Chapter 9

Agriculture

Indian economy hinges on agriculture. About 58.2 per cent of Indian population is directly or indirectly dependent on agriculture. Agriculture and allied sectors contribute nearly 14.4 per cent of Gross Domestic Product (GDP) of India (India 2012). Besides, agriculture is an important source of raw material for industrial production, and serves as a huge market for the industrial products. In the opinion of Gunnar Myrdal "It is in the agriculture sector that the battle for long term economic development will be won or lost." If agriculture goes wrong, nothing else will have a chance to go right in India (M.S. Swaminathan). The agricultural output, however, depends on monsoon as nearly 55% of area sown is dependent on rainfall. It not only provides food to its teeming millions; the agro-based industries for their raw material are dependent on agriculture. Moreover, agriculture fetches substantial amount of valuable foreign exchange.

The domestication of plants and animals is known as agriculture. It includes cultivation of crops, animal husbandry, horticulture, pisciculture, sericulture, silviculture, floriculture, etc. Being located in tropical and subtropical latitudes, the greater part of the agricultural land of India can produce two or more than two crops in a year.

LAND UTILISATION

Land utilisation statistics are available for about 93 per cent of the total geographical area (328.75 million hectares) of the country. The net sown area accounts for about 46.15 per cent of the total reporting area of India, against the world average of about 32 per cent. The general land use of the country has been given in **Table 9.1** (**Fig. 9.1**).

Table 9.1 *India—General Land Use in 2009–10*

Land Categories	*Area in Million Hectares 2009–10*	*Percentage*
1. Total geographical area	328.75	
2. Total reporting area for land use	306.25	93.20
3. Area under forests	69.00	22.55
4. Area not available for cultivation		
(a) Area put to non-agricultural uses	23.25	7.61
(b) Barren and uncultivable land	19.18	6.25

(*Contd.*)

(*Contd.*)

5. Other uncultivated land excluding fallow		
(a) Permanent pastures and grazing lands	11.00	3.61
(b) Land under tree crops and groves	3.62	1.18
(c) Culturable waste	13.83	4.52
6. Fallow Lands		
(a) Current fallow	14.80	4.83
(b) Other fallow	10.11	3.30
7. Net sown area	141.23	46.15
8. Area sown more than once	48.51	32.60
9. Total (gross cropped) cropped area	189.74	
10. Area under irrigation	78.00	55.3

Source: ***Statistical Abstracts of India—2005–06, Govt. of India Publication.***

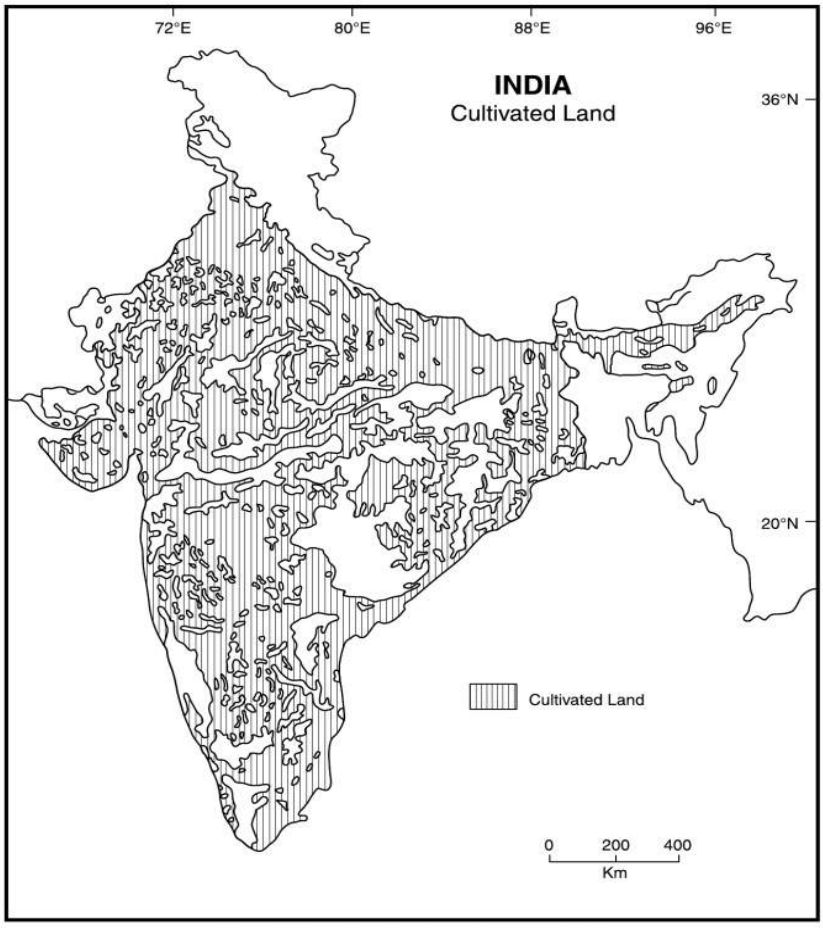


Fig. 9.1 Arable Land (2005–06)

