UNIT 10 IRRIGATION IN INDIA

Structure

10.0 OBJECTIVES

After going through this unit, you would be in a position to:

- explain the role of irrigation in agricultural growth;
- identify the extent of irrigation coverage in various states of India in the post-independence period;
- distinguish among major, medium and minor irrigation projects;
- identify the sources of irrigation;
- compare the pros and cons of irrigation projects;
- explain the benefits of efficient utilisation of irrigation facility and scientific pricing of irrigation water; and
- explain the government schemes meant for irrigation development.

10.1 INTRODUCTION

Providing water to crops other than direct receipt of rainfall by plants is called irrigation. Irrigation is the process of watering the cultivated crops through artificial means. Irrigation plays both protective and productive role in the crop growth cycle. Irrigation is the application of the water to soil for the purpose of supplying moisture essential for plant growth especially during stress period. It provides an insurance against short duration drought during crop season. Irrigation boosts productivity and overall production. It also increases gross cropped area (GCA) through an increase in cropping intensity.

The timing and quantity of rainfall is beyond the control of human being. Moreover, the northwestern part of the country receives very little rainfall. Thus we cannot rely on rainfall alone for agricultural development. Irrigation facility, on the other hand, is controlled and thus quite desirable. So long as a major technical breakthrough in the art of rain-fed farming does not occur, the emphasis on irrigation is bound to persist.

Irrigation development comes to the forefront of infrastructure development strategy for agriculture. Out of total geographical area of 329 *million hectares* (mha), the gross cropped area (GCA) in the country is 186 mha and the net sown area (NSA) is only 142 mha. However, the entire cultivated area in India cannot be irrigated because of limited availability of water. It is estimated that the ultimate irrigated area of the country from all the sources is around 113.5 mha. Of these, the potential of major and medium irrigation is 58.5 mha while that of minor irrigation is 55 mha.

There has been rapid development of irrigation facilities in India since 1951. It has undoubtedly played a crucial role in increasing the food production, from around 50 million tonnes in 1951 to 206 million tonnes fifty years later. The increase has been achieved principally through improvement in the productivity of land, since the area under crops has increased only marginally. The liberal use of chemical fertilizers, the steady increase in the use of certified/quality seeds, and the extensive use of electricity in agriculture are among the other factors that have helped the rapid growth of agricultural production. The role of irrigation is of a catalytic agent because no farmer would invest on costly inputs like chemical fertilizers without assurance of the basic input, water, which is scanty in most parts of the country.

10.2 EXTENT OF IRRIGATION IN INDIA

Expansion of irrigation facilities along with consolidation of the existing system has been the main strategy for increasing production of foodgrains. Irrigation support is provided through major, medium and minor irrigation projects and command area development. With sustained and systematic development of irrigation, its potential has increased from 22.5 mha in 1951 to around 91 mha ha by 1999-2000.(see Table 10.1 for irrigation potential created up to 1994, and Tables 10.2 to 10.5 for related information).

Table 10.1 : Irrigation Potential Created and its Utilisation

(up to 1994; in thousand hectares)

	Potential created			Potential Utilized			Percentage utilisation		
	1			2			3		
	a	b	c	a	b	c	a	b	c
State	Major & Medium	Minor	Total	Major & Medium	Minor	Total	Major & Medium	Minor	Total
Andhra Pradesh	3039	2937	5976	3214	2649	5863	106	90	98
Arunanchal Pradesh	-	70	70	-	54	54	-	77	77
Assam	179	591	770	116	524	640	65	89	83
Bihar	2796	5087	7882	2745	4329	7074	98	85	90
Goa	13	19	32	15	21	36	115	111	113
Gujarat	1281	1934	3215	1343	1803	3146	105	93	98

Haryana	2058	1535	3593	1836	1479	3315	89	96	92
Himachal Pradesh	8	145	153	4	119	123	50	82	80
Jammu & Kashmir	174	368	542	150	351	501	86	95	92
Karnataka	1434	1480	2914	1308	1406	2714	91	95	93
Kerala	504	536	1040	669	487	1156	133	91	111
Madhya Pradesh	2025	2634	4659	1624	2372	3996	80	90	86
Maharastra	2080	2493	4573	1307	2211	3518	63	89	77
Manipur	62	51	113	78	41	119	126	80	105
Meghalaya	-	45	45	3	38	41		84	91
Mizoram	-	11	11	-	9	9		82	82
Nagaland	-	66	66	-	56	56		85	85
Orissa	1444	1265	2709	1333	1116	2449	92	88	90
Punjab	2386	3319	5705	2570	3217	5787	108	97	101
Rajasthan	2047	2438	4485	1926	2317	4243	94	95	95
Sikkim		23	23		17	17		74	74
Tamilnadu	1550	2130	3680	1458	2120	3578	94	100	97
Tripura	3	92	95	1	79	80	33	86	84
Uttar Pradesh	6876	19912	26788	5897	17294	23191	86	87	87
West Bengal	1370	2872	4242	1614	2298	3912	118	80	92
All India	31329	52051	83380	29216	46486	75702	93	89	91

