CHAPTER 21: Irrigation terminology

A.	
Actual evapotranspiration	Represents the actual rate of water uptake by the plant which is determined by the level of available water in the soil.
B.	
Balance of water resources and needs	The usable water resource of a certain water management unit in a given period of investigation, and the assessment and comparison of quantitative and qualitative characteristics of the water requirements to be supplied by this resource.
Basin irrigation	A gravity surface irrigation method in which crops are surrounded by a border to form a submersion check called basin of round, square or any other form. Irrigation water generally comes directly from the supply ditch/canal or from other basins.
Border irrigation	A sub-system of controlled flood (surface) irrigation in which the land is divided into parallel border strips demarcated from one another by earth ridges. Water is successively delivered into each strip from a head or field ditch at its upper end. On the upstream part of each strip is a flat zone, the level portion from which the stream of water spreads evenly across the entire downstream portion.
Bulk density	Bulk density or volume weight or apparent density or apparent specific gravity (As) of a soil is the dry weight of a unit volume of soil, which includes both the soil particles and the pores between them. It is expressed in g/cm^3 and varies from soil to soil according to texture and structure. It depends on soil porosity. Then, the larger the pore percentage the smaller the volume weight (Bulk density) of the soil.
C.	
Capacity of a well	The rate at which a well will yield water, in litres per second or cubic metres per hour.
Capital cost	The total expenditure incurred on a work since the beginning of its construction or supply of equipment and installation, excluding cost of operation, maintenance and repairs, but including cost of investigations and of all extensions and improvements.
Catchment area	The area from which a lake, a reservoir or a chosen cross-section of a stream or waterway receives water (= watershed or drainage basin, but usually smaller).
Command area (=designed area)	The specific land area, designed for irrigation by the irrigation system.
Centre pivot sprinkler	A sprinkler system in which the water source is in the centre, and a system of pipes and sprinkler heads rotates or pivots about the central point to water a given circular area.
Conventional technology	Technology based on a long history of experience without making use of later developments (compare with alternative technology).

Conveyance losses	Losses of water in transit from the source of supply to the point of service whether in natural channels or in artificial ones, such as canals, distributaries, ditches or watercourses. They comprise evaporation from the water surface, seepage, and incidental transpiration by vegetation growing in the water or along the banks of natural channels, canals or watercourses (= transmission losses).
Conveyance structures	Structures built to help provide general control and conveyance of the flow from the intake structures to the area to be irrigated.
Crop water requirement	The total water needed for evapotranspiration from planting to harvest for a given crop in a specific climatic regime when adequate soil water is maintained by rainfall and/or irrigation so that it does not limit plant growth and crop yield.
D.	
Discharge	Quantity (volume) of water passing through a given section of pipe, canal, valve, sprinkler nozzle or emitter etc. during a given period of time expressed in m^3 per hour, litres per second, gallons per minute, etc.
Drip irrigation	In its simplest form, it is an irrigation method using a system of perforated plastic pipes along the ground at the base of a row of plants (= trickle irrigation). In its more advanced form, it is a micro-irrigation system in which water flow is very low, generally less than 8 litres/h and without pressure, i.e. drop by drop. The water emerging infiltrates directly into the soil where it wets a volume of soil called bulb.
Drip tapes	Drip Irrigation Tapes are thin walled (0.12–1.1 mm) integral drip lines with emission points spaced at 10, 20, 30, 35, 45 cm, or any other distance apart, delivering very low quantities of water, 0.4–1.0 litre per hour at low operating pressures of 0.6–1.0 Bar. They are made of black PE (Polyethylene) in various diameters from 12 mm to 20 mm and in several wall thicknesses.
Drippers	Small emitters made of durable plastic, mounted on, or built in the small size (12–25 mm) PE irrigating pipelines at desired frequent spacing. The water enters at certain operating pressure and is discharged at zero pressure in the form of drops at constant low rates (1–24 litres per hour).
Duration of application	Time required for the completion of one irrigation cycle.
E.	
Economic value of unit of irrigation water	The value of a crop raised by a unit of irrigation water if run continuously throughout the life of the crop.
Effective root depth (D)	Soil depth from which the plants take nearly 80 percent of their needs in water (mostly from the upper part where root system is denser).