It may be seen from **Table 9.1** that over 46 per cent of the total reporting area was net area sown in 2005–06, and 32 per cent was double cropped area (**Fig. 9.2**). The forest occupied 22.55 per cent while 6.25 was barren and uncultivable land. The barren and wasteland occupy 6.25 per cent of the total reporting area **Table 9.1** (**Fig. 9.3**). The various categories of degraded lands have been given in **Table 9.2**

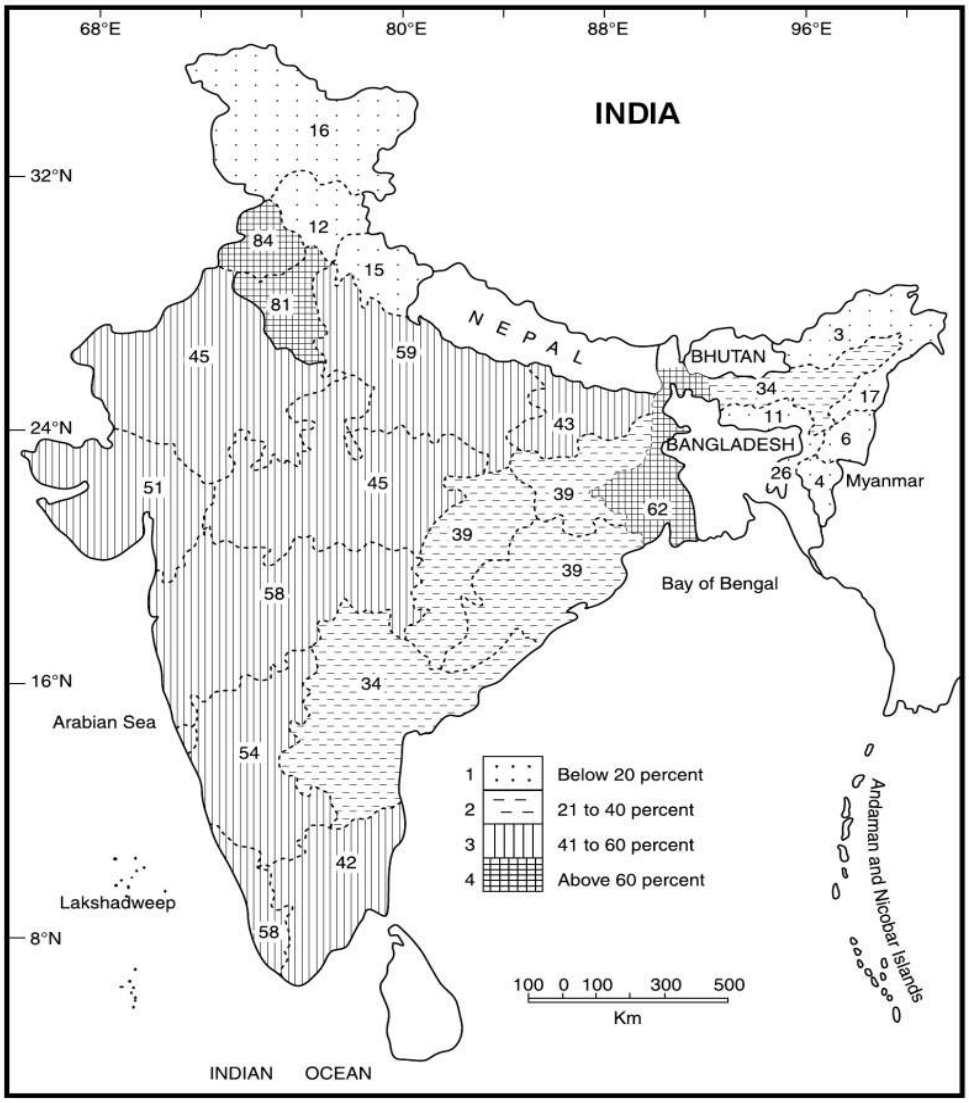


Fig. 9.2 Net Sown Area (2005–06)