Source: Centre for Monitoring Indian Economy 1999

Table 10.2 : Percentage Distribution of Irrigated Area under Principal Crops (1995-96)

State	Rice	Maize	Wheat	Total Cereal	Total pulses	Total Food grain	Groundnut	Rapeseed & Mustrd	Total Oil-seed	Sugar cane	Cotton	Tobaco	Total (all cross
Andhra Pradesh	94.8	15	72.7	69.9	1.2	53.8	16.8	…	17.6	95	14.9	33.1	40.7
Bihar	40.2	40.5	88.4	52.2	2.2	47.1	…	33.3	20.6	22.4	…	73.7	45.7
Gujarat	5.6	9.6	74.4	34	10.8	29.6	9.5	97.8	27.4	100	36.1	73	32.7
Haryana	99.4	15.4	98.3	83.3	25.6	76.8	50	66.8	68.1	97.2	99.5	…	78.2
Jammu & Kashmir	91.2	5.9	24.2	39.4	15.6	38.4	…	79.7	70.6	…	…	…	41
Karnataka	66.8	65.2	33.8	26.6	3.9	21.6	20.5	16.7	19.5	100	23.6	3.4	23.8
Madhya Pradesh	23.7	1.3	68.1	32.7	21.2	29.3	6.7	45.3	7.2	97.3	33.1	…	24.7
Manipur	32.5	…	…	31.6	…	31.5	…	…	…	…	…	…	27.7

Nagaland	44.3	…	100	34.6	…	32.6	…	75	35.3	…	…	…	31.6
Orissa	35.5	10.8	100	33.2	6.8	25.4	34.5	16.1	13.9	100	…	10	25.8
Punjab	99.8	56.7	97.1	96.6	72.5	96.1	50	87.4	88.8	94.9	99.6	…	95.2
Rajasthan	38.6	13.5	94.6	30.2	9.8	24.1	35.2	73.4	56.9	96.4	98	100	32.3
Tamil Nadu	92	53.2	…	68.4	6.6	58.2	27.7	…	35.5	100	36.8	100	50.8
Uttar Pradesh	62.3	31.3	92.5	70.3	27.5	64.3	1.5	75.2	51.4	88.2	91.7	100	65.8
West Bengal	27.2	…	89.3	29.9	3.2	28.6	…	85.2	70.9	50	…	…	29.8
All India	56.1	22.7	86.8	47.1	13	40.5	18.1	66.3	26.1	88.5	34.8	48.8	38.3

Source: Agricultural Statistics at a Glance 1999

Table 10.3 : Source-wise Distribution of Net Irrigated Area

(in thousand hectares, for 1995-96)

S.N.	State	Source of Irrigation					
		Canals	Tanks	Tube-wells	Other wells	Others	Total
1.	Andhra Pradesh	1539	747	709	947	181	4123
2.	Assam	362	...	...	...	210	572
3.	Bihar	1099	140	1728	96	617	3680
4.	Gujarat	593	35	724	1642	8	3002
5.	Haryana	1375	1	1353	...	32	2761
6.	Jammu & Kashmir	364	2	1	1	18	386
7.	Karnataka	950	230	372	428	322	2302
8.	Kerala	107	49	73	...	113	342
9.	Madhya Pradesh	1796	205	874	2294	759	5928
10.	Maharastra	538	369	...	1571	89	2567
11.	Orissa	949	305	299	537	...	2090
12.	Punjab	1356	...	2356	1	134	3847
13.	Rajasthan	1497	189	703	2797	46	5232
14.	Tamil Nadu	771	512	200	1127	15	2625
15.	Uttar Pradesh	3075	58	7771	390	381	11675
16.	West Bengal	717	263	689	23	219	1911
	All India	17142	3111	17937	11860	3460	53510

Source: Fertilizer Statistics, 1998-99, FAI, New Delhi.