Erosion control	The application of necessary measures to control accelerated erosion of land surfaces by vegetation or artificial structures, such as terraces, dams or bunds.
Eutrophication	The process of a water body becoming anaerobic, i.e. without oxygen. Human activities that add nutrients to a water body can accelerate this process.
Exchangeable sodium percentage (ESP)	The degree of saturation of the soil exchange complex with sodium. It may be calculated by the formula: ESP = exchangeable sodium (meq/100 g soil)/cation exchange capacity (mec/100 g soil) *x* 100.

F.	
Fertigation	The fertilizers are applied through the system with the irrigation water, directly to the region, where most of the plants roots developed. The process, called "fertigation", is done with the aid of Fertilizer apparatus (injectors) placed at the Head Control unit of the system. The fertilizer, liquid or dry, is firstly dissolved and diluted in a separate container and then poured into the injector's tank, to be ejected into the system while in operation.
Field capacity (FC)	The amount of moisture retained in the soil one to four days after saturation, when the gravitational water is drained down to the lower soil layers. In light soils the time needed for the gravity water to drain is from 18 to 36 hours after saturation and in heavy soils from 36 hours to 4 days. In light soils the FC is lower than in heavy soils. In order to bring the state of moisture in the soil at FC at a certain depth, the amount of water required in a light soil is less than in a heavy soil. Again the same amount of water applied by irrigation or rain will wet a light soil to a greater depth than a heavy soil.
Flood irrigation	All types of irrigation which make use of rising water from flood for inundating areas without major structural works, e.g. flood recession, spate irrigation and wild flooding.
Flow-duration curve	A duration curve of stream flow, used for example to define minimum discharge and identify low-flow periods for the appraisal of irrigation water withdrawal.
Flow capacity	Water flow in m^3/hr or l/sec (lps) given or designed to fulfill the irrigation requirements of the command area at peak water demand. It is inversely proportional to the duration of application. It is often designed to be the lowest permissible to economize on sizes of pipes and equipment of the system network.
Friction losses (= head or pressure loss)	Loss of pressure (head) in the irrigation system that occurs during the flow of water in the system closed piping network as a result of the friction between the water and the pipes walls. The losses are proportional to the flow (discharge) and are dependent on the area of the pipe and on various obstructions to the flow such as contractions, outlets, valves, etc. The losses are measured in meters/feet or atmospheres/bars.
Fully automatic irrigation system	An irrigation system or network on a farm, whereby the water requirements of the plants are met automatically. It makes use of devices which measure soil moisture (e.g. tensiometer), or other indicators of irrigation need (e.g. time elapsed since rainfall), and trigger a series of operations to convey the necessary water through the network at the proper time.
Furrow irrigation	A method similar to corrugation irrigation used in permeable soils. It consists in feeding narrow furrows very close to one another with small discharges so as to wet more easily all the soil situated between two rows of crops (often orchards). Furrows parallel to the rows may be laid mechanically with a drill plough.
G.	
Gravity irrigation	Method of operating a system or part of a system using gravity alone, water being available at a sufficient level (or pressure) to ensure its conveyance or delivery to the fields or its distribution in the fields.
H.	
Hydraulic conductivity	1. The rate of flow of a fluid through a unit cross-section of a porous mass under a unit hydraulic gradient, at a specified temperature (sometimes called unit of permeability, transmission constant or coefficient of transmission). 2. The flux of water per unit gradient of hydraulic potential.

I.	
Individual irrigation system	Systems located downstream of the outlets served by the collective irrigation system and meant to deliver water to the farms or fields of an individual area.
Infiltration Rate	Infiltration or intake rate of soils is the maximum amount of water per unit of area, which can enter the soil (level) surface per unit time during the irrigation. It is expressed in millimeter per hour and it is governed by the conditions of the soil surface and the soil physical characteristics.
Irrigation Application Efficiency (Ea)	Percentage of the irrigation water, applied to the command area that is stored in the root-zone directly available to the crop; it is expressed in Percentage % or in fraction: Ea (%) = (water stored *x* 100)/ water applied
Irrigation cycle	Successive deliveries of water on all the units of a network in such a way as to achieve a given irrigation on the entire field concerned.
