LECTURE NOTES

Irrigation and Hydraulic Structures

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CHAPTER-1

INTRODUCTION

1.1 Irrigation: Why and What for ?

Three basic requirements of agricultural production are soil, seed, and water. In addition, fertilisers, insecticides, sunshine, suitable atmospheric temperature, and human labour are also needed. Of all these, water appears to be the most important requirement of agricultural production. The application of water to soil is essential for plant growth and it serves the following functions:

(*i*) It supplies moisture to the soil essential for the germination of seeds, and chemical and bacterial processes during plant growth.

(*ii*) It cools the soil and the surroundings thus making the environment more favourable for plant growth.

(*iii*) It washes out or dilutes salts in the soil.

(*iv*) It softens clods and thus helps in tillage operations.

(*v*) It enables application of fertilisers.

(*vi*) It reduces the adverse effects of frost on crops.

(*vii*) It ensures crop success against short-duration droughts.

In several parts of the world, the moisture available in the root-zone soil, either from rain or from underground waters, may not be sufficient for the requirements of the plant life.

This deficiency may be either for the entire crop season or for only part of the crop season. For optimum plant growth, therefore, it becomes necessary to make up the deficiency by adding water to the root-zone soil. This artificial application of water to land for supplementing the naturally available moisture in the root-zone soil for the purpose of agricultural production is termed *irrigation*.

Irrigation water delivered into the soil is always more than the requirement of the crop for building plant tissues, evaporation, and transpiration. In some cases the soil may be naturally saturated with water or has more water than is required for healthy growth of the plant. This excess water is as harmful to the growth of the plant as lack of water during critical stages of the plant life. This excess water can be naturally disposed of only if the natural drainage facilities exist in or around the irrigated area. In the absence of natural drainage, the excess

water has to be removed artificially. The artificial removal of the excess water is termed *drainage* which, in general, is complementary to irrigation.

To keep the optimum content of water in soil, irrigation supplies water to the land where water is deficient and drainage withdraws water from the land where water is in excess.

The object of providing irrigation and drainage is to assist nature in maintaining moisture in the root-zone soil within the range required for maximum agricultural production. Usefulness and importance of irrigation can be appreciated by the fact that without irrigation, it would have been impossible for India to have become self-sufficient in food with such huge population.

1.2 Advantages of Irrigation

ASPECT	**ADVANTAGE**
Engineering	• Improvement of the water regime of irrigated soils. • Improvement of the micro climate. • Possibility provided for waste water use and disposal. • Retention of water in reservoirs and possible multipurpose use thereof.
Health	• Securing increased agricultural production and thus improving the nutrition of the population. • Recreation facilities in irrigation canals and reservoirs.
Social And Cultural	• Culturing the area. Increasing the social and cultural level of the population. • Tourist interest in the area of the newly-built reservoir.
Aesthetic	• New man-made lakes in the area.
Political	• Increased self-sufficiency in food, thus lesser dependence on other countries.

1.3 Status of Irrigation in India

Based on the data available at the Directorate of Economics & Statistics, Ministry of Agriculture and Farmers Welfare, the status of irrigation in India in terms of Net Area under Irrigation by Sources could be understood from the following table:

(000 Hectares

Year	Source of Irrigation							Net Irrigated Area
	Canals			Tanks	Tube-Wells	Other Wells	Other Sources	
	Government	Private	Total					
1	2	3	4	5	6	7	8	9
2001-02	14993	209	15202	2196	23245	11952	4342	56936
2002-03	13867	206	14073	1811	25627	8727	3658	53897
2003-04	14251	206	14458	1916	26691	9693	4299	57057
2004-05	14553	214	14766	1734	25235	9956	7538	59229
2005-06	16490	227	16718	2083	26026	10044	5966	60837
2006-07	16802	224	17027	2078	26942	10698	5999	62744
2007-08	16531	217	16748	1973	28497	9864	6107	63189
2008-09(p)	16686	195	16881	1981	28367	10389	6020	63638
2009-10(p)	14789	188	14978	1587	28371	9992	7008	61936
2010-11(p)	15472	171	15643	1980	28543	10629	6864	63659
2011-12(p)	15833	172	16005	1919	29943	10595	7236	65697
2012-13(p)	15506	165	15672	1753	30543	10763	7536	66266
2013-14(p)	16115	163	16278	1842	31126	11312	7542	68100

(p) : Provisional

Source: Directorate of Economics & Statistics, Ministry of Agriculture and Farmars Welfare.