According to a recent estimate the ultimate irrigation potential of India is about 140 mha. Contribution from major and medium irrigation projects will be 58.5 mha while minor irrigation has a potential of 81.5 mha. In the case of minor irrigation, 17.5. mha will be contributed by minor surface projects while 64 mha contribution will be from minor ground water projects.

It is estimated that the total annual precipitation over India is about 4000 *billion cubic metres* (bcm), which contributes 1,869 bcm to surface flow. But out of this surface flow, only 690 bcm (37 per cent) is utilized. The replenishable ground water potential in the country is 432 bcm. So the total utilizable water is 1122 bcm as per present estimates. You would have observed that most of the activities in irrigation sector in India have been construction driven, that is construction of reservoir, canal, field channel, etc. gets priority. Little attention has been paid to management of distribution of water for irrigation.

Table 10.4 : Outlay and Potential Created under Major and Medium Irrigation Projects

Period	Outlay: Expenditure (Rs. in crore)	Potential created during the plan (mha)	Cumulative potential created (mha)
Pre-plan period	Not available	9.70	9.70
First plan (1951-56)	376	2.50	12.20
Second plan(1956-61)	380	2.13	14.33
Third plan (1961-66)	576	2.24	16.57
Annual plan(1966-64)	430	1.53	18.10
Fourth plan (1969-74)	1242	2.60	20.70
Fifth plan (1974-78)	2516	4.02	24.72
Annual plan (1978-80)	2079	1.89	26.61
Sixth plan (1980-85)	7369	1.09	27.70
Seventh plan(1985-90)	1107	2.22	29.92
Annual plan (1990-92)	5459	0.82	30.74
Eighth plan (1992-97)	22415	5.09	35.83

Source: India 1996, Government of India

Table 10.5 : Potential Created and Utilised under Minor Irrigation Projects

Plan	Potential	Utilization
First Plan	14.1	14.06
Second Plan	14.8	14.8
Third Plan	17.0	17.0
Annual Plan	19.0	19.0
Fourth Plan	23.5	23.5
Fifth Plan	27.3	27.3
Annual Plan	30.0	30.0
Sixth Plan	37.5	35.3
Seventh Plan	46.6	43.1
Eighth Plan	10.7	9.4

Source: India 1996, Government of India

10.3 SOURCES OF IRRIGATION

A variety of structures comprise the Indian irrigation sector. These can be classified in more than one way:

1) major or minor irrigation

2) surface water or ground water bases

3) gravity flow or lift irrigation.

The first classification is peculiar to India as large-scale irrigation is under the head major and medium irrigation and small-scale irrigation under minor head.

According to the size, irrigation project may be

a) **Major Irrigation Project**

Having cumulative command area (CCA) of more than 10000 hectare or which cost more than Rs. 5 crore.

b) **Medium Irrigation Project**

Having cumulative command area less than 10000 hectare but more than 2000 hectare or which cost between Rs.20 lakh to Rs.5 crore.

c) **Minor Irrigation Project**

Having cumulative command area less than 2000 hectare or which cost Rs. 5 lakh in plain areas and Rs.30 lakh in the hills.

10.3.1 Sources of Minor Irrigation

The minor irrigation works include dug-wells, tube-wells, tanks, etc. Minor irrigation structures are created through tank, surface percolation wells, tube-wells and fluxial wells. The water source for a minor irrigation project could be either surface flow or ground water storage. While tank and pond irrigation are examples of surface flow, construction of well is an example of ground water storage.

a) **Tank irrigation**

Most of the irrigation tanks are located in Andhra Pradesh, Karnataka, Orissa, Tamil Nadu and West Bengal. These provide irrigation to gross area of about 4.5 mha. Tank is a multipurpose use source (pisiculture, ducking, washing, irrigation, flood control, agro-forestry, etc.) and has great importance particularly to maintain water supply to command area and to recharge ground water level.

b) **Tube-well and Filter point well**

Shallow tube-wells meant for irrigation are privately owned and tap shallow aquifers (groundwater storage). These are used to irrigate only a few hectares and have a life period of 5 to 15 years, while deep tube-wells generally tap deep aquifers and give a recharge of more than 125000 liters per hour and irrigate a gross area of 80 to 100 ha.

c) **Open-well**.

Open-wells are traditional sources of irrigation. The new wells constructed during any period do not make an addition to the total number to the full extent during that period as some wells go out of use. Open-wells are the cheap source of irrigation water use where topography is undulating and canal water does not feed the area. Open-wells are basically privately owned and the potential for irrigation is also not much.