Irrigation efficiency	The ratio or percentage of the irrigation water consumed by crops of an irrigated farm, field or project to the water diverted from the source of supply. It is called farm irrigation efficiency or farm delivery efficiency when measured at the farm head-gate; field irrigation efficiency when measured at the field or plot; and water conveyance and delivery efficiency, or overall efficiency when measured at the source of supply.
Irrigation potential	Total possible area brought under irrigation, plus that which can be planned for irrigation in a river basin, region or country, from available water resources, with designs based on good technical practice at the time of assessing the potential.
Irrigation requirements	The quantity of water exclusive of precipitation, i.e. quantity of irrigation water, required for normal crop production. It includes soil evaporation and some unavoidable losses under the given conditions. It is usually expressed in water-depth units (millimetres) and may be stated in monthly, seasonal or annual terms, or for a crop period.
Irrigation water quality table	This indicates guidelines for the interpretation of water quality for crop production. The table was adapted from the University of California Committee of Consultants, the United States, in 1974 and revised in 1979. It emphasizes the long-term influence of water quality on crop production and farm management.
L.	
Leaching requirement	The fraction of water entering the soil that must pass through the root zone in order to prevent soil salinity from exceeding a specified value. Leaching requirement is used primarily under steady-state or long-term average conditions.
Localised Irrigation	The irrigation methods, where the water is delivered to the plants without spreading it over the entire area, but applied it to limited soil surface around the plants.
M.	
Main drainage system	System which conveys drainage water from the field drainage system to an outlet.
Method of water delivery	Way of making an irrigation system function to convey water from the source of supply to each field served by the system.

Micro-irrigation with mini-diffusers	A micro-irrigation system in which water is emitted in small sprinklings through fixed small diffusers in the form of fine droplets distributed over a certain area, or by individual low pressure jets localizing the water on the soil in separate spots. Their discharge is generally limited (20–60 litres/h at 1 bar) and often emitted in the form of circular sectors either to avoid wetting the neck of the trees or to limit the range on the sides of the space between rows, which should remain dry. Their use is limited to orchards.
Micro-emitters	Small water emitters (drippers, sprayers, bubblers, mini-sprinklers) made of durable plastic material. The rate of water discharge is in the range of 1 litre/hour to 170 litres/hour approximatively at operating pressure ranging from 0.6 bars to 2.0 bars. They have small water-passage diameters and the filtration requirements are from 100 microns (drippers) to 200 microns (minisprinklers).
Mobile micro-irrigation	An irrigation machine (generally frontal nozzle-line) in which the mobile nozzle-line functioning at low pressure applies water directly to the space between rows of annual crops. Suspended flexbles pipes fitted with mouthpiececs at their end feed continuously into small basins dug beforehand or simple partitioned corrugations.
Moisture (water) holding capacity	The quantity of water (moisture) hold by the soil is expressed by the "dry weight" percentage water in the soil $$PW = \frac{Ww - Wd}{Wd} \times 100$$ Where, **PW** is the soil water content percentage (dry weight), **Ww** is the weight of wet soil and **Wd** is the weight of the dry soil.
N.	
Net irrigable area	The total area within the extreme limits set for irrigation by a project, supply system or canal less areas excluded because of their un-suitability for irrigation (nature of the soil, ground too high to be irrigated by gravity flow or economically by pumps or other water lifting devices).
Net irrigation requirement	This is the crop's irrigation need (without including losses of any kind) expressed as a layer of water in millimeters per day, month or other period of time.
Nominal discharge of a dripper	Discharge in litres per hour at the nominal pressure indicated by the manufacturer. This discharge is determined by a test carried out as per the ISO standard on 25 samples taken at random. In the case of a self-regulating dripper, the test pressure is the arithmetic mean of the minimum and maximum pressures in the regulation range indicated by the manufacturer.
O.	
Operation and maintenance (O&M)	Operation is the organized procedure for causing a piece of equipment, a treatment plant, or other facility or system to perform its intended function, but not including the initial building or installation of the unit. Maintenance is the organized procedure for keeping the equipment, plant, facility or system in such condition that it is able to perform its intended function continually and reliably.
Overall efficiency	The ratio or percentage of the irrigation water consumed by crops to the water diverted from the source of supply (measured at the source of supply).
Overhead irrigation	Irrigation by which water is ejected into the air to fall on the soil surface as spray.
