blocks consist of two parallel rectangular or cylindrical matchbox size pieces made of gypsum embedded with electrodes. These blocks are buried in the field and the electrical resistance between the electrodes, which is inversely proportional to its surrounding soil water content, is measured with a digital meter. When soil is wet, water is drawn into the block and indicates low resistance. As soil dries, water is drawn from it to adjoining soil and higher reading of resistance between the electrodes is indicated on meter.

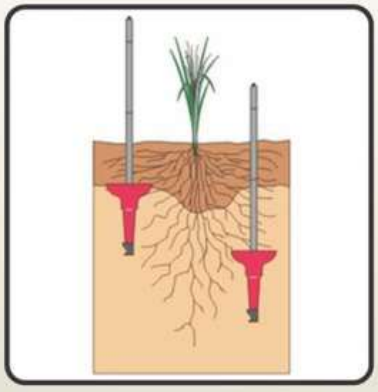


Almometers

The Almometers gives an accurate measurement of actual evapotranspiration (ET) at any field location. The ET readings are made directly from the site tube mounted in front of a ruler eliminating the use of any electronic equipment or computer interface. The crop evapotranspiration is an effective tool for scheduling irrigation especially when combined with a program of soil moisture measurement.

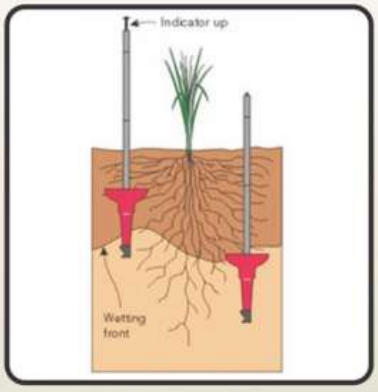
Wetting Front Detector-"Full Stop"

The wetting front detector (WFD), which is registered as "Full Stop", was developed in response to low adoption of existing soil moisture measuring tools for improving the accuracy of irrigation and assisting in fertilizer and salt management as well as detecting water logging. It is basically a switch that indicates passing a wetting front through a given depth in the root zone. The downward moving water through the root zone converges inside a specially shaped funnel. As the soil at the base becomes so wet that water seeps out of it, passes through a filter and is collected in a reservoir activating a float that in turn triggers a red indicator flag above the soil surface. It is relatively a simple, low-cost, and interactive tool with no electronics involved for aiding accurate irrigation scheduling.



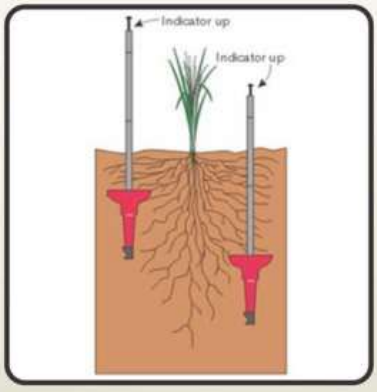
Shallow Indicator: DOWN
Deep Indicator: DOWN
If neither indicator is triggered, then watering is generally too shallow.

Too Little Water



Shallow Indicator: UP
Deep Indicator: DOWN
Water has moved past the shallow detector to the lower part of the root zone.

About Right (Desired Result)



Shallow Indicator: UP
Deep Indicator: UP
The deep indicator should be triggered only when it is necessary to fill the whole root zone.

Too Much Water

ADVANCED IRRIGATION SYSTEMS

Surface flooding is the most widely used irrigation method in Pakistan due to its lower costs. This is, however, an inefficient practice with excessive water losses through runoff, deep percolation, and evaporation from farm channels as well as in the field. There has been many advancements in irrigation conveyance application systems that substantially increase the irrigation efficiency many fold. Some of the advanced irrigation systems are described below.

Drip and Sprinkler System

Drip system has become the most valued innovation that allows controlled spoon-feed water and nutrients directly to plant's root zone. Drip technology is best suited for orchards and high value row crops such as vegetables, cotton, maize, sugarcane etc. The sprinkler system is the overhead irrigation that irrigates field somewhat like rain, which is usually applicable for field crops e.g. wheat, fodder, gram etc. These systems are versatile in their applicability and provide complete control in irrigation operations. Drip and sprinkler systems can be adopted on variable soil conditions, uneven topography, odd field dimensions, rolling sandy areas, long lengths of run etc.






Bed and Furrow

Bed and furrow system is actually a type of flood irrigation that facilitates diverted water to move into narrow channels (furrows) dug between the rows of crops. It reduces the wetted area of field that considerably saves water besides generating other benefits. Furrow system is generally used in row crops such as vegetables, cotton, corn, sugarcane etc. Close growing crops like wheat are also now being successfully grown on bed and furrow system.





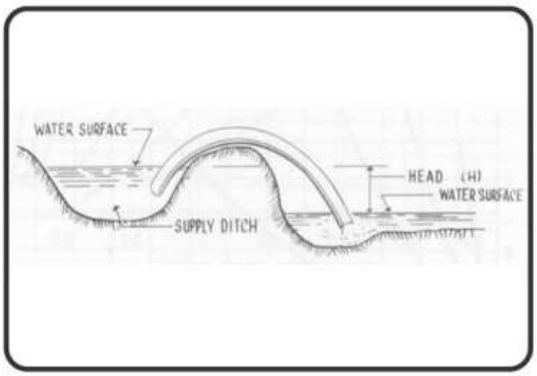

Gated Pipe

Gated pipe irrigation is a type of surface irrigation in which the conventional main conveyance channel and field lateral ditch are replaced by above ground pipeline. Irrigation water flows from regularly spaced orifices (gates) installed along the pipeline on desired intervals/spacings. It increases the water application uniformity of furrow irrigation by allowing regulation of stream size flowing into the furrows. It is generally used for furrow irrigation, although in some cases it can be employed for border and basin systems. The gate pipe system is simple in operation, easy in handling, fast in installation, and requires minimal maintenance. More importantly, the material is recyclable that makes it more economical.