10.3.2 Sources of Major and Medium Irrigation

Big dams and barrages built across rivers are sources of major and medium irrigation. Major irrigation done through canal draws their water from rivers or from artificial storage. River canals are of three types.

1) Inundation canal
2) Perennial canal
3) Storage canal.

Check Your Progress 1

1) Define minor, medium and major irrigation.

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2) What are the sources of minor irrigation?

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3) What are the sources of major irrigation?

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10.4 MAJOR VERSUS MINOR IRRIGATION: COMPARATIVE ANALYSIS

Both major and minor irrigation projects have their potential for water resource exploitation. However, both the types are different in nature and have their comparative merits and demerits. Tube-well technology is technically not feasible in non-alluvial tracts, which constitute nearly 70 per cent of Indian landmass. The option in these undulating plateaus and non-alluvial tracts is runoff collection in ponds and other water harvesting structures under minor irrigation projects or canal irrigation system under multipurpose river valley projects.

The factors which help us to make a choice between minor and major projects are: i) the availability of funds, ii) topographic positions, iii) social preferences, and iv) environmental considerations. You would have observed that a major project requires huge investments while a minor project require a small amount. Moreover, hilly areas will require different type irrigation than plain areas. We will take into consideration factors such as capacity utilisation, gestation lag and resource requirements while undertaking a comparative analysis of both the types of irrigation.

10.4.1 Capacity Utilization and Efficiency

The 'potential created' under any irrigation system is the area supplied with water delivery facility. On the other hand, 'potential utilized' is the area that is practically supplied with irrigation water for at least one season. Difference between the two can arise because some areas are planned to have irrigation facilities, but do not receive irrigation water. When the area that actually receives water is less than the area planned for irrigation, we say that there is under-utilisation of capacity. The phenomena of 100 per cent efficiency is rare and is not a ground reality.

Studies have shown that for the minor irrigation project, the capacity utilisation is only to the extent of 80 per cent in a normal rainfall year. The percentage varies across states : 50-60 per cent in Orissa and Tripura, 60-70 per cent in Assam, Goa, Karnataka, Minipur, Meghalaya, 70-80 per cent in west Bengal, Tamil Nadu, Kerala, and Arunachal Pradesh.

Minor irrigation is a low cost option. However, studies have shown that the production impact of minor irrigation is double that of major irrigation. Minor irrigation is mainly covered by tube-wells wherever ground water is sufficiently available. Different studies reflect that the rate of capacity utilization in the tube-wells averaged at 67 per cent for shallow tube-wells and 72 per cent for deep tube-wells. Capacity utilization in major irrigation projects is reported to be somewhat lower than that of minor irrigation. Sometimes it comes down below 60 per cent as conveyance loss, evaporation loss and field losses are more in major projects. However, situation may be completely different depending upon conveyance and distribution systems in each command.

Minor irrigation is mostly in private sector. Here benefits accrue directly to the owner. Thus proper maintenance of the project and management of water is taken care of. On the other hand, major and medium irrigation projects are generally owned by the government. Here it does not costs a farmer if there is mis-management or excess use of water. This appears to explain the higher efficiency of minor irrigation.

10.4.2 Gestation Period

The time lag between the investment and the return from development projects is called gestation period. The gestation period of irrigation projects is found to be very high as administrative and technical problems are compounded with legal problems. Many irrigation projects, especially large and medium ones, suffer from gestation lags.

In some cases the gestation lag exceeds two decades resulting in severe cost and time overruns. A medium scheme can generally be completed between 5 to 7 years. However, gestation period differs from project to project depending upon factors ranging from availability of finance to technical difficulties and now a days environmentally conscious groups or individuals.

In normal course of action also the gestation lag itself may vary over time. For a major project it may vary from 10 to 12 years if timely funding is available. In cases where funding and other constraints are present, the gestation lag could stretch up to 20 years. On the other hand, in the case of minor irrigation projects, the gestation period is usually one to two years. However, it depends upon availability of funds and organizational ability to get the project running.

Now a days, under different poverty alleviation programmes emphasis is given on minor irrigation projects as the gestation period, environmental impacts and investments are less. The gestation lags also may arise due to slow adaptability of irrigated agricultural practices by beneficiary farmers. The longer gestation period lead to cost and time overruns making the project often financially non-viable.