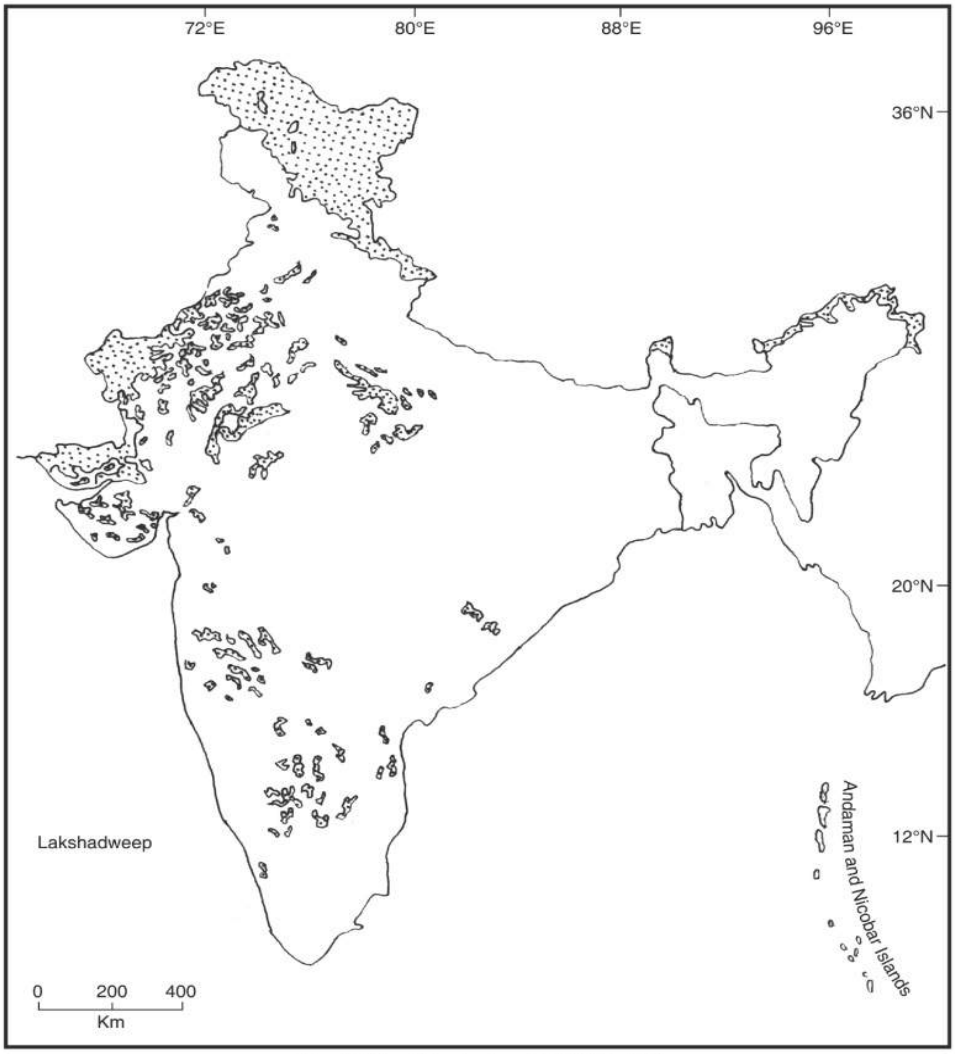


Fig. 9.3 Wasteland (2005–06)

Table 9.2 *Waste Lands and Degraded Lands*

Type of land	*Percentage*
Gullied land	2.05
Land with or without scrub	19.40
Water-logged and marshy land	1.66
Land affected by salinity and alkalinity	2.05

(*Contd.*)

(*Contd.*)

Shifting cultivation area	3.52
Degraded notified forest land	14.06
Degraded pastures	2.60
Degraded land & plantation crop	0.58
Coastal sandy land	5.00
Mining industrial wasteland	0.12
Barren rocky wasteland	6.46
Steep sloping area	0.77
Snow covered and glacial area	5.38
Total	63.65

Source: ***Planning Commission, Government of India, Tenth Five Year Plan.***

An examination of **Table 9.2** reveals that land with or without scrub and degraded notified forests occupied 19.40 and 14.06 per cent of the waste land respectively. The reclamation of degraded and waste lands can help in increasing the agricultural land as well as in improving the ecology and environment.

CHARACTERISTICS AND PROBLEMS OF INDIAN AGRICULTURE

As stated at the outset, Indian economy hinges on agriculture. The socioeconomic status of the people, the national polity and the gamut of life of the people is directly controlled by agriculture. The Indian agriculture, however, has its own characteristics. Some of the important characteristics and problems of Indian agriculture have been described briefly in the following section:

1. Subsistent in Character

Despite eleven five year plans, in greater parts of the country, Indian agriculture is subsistent in character. The cultivators and farmers grow crops mainly for the family consumption. It is only in the controlled irrigated parts of the country like Punjab, Haryana, western Uttar Pradesh, and Kaveri delta where agriculture has become an agri-business or is market oriented.

2. Heavy Pressure of Population

The Indian agriculture is characterised by heavy pressure of population. About 68 per cent of the total population of the country is directly or indirectly dependent on agriculture. At present, the per capita agricultural land is only about 0.10 hectare as against 0.30 hectare in 1951. The world average of per head availability of agricultural land is about 4.5 hectares. The