Syphon Tubes

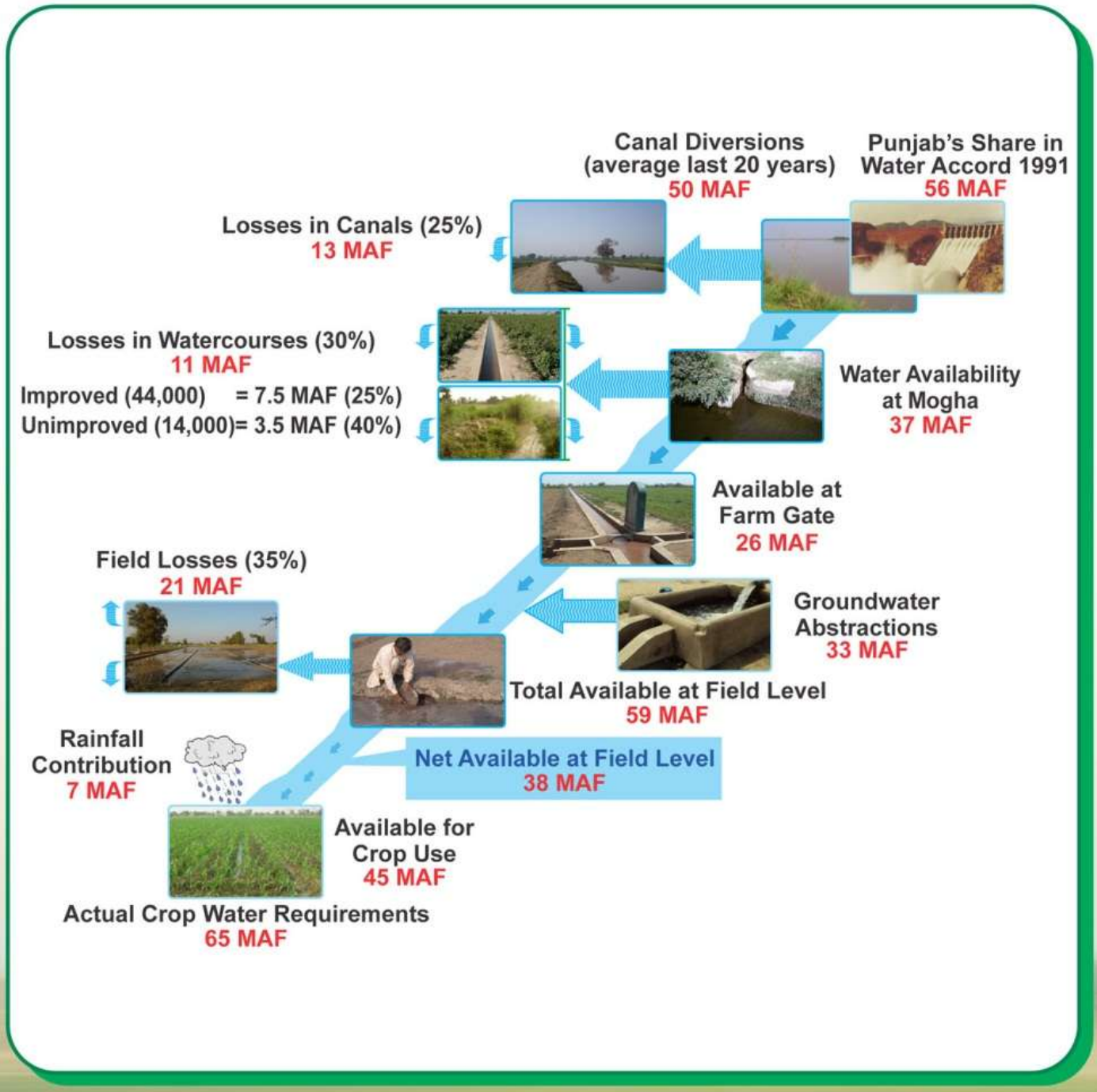
A syphon tube is a curved plastic pipe laid over the channel bank operated by simply filling the tube (pipe) with water, keeping one end in the channel and the other temporarily sealed side in the field. The seal is then removed conveying water from the submerged higher side (ditch) to the lower end (field) based on siphon principle. After completing the required irrigation in one field, the syphon tubes can be easily relocated to the other.



Pipe Nacca

Pipe nacca is a low cost portable concrete structure used to divert water from farm channel to the field avoiding each time cutting the channel banks. It is easy to install and requires no construction fatigue unlike panel naccas. As such, the farmer himself can fix it wherever required in the field. It is easy to operate, relatively leak proof, and provide good control in irrigation operation.

PUNJAB WATER BUDGET



WATER MANAGEMENT ACTIVITIES

LASER Land Leveling

Watercourse Improvement

Sprinkler Irrigation

Drip Irrigation

Bed & Furrow Technology

Solar Water Pump

Hydro Flume Irrigation

Flexible Pipe Irrigation

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