10.4.3 Cost Comparison

It is debatable whether minor irrigation is more cost efficient than major irrigation projects. The Planning Commission has estimated that investment needed for irrigating one hectare of land was Rs.1,530 in the Fifth Plan. It increased to Rs.36,210 per hactare in the Ninth Plan. For minor projects the cost of irrigation per hectare cultivated land was Rs.7331. However, the estimates are non-comparable as the values are expressed in the prevailing market prices of that period not adjusted for inflation over the years.

The cost of the major irrigation projects involves total capital investment for the construction of the reservoirs, dams, canal and conveyance systems up to the plot of land. The cost of the minor irrigation project involves the capital investment on the construction of the tanks, wells or tube-wells and the conveyance system. It is estimated that the project cost of minor irrigation project is around Rs.5 lakh for plain areas and Rs.30 lakh for hills. The cost of major irrigation project involves capital expenditure of around Rs.5 crore.

We present a summary of the distinction between major and minor irrigation projects in Table 10.6.

Table 10.6 : Major versus Minor Irrigation Projects

Major irrigation project	Minor irrigation project
1. Gestation period is high	1. Gestation period is low.
2. Investment cost and maintenance costs are very high.	2. Investment cost and maintenance costs are low.
3. Investment cost is more than Rs. 5 crore.	3. Investment cost is Rs. 5 lakh to Rs. 30 lakh.
4. It covers an area about 10,000 ha or more.	4. It covers an area about 1000-2000 ha or less.
5. Benefit-cost ratio of major irrigation project are generally less compared to minor irrigation project as the loss of water due to seepage, over use, unnecessary use of irrigation water and larger externalities.	5. Benefit-cost ratio of minor irrigation projects are generally higher than major irrigation projects due to less wastage of water by seepage and other means.
6. It has been observed that in the world as a whole, as much land goes out of production owing to water logging and salination every year as is brought under production through new projects	6. Depletion of natural aquifers is the major problem.
7. The costs over-run are much greater.	7. The costs over-run are less.

Check Your Progress 2

1) What are the reasons behind higher production impact of minor irrigation projects?

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2) Contrast minor irrigation with major irrigation with respect to capacity utilisation, gestation lag and investment cost.

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3) Bring out the distinguishing features of minor and major irrigation.

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10.5 IRRIGATION MANAGEMENT

A serious problem experienced often in irrigation works is the inability of the system to deliver the planned benefits owing to a variety of unforeseen developments. For instance, in storage reservoirs, sedimentation has been taking place at a much faster rate than was provided for in the project planning, resulting in diminution of storage space and its benefits. Canals have not been able to carry the authorized flows because the assumptions made or the design could not be achieved on the field. Canal cross regulators and flood disposal works provided were found inadequate for efficient functioning of the canal in many cases.

While irrigation has significantly influenced agricultural productivity, the yields are distinctly low with respect to international norms in most of the irrigated crops in the country. The average cereal yields (paddy, wheat, etc.) of 1.7 tonnes per ha achieved in India falls well below the international norm of 3 to 4 tonnes realized in well managed systems of the world. The gap is attributed to a number of factors such as: i) sub-optimal use of inputs, ii) obsolete cultivation practices, and iii) inefficient irrigation management. Given the sensitivity of crops to water stress and excess water and their effects on yield, irrigation management emerges as a major determinant of agricultural productivity.

The common problems of flow irrigation (canal) management are:

a) excessive canal seepage
b) inadequate water supply at tail end
c) insufficient drainage and water logging
d) main system deficiency
e) improper cropping pattern and crop calendar
f) lavish use of water
g) inadequate maintenance
h) poor revenue generation.

10.5.1 Shortage of Funds

Due to shortage of funds in most instances of major projects, the storage works or reservoirs were completed much ahead of the canal system. This resulted in abundant water availability for the limited areas opened for irrigation. As a result, the cropping pattern got distorted in favour of high water consuming crops irrespective of the suitability of the soil. In such situations the development of canals to its full length as originally planned will become difficult. The head-reach beneficiaries would appropriate excessive water due to cultivation of water-intensive crops. On the other hand, the tail-end beneficiaries may not get adequate amount of water as planned.

10.5.2 Utilisation Efficiency

While the role of irrigation in India's increased agricultural production is impressive, there is a need for retrospection to meet the future requirements of a continuously rising population. Since the 1950s, the aggregate growth rate of agricultural production has increased considerably. However, the present strategies may lead to stagnancy after a time calling for something new. In this context increasing the efficiency of irrigation is an important option. For sustained growth of agricultural production, irrigation will have to play a notable role commensurate with the high investment made in it.