Over-irrigation	Excessive irrigation with regard to the actual requirements, due to excessive doses of watering, an insufficient irrigation interval or an overestimation of the requirements (lesser evapotranspiration or excess of rains with respect to the normal). It causes either a leaching of the soil if it is sufficiently drained, or a water-logging of the soil which harms crop growth.

P.	
Pan evaporation	Rate of water loss by evaporation from an open water surface of pan (usually, Class A pan or Colorado sunken pan).
Peak period crop water requirements	For a given crop, the peak crop water requirements during the month of highest water requirements.
Percolation rate	The maximum rate at which water will flow into the subsoil from the topsoil under specific conditions, expressed in millimetres per hour or day.
Perennial irrigation	An irrigation is termed perennial when the lands of the area can be irrigated throughout the year and have the volume of water actually required.
Perforated pipe sprinkler irrigation	A sprinkler method in which the nozzle-lines consist of portable and lightweight pipes, the wall of which is perforated with several rows of small holes in such a way as to cause the water to be applied on both sides of the nozzle-line.
Permanent wilting point	The moisture content of the soil, expressed as a percentage of the soil volume or as a percentage of dry weight, at the time when the leaves of a plant growing in the soil first undergo a permanent reduction in their moisture content as the result of the deficiency in the soil moisture supply.
Permissible velocity	The highest velocity at which water may be carried safely in a canal or other conduit. The highest velocity throughout a substantial length of a canal or other conduit that will not scour.
Poor drainage	Occurs in soils which lose gravitational water slowly, or which are situated where the groundwater table remains high in the profile. In most years, the soil root zone loses excess soil water only during the summer months. In an unimproved condition, successful cropping is unlikely (e.g. standing water, water margin, wetland and peatland environments).
Pore Space of Soil	Percentage of volume of the soil not occupied by the soil particles and filled with water and air. Fine texture soils (heavy) have greater pore space than coarse texture (light) soils. The pores can be divided theoretically into capillary pores holding the water against gravitational pull and non-capillary pores containing air. Downward movements of water due to gravity are through these pores.
Potential evapotranspiration (ETo)	1. The amount of water that could pass into the atmosphere by evapotranspiration if the amount of soil water were not a limiting factor. 2. The amount of water utilized by a crop for its growth plus evaporation from the soil if the soil contains sufficient moisture for crop growth at all times.
Potential yield (of a well)	The greatest rate of artificial withdrawal from an aquifer which can be maintained throughout the foreseeable future without regard to cost of recovery. The potential yield (or physical yield limit) is, therefore, equal to the present recharge, or that anticipated in the foreseeable future, less the unrecoverable natural recharge.
Pressure of the system	Maximum water pressure or head of water needed for the normal operation of the system and encompasses: a) the total losses of head due to friction in the pipes, the connector fittings and other accessories from the beginning to the distal end of the close piping network, b) the pressure required for the water emitter, c) the pressure needed for the head control unit, d) plus or minus the difference in elevation from the beginning to the distal end of the close piping network pressure.
Pumping irrigation	Method of operating a system or part of a system using, fully or partly, an artificial pressure for ensuring the conveyance of water, its delivery or distribution in the fields.

R.	
Rainfall intensity	The rate at which rainfall occurs expressed in depth units per unit of time. It is the ratio of the total amount of rain to the length of the period in which the rain falls.
Readily available moisture	The state of moisture in the soil, which amounts 40 to 70 percent of the total available moisture (Sa) easily absorbed by the plants. It is the product of the Sa multiplied by P (fraction) maximum permissible moisture deficit or depletion of the Sa in percentage, hence: Readily available moisture = Sa *x* P
Reference crop evapotranspiration (ETo)	The rate of evapotranspiration from an extensive surface of 8–15 cm tall green grass cover, actively growing, completely shading the ground and not short of water. Alternative approaches for estimating ETo are the radiation, the Penman and the Pan Evaporation (presented in FAO bulletin Irrigation and Drainage No 24). In all methods is expressed in millimeter per day mean value over 30 or 10 days period. ETo data are normally available in all countries. They can also be computed from climatic data.