Table 1: Net Area under Irrigation by Sources

1.4 Classification of Irrigation Systems:

The classification of the irrigation systems is mainly based on the way the water is applied to the agricultural land. The main classifications of the systems are:

i) Gravity Irrigation System

ii) Lift irrigation System

iii) Combined System

iv) Drip Irrigation System

v) Sprinkler Irrigation System

1.4.1 Gravity Irrigation

Also known as Flow Irrigation System. The irrigation water reaches the field surface mainly through the gravitational force. In other words it means that in such cases the source of Irrigation water is higher than the field level where the water is required to be applied. The water from the source flows through a network of canal system to the farms.

Fig.1 Flow Irrigation System

This system can be classified into the following:

i) Direct Flow irrigation

Where the irrigation water is obtained directly from the river, without any intermediate storage. This type of irrigation is possible by constructing a weir or a barrage across a river to raise the level of the river water and thus divert some portion of the river flow through the canal system under gravity to the fields.

ii) Indirect Flow Irrigation

It is also known as *Reservoir/tank/storage irrigation*. In this case the irrigation water is got from a river, where storage is created by constructing a suitable obstruction across the river like a dam etc. The water is then taken off from this storage by the construction certain head works and conveyed to the fields through a suitable conveyance system, mainly the canal system. This ensures dependable irrigation water flow even during the lien periods when the flow in the river is very less.

1.4.2. Lift irrigation system

Where the irrigation water is available at a level lower than that of the land to be irrigated, the Lift System of Irrigation comes into place. In this System the water is lifted from the sources by a suitable lifting like Pumps or by other mechanical and conveyed to the agricultural land through the water courses under gravity.

Fig.2 Lift Irrigation System

Well Irrigation is also an important type of lift Irrigation. In such case the ground water is utilsed for the purpose of irrigation by digging the wells, which may open shallow wells or deep tube wells. The water is lifted from these well through a suitable lifting system and then conveyed to the fields through water courses.

Fig.3 Well Irrigation System

1.4.3 Combined System of Irrigation

Sometimes the Source of Irrigation water is at a considerable distance from the fields and is to be lifted at its source by a suitable lifting system and then flown to the fields through the network of a canal system. In such cases the system is termed as the *Combined System of Irrigation*.

Fig.4 Combined(lift and flow) System of Irrigation

1.4.4. Drip irrigation

Drip irrigation, also called *trickle irrigation*, involves slow application of water to the plant root zone. The losses by deep percolation and evaporation are minimized. A precise amount of water is applied to replenish the depleted soil moisture at frequent intervals, for optimum plant growth. The system enables the application of water and fertilizer at an optimum rate to the plant root system. The amount of water supplied to the soil is almost equal to the daily consumptive use, thus maintaining a low moisture tension in soil.

Fig.5 Drip Irrigation System

1.4.5 Sprinkler irrigation

In sprinkler irrigation, water is sprayed into the air through a sprinkler nozzle and allowed to fall on the land surface in a uniform pattern at a rate less than the infiltration rate of the soil. Sprinklers were introduced in India during the early 1950s. Initially, the sprinklers were used on high value plantation crops such as tea, coffee, chicory, cardamom and in orchards. Their use is gaining popularity on food crops, orchards, cotton and vegetables in areas where sprinklers are economically justifiable and technically feasible. Sprinkler irrigation can be used for almost all crops (except rice and jute) and on nearly all soils.

Fig.6 Sprinkler Irrigation System