It is estimated that the demand for food in future (2025 AD) will be around 345 million tonnes in India. That has to be met from rain-fed and irrigated farming. The national average yield from rain-fed agriculture is 1.25 tonnes per hectare and from irrigated agriculture it is 2.75 million tonnes. It has been estimated that 198 million tonnes of foodgrains will have to be produced from irrigated agriculture and 148 million tonnes from rain-fed agriculture.

Another point to be kept in view is that while there is significant decline of the share of agricultural sector in the GNP, the proportion of households dependent on agriculture has remained nearly constant. Irrigation activities will have to aim at the improvement of economic condition of farmers through better irrigation management practices and by extending benefits to new areas.

10.5.3 Pricing of Irrigation Water

In India irrigation water is not economically priced, as the present prices do not reflect scarcity value of water. The Vaidyanathan Committee recommended pricing of water as per the principle that can cover at least operation and maintenance cost and a part of capital cost. The Irrigation Commission in 1972 had recommended irrigation rates for cereal crops at 5 per cent and for cash crops at 12 per cent of the output. Presently the total receipt from irrigation sector does not cover even 2% of the gross output. However, farmers using water from private sources are paying much more than those depending on the publicly supplied irrigation water. The ability and willingness to pay has not been properly projected in the projects. The uneconomic pricing of irrigation water and electricity have induced the farmers for profligate use of precious water resulting in severe externalities like salinity and water-logging. Different committees have recommended that irrigation price should be increased to a level such that at least operation and maintenance cost and 1% of capital cost are recovered from beneficiary farmers.

10.6 ENVIRONMENTAL EFFECTS OF IRRIGATION

Irrigation results in an alteration of natural condition of the landscape by i) extracting water from the available sources, ii) adding water to fields where there was none or little, and iii) introducing man-made structure and features to extract, transferring and dispose of water. Irrigation projects and irrigated agriculture practices can impact the environment in a variety of ways, viz.,

a) Construction of irrigation projects

b) Water supply and operation of irrigation projects

c) Irrigated agriculture management practices

The consequences of minor and major irrigation could be different. In case of major irrigation there could be:

a) Relocation of the population of the area to be inundated

b) Negative impact on wildlife, particularly endangered and archeological patrimony

c) Relocation of the infrastructural system, i.e., roads, powerline, canal, etc.

d) Use of hazardous materials during the construction of large dams

e) Soil erosion and subsequent transport of sediments through runoff of excess irrigation water from croplands.

10.6.1 Displacement of Population

The gigantic dams costing hundred of crore of rupees have caused a great deal of harm to the people and environment. They displace crores of innocent people, mostly tribals and the poor. These projects have drown millions of hectares of rich forest. They have failed to prevent and control floods. Often panic discharges from these reservoirs have led to destruction through floods in the valley downstream. The average annual loss due to flood on standing crop, cattle, agricultural lands, houses, roads, railways, embankments, cottage industries, etc. are estimated to be anywhere between Rs.1000 crore to Rs.1500 crore.

In recent times, no major irrigation project has gone without protest. This has delayed the timely completion of projects and resulted in cost over-runs.

10.6.2 Destruction of Habitat

Large dams and multi purpose river valleys have become India’s most controversial environmental issues. The construction of large dams in India has resulted in depletion of thousands of hectares of forest land causing destruction of natural habitat of wildlife.

Construction of large dams (major irrigation project) involves huge forest cutting for the water reservoir. It also involves huge digging of soil and displacement of soil for reservoir construction. Huge loss of forest and soil accounted for the major and medium irrigation project construction and developments.

10.6.3 Impact of Minor Irrigation

Because of the localized nature of minor irrigation the above problems may not arise. However, there could be depletion in water table because of excessive extraction of water from under-ground sources, particularly through deep tube-wells. Groundwater development for irrigation purpose and its excessive use has given rise to problems of groundwater depletion. In Punjab, for example, pumping exceeds recharge by 33 per cent causing water-table to drop by about 1 meter per year.

In coastal areas there could be damage to groundwater resource due to ingress of sea water into inlands. Stocks of weed water, such as intrusion from naturally brackish groundwater into adjacent normal groundwater reserves are also reported from arid land tracts of Haryana, Rajasthan and Northern Gujarat.

Another major externality pertains to ground water depletion due to cultivation of water intensive crops in low rainfall areas by using ground water reserves. The quality and quantity of ground water has changed over the years. In fact better part of the cropping potential developed after Independence comes from well-irrigation and not from canal irrigation. Stories of receding water table have emanated from many pockets in northwest and southern India. A receding water table not only means higher capital and operational cost of irrigation in future but also lesser reservoir of ground water resources to fall back upon during drought year.