Regulation structure	A stage-discharge regulating device of a spillway. It may be of any form, viz. weir, side channel, glory spillway, orifice, tube, pipe or a channel. (= control structure)
Regulation with downstream control	Method of regulation in which the flow in a canal (or in a pipeline) is controlled at a gate by the level of the water (or pressure) measured by a sensor or by a float connected to the gate placed in the immediate **downstream** of the gate. It is a **delivery**-oriented control method.
Regulation with upstream control	Method of regulation in which the flow in a canal (or in a pipeline) is controlled at a gate by the level of the water (or pressure) measured by a sensor or by a float connected to the gate placed in the immediate **upstream** of the gate. It is a **supply**-oriented control method.
Roll-move sprinkler lateral system	A sprinkler method in which the nozzle-line, which carries medium pressure sprinklers, is used as an axle to the wheels which support it at regular intervals. Watering is done in a permanent shift and the nozzle-line is moved manually between waterings to its new position by rolling it fully.
S.	
Salinity control	Abatement or prevention of saltwater contamination of agricultural, industrial and municipal water supplies, or reducing alkaline salts and preventing deterioration of cultivable lands.
Seasonal irrigation	Irrigation is termed seasonal when the lands of the area are irrigated only during a part of the year, called watering season.
Semi-automatic field water distribution system (partially automatic system)	Irrigation system in which the water distribution and field application are partly automatic and partly manual. A semi-automatic system may carry out a sequence of operations automatically for a single irrigation, but need to be manually started or manually reset prior to the subsequent irrigation. It may involve use of volumetric or timer controlled valves that are started manually but which close automatically.
Semi-module (flexible module)	A device that automatically delivers a discharge which is independent of fluctuations of water level or pressure on the delivery side, and only varies with water level or pressure on the supply side (used for regulation with down-stream control).
Sensitivity analysis	The study of the influence of discrete parameter changes on optimized results. Those parameters whose changes in value have more significant influence on the results need treating with great care, while other parameters can be recognized as relatively insignificant.

Social benefits	Benefits as a result of the project, during and after construction, consisting mainly of opportunities for: (i) employment of labour; and (ii) employment of capital.
Sodium adsorption rate (SAR)	A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with soil: $SAR = Na^{+} \; x \; [(Ca^{2+} + Mg^{2+})/2]^{-0.5}$ where the ionic concentrations are expressed in meq/litre.
Soil available moisture (Sa)	Available moisture (or water) is the percentage content of water in the soil at the range between Field Capacity and Wilting Point. It is the principal source of water for plants and is usually called as capillary water. Available Water Sa % = FC% – WP% The "dry weight" percentage water in the soil at any state is converted to "volume weight" when multiplied by the soil Bulk density. Values of Available water are always given in "volume weight". Then, Sa % "dry weight" *x* Bulk density g/cm^3 = Sa % "volume weight" The percentage "volume weight" Soil Available Moisture Sa can be expressed as amount (depth) of water in mm per meter soil depth, e.g. Sa 10.92 % volume weight = 109.2 mm of water per meter depth of soil.
Soil moisture characteristics	Saturation, field capacity and wilting point of a soil can be determined by several methods direct or indirect required field and or laboratory work and simple calculations. The "gravimetric method" to determine FC is the oldest one, the most common and reliable method. Soil samples taken from several depths are put in an oven at 105º Celsius and kept for 8 hours (light soils) to 16 hours (heavy soils) Three soil samples are weighted before and after drying and the difference in dry weight gives FC percentage by weight. Other methods to determine the Soil FC are a) by the use of pressure on the soil samples, 0.10–0.30 atmospheres in the "pressure plate apparatus", b) the "moisture equivalent centrifuge" and c) the "speedy moisture test". Figures given by the "pressure plate apparatus" method are higher than those given by the "gravimetric" method in heavy soils. The permanent wilting point can be determined by the "pressure membrane apparatus" method, where 15 atmospheres air pressure is applied to saturated soil samples and then by the gravimetric method the moisture content is found.
Soil moisture deficit	The amount of water that must be applied to the soil to cause thorough drainage.
Soil permeability	It is the readiness with which the soil conducts or transmits water. It is quantitatively defined as Hydraulic Conductivity (K) and greatly depends on the soil texture and the quality of the irrigation water.