10.7 PROBLEM OF SALINITY AND WATER-LOGGING

Salinity is one of the most serious problems facing irrigated agriculture. Salinity is linked with the rise in ground water tables resulting from excess irrigation and poor drainage in major irrigation systems. The resulting shallow water table brings salt to the upper layers of the soil profile. The increase in salinity in some areas like Haryana, Punjab, western Uttar Pradesh results from unscientific water application in high water intensive cereal crops. Followed over a period of time with the consequent result of rising ground water table in canal-irrigated areas or increase in surface return flows causes increase in salinity. The problem of soil salinity because of canal irrigation was widely reported in western-Yamuna canal command area. It is estimated that 15 to 20 per cent of net sown area in India suffer from soil salinity or alkalinity.

Technological options are available for checking salinity problems. Scientific water pricing, on-farm development including precious land leveling, appropriate crop-mix and improved water application (like drop or sprinkler) reduces salinity effect. Salt scrapping, gypsum application, rescheduling irrigation, use of farmyard manure, kharif fallow methods are followed for contriving salinity problems. The use of brackish underground-water is checked through policy measures. Irrigation induced soil salinity problem in arid and semi-arid area result in loss of 2,00,000 to 3,00,000 hectares of irrigated areas every year because of soil salinity and water-logging. In India around 13 million hectares of irrigated land suffer from soil salinity and water-logging. The result of salinity is reflected in decline in production potential of important agricultural crops in fertile irrigated areas.

Surveys in different canal commands of the country corroborate the fact that there has been severe crop loss due to faulty water management practices. Improving water use efficiency in water delivery system, main distributaries and minor systems can check excessive water use and related problems like salinity, and water-logging, Withdrawing ground water may cause the land to subside, aquifers to become saline or may accelerate other type of ground water pollution.

Canal related water-logging–salinity affected 6 out of 20 mha under canal commands as reported by B. D. Dhawan. The adverse externalities of irrigation emerges from water-logging and salinity related problems in canal command areas and excessively used groundwater areas with increasing canal development activities. In the post-independence period the area under water-logging and salinity has been increasing.

10.8 SUGGESTIONS FOR BETTER WATER MANAGEMENT

Balanced development of irrigation sector, duly recognizing hydrological linkage between surface water and ground water resources, should be the aim of Indian irrigation planning. The demand for water for irrigation is ever increasing because of the rising population. Storing, diverting, and conserving or managing usable water resources efficiently can meet the demand. Continuous efforts need to be made to utilize the scarce water resources scientifically, judiciously and economically. It is suggested that there should be a close integration of water use and land use policies. Water allocation in an irrigation system should be done with due regard to equity and social justice. Disparities in the availability of water between head-reach and tail-end in all the systems of irrigation network like main canal, branch, distributary and scheduling of canal water supply should be minimized. Disparity between large and small farms should be obviated by adoption of a rotational water distribution system and supply of water on volumetric basis subject to certain ceiling.

The methods to be used for better water management are:

- Drip irrigation can be used for horticultural crops for water saving and better yields.
- Sprinkler irrigation can be used for closely spaced crops such as millets, pulses and oilseeds. Large-scale adoption of sprinkler in canal and tank irrigation project is necessary to use water efficiently and to increase the productivity.
- Diversification of crops and cropping pattern based on the availability of water/rainfall in the canal and tank irrigated areas should be followed.
- Farmer should avail proper information about the availability of water for rational planning of the crop husbandry.
- Drainage system should be well developed and care should be taken of the conveyance channel.
- Large scale adoption of micro irrigation in well-irrigated areas for wide spread high value crops such as coconut, banana and grapes may be taken up.
- Adoption of pipelines even in the canal command areas to minimize water loses can be a good proposition.

Further these are some of the factors that deserve special attention for the implementation and smooth functioning of irrigation projects:

i) Checking the diversion of investible funds to subsidise payments (including hidden subsidies in canal irrigation) and to meet profligate ministerial and other government expenses.

ii) Minimization of environmental effects of big dam projects

iii) Eliminating the mounting inefficiencies in projects implementation (e.g., large time and cost over run) and in the management and maintenance of canal.

iv) Resolving speedily interstate water disputes.

Apart from removing hindrance from the apex level, the base level should be strengthened for efficient water use. The following suggestions are given for the optimum water use from the available sources:

a) Making the maximum use of rainfall for raising crops, utilizing irrigation for making up deficiencies.

b) Adoption of most suitable cropping pattern considering soil, climate and availability of irrigation supplies.

c) Making most efficient use of irrigation supplies by minimizing losses in conveyances by lining and adopting scientific methods of irrigation on properly prepared fields.

d) Deployment of irrigation supplies for maximum overall production and not necessarily maximum yields.

e) Reuse of water to the extent feasible.

f) Conjunctive use of surface water and ground water in accordance with precipitation in canal command areas.

10.9 COMMAND AREA DEVELOPMENT PROGRAMME

The central government sponsored Command Area Development Programme since 1974-75 with objectives of bridging the gap between creation and utilization of irrigation potential has been optimizing agricultural production from irrigated land in different states. Accordingly Command Area Development Authority (CADA) was created for effective conveyance of water to fields, drainage and on-farm development works. The programme broadly covers construction of field channels, land levelling, field drains and introduction of *warabandi* for rational supply of water to ensure equitable and assured supply of water to each and every farm holding. It also includes arrangement of supply of inputs and credits, agricultural extension, construction of markets and go-downs, and development of ground water for conjunctive use.

Prima facie, there is a vast scope for achieving improved yields from irrigated agriculture by introducing scientific water pricing method. Water Users' Associations are being formed in different states under the command of minor canals for better distribution of irrigation water. Water Users' Associations will have to be sponsored, encouraged, evaluated and replicated on an extensive scale. Research and development will have to be deployed widely for evolving various engineering and other strategies suitable for a variety of situations existing in the country. While government departments and agencies should provide overall guidance, direction, coordination and funding, the non-governmental organizations functioning in the field will all have to be involved in the task of organising the people and extension activities. It is now generally recognized that farmers' participation in management would go a long way in promoting sound water management practices. But the steps taken so far are in no way commensurate with the task ahead. The maxim of "some for all rather than more for some", which is particularly valid for irrigation systems can be achieved only through meaningful participatory management.

Check Your Progress 3

1) What are the environmental impacts of major irrigation projects?

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2) Why does the problem of salinity take place? How can we tackle this problem?

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3) What steps should be taken towards better management of irrigation water?

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4) What is the role of farmer and farmer associations in better water management?

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10.10 LET US SUM UP

Land under irrigation in India has increased from 22 million ha in 1951 to 90 million ha by the end of the Eighth Plan. This has helped in realizing a higher growth in foodgrains and yield. The irrigation potential of the country, however, are limited and the option of dry land farming needs to be considered.

Irrigation in India has resulted in number of environmental problems. Construction of large dams has resulted in loss of forest-land, displacement of people and resettlement problems. On the other hand, excessive extraction of ground water in low rainfall areas has resulted in depletion of water table.

The dream to touch the maximum feasible area of 113 million ha in 2005 AD can only be realized by water saving and using improved methods for surface irrigation. Drainage (removal of excess water from root zone) is as important as irrigation and proper action should be taken to provide drainage channel to remove excess water.

10.11 KEY WORDS

Salinity : Due to excess flow of water the water table comes up within three meters of the land surface. As a result, salinity of the land increases and productivity of land decreases.

Warabandi : According to this practice plots of land will receive irrigation water on stipulated days and not on other days. Thus excess water use in head-reach plots can be checked. This will lessen the excess water related problem such as salinity.

10.12 SOME USEFUL BOOKS

Dhawan, B. D., 1988, *Irrigation in India's Agricultural Development*, Sage Publications, New Delhi.

Mal, P., 2001, *Infrastructure Development for Agriculture and Rural Development*, Mohit Publications, New Delhi.

Ministry of Agriculture, 1999, *Agricultural Statistics at a Glance*, Government of India.

Mishra, K. M., 1990, *Irrigation and Economic Development*, Ashish Publishing House, New Delhi.

10.13 ANSWERS/HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) Go through Section 10.3 and define these concepts on the basis of command area.

2) Read Sub-section 10.3.1 and answer.

3) See Sub-section 10.3.2 for the answer.

Check Your Progress 2

1) Go through Sub-section 10.4.1 and answer this question.

2) Read Section 10.4 and answer.

3) Bring out the distinct features of minor and major projects on the basis of Table 10.6.

Check Your Progress 3

1) Discuss the issues of displacement and destruction of habitat.

2) Read Section 10.7 and answer.

3) Read Section 10.8 and answer.

4) Read Section 10.8 and bring out the issues which can be tackled by the farmers.