Soil profile	The whole arrangement of different layers (horizons) from top to bottom, from soil surface to mother rock. The top layer, called "A" horizon, is normally cultivated for crops. The layer below is called horizon "B" usually with higher clay content and further below is horizon "C". Horizons "A" and "B" can be defined as the soil. Soils formed under different conditions have different profiles. Young soils formed by alluvial materials have moderate or no profile development and sometimes show a significant variation in texture within the depth of the root zone. An average depth of 70 cm and even less is suitable nearly for all kind of crops. Under modern irrigation and nutrient supply methods (fertigation) soil depths of 45 cm are sufficient for most vegetables and shallow root trees.

Soil saturation	When all the pore space of the soil is filled with water, after a heavy irrigation or rainfall, the soil is saturated. The amount of water, which can be held by a soil at saturation capacity, depends on the volume of its pore space. Hence the saturation capacity is larger in heavy soils than in light ones.
Soil texture	The soil as a physical body is described by the size and arrangement of its particles, determining the porosity. Soil particles are divided into three major size fractions: a) sand, b) silt and c) clay. Soils are classified, according to United States Department of Agriculture (USDA) classification system, by their textural class i.e. the percent composition of sand, silt and clay. Soils with high sand content are called "light soils" or "sandy soils" and soils with high clay content are called "heavy soils". The soil properties such as water holding capacity and intake rate mostly depend on the texture.
Soil water stress	The sum of soil water tension and osmotic pressure to which water must be subjected to be in equilibrium with soil water.
Soil moisture tension	The equivalent negative pressure or suction in the soil moisture; expressed in pressure units (bar or pascal).
Spate irrigation	A method of random irrigation using the floodwaters of a normally dry (stream, river) system. It includes the construction of earthen diversion banks across the bed and then canals leading to embanked fields where the water is ponded until total infiltration.
Sprinkler irrigation system	It is a designed network of pipes with sprinkler emitters or nozzles attached for shooting water jets or spraying water in the form of drops over the land surface, under pressure.
Subsurface drainage system	Any drainage system (drainage wells, open ditches or drain pipes) that is designed to control the groundwater table.
Supplemental irrigation	Irrigation carried out only occasionally to make good for short and irregular drought periods.
Surface drainage system	Shallow ditches or open drains that serve to receive surface flow or drainage water.
Surface irrigation	A method of irrigation in which water is applied to the land by allowing it to flow by simple gravity, before infiltrating. It includes various systems depending upon the relative magnitude of the surface flooding phase and infiltration phase after accumulation (submersion).
T.	
Technology transfer (transfer of know-how)	Technology transfer consists in supplying project users or training personnel with technical knowledge and training essential for proper command of O&M functions. This transfer may remain too theoretical or abstract if not accompanied by: a transfer of know-how from the development corporation officials to the users; a set of demonstrations; and a suitable follow-up of the concrete operations (technical and management).
Tensiometer	An instrument for measuring the suction that plant roots have to exert in order to extract moisture from the soil.

U.	
Undertree sprinkler method	Sprinkler method used in orchards with small sprayers with an outstretched jet in order not to wet the leaves and avoid the wind effect on the distribution of water. Such sprayers can be permanent, semi-permanent or portable.
W.	
Water conveyance and delivery efficiency	The ratio or percentage of the irrigation water delivered at the irrigation plot to the water diverted from and measured at the source of supply.
Water emitter	Also named "water distributor" is a device of any kind, type and size, which fitted on a pipe, is operated under pressure to discharge water in any form - by shooting water jets into the air (sprinklers and rain guns), by small spray or mist (sprayers), by continuous drops (drippers), by small stream or fountain (bubblers). The pressure/discharge rate relationship and other performances, e.g. coverage pattern, way of dissipating energy (pressure), size and type of connection, is always specified. Sprinklers, drippers, spitters, sprayers, bubblers, pulsators and garden hoses are water emitters.
Wetting front	The depth in the soil above that the moisture content of the soil is at maximal field capacity, is called the wetting front and depends on the amount of water applied and the soil texture.
Wilting point (WP)	The state of moisture in the soil at which water content is very low and not readily available to the plants. At "permanent" wilting point the moisture in the soil is even less, only hygroscopic water, and the plants wilt permanently. The water percentage content at wilting point is nearly half the water content at field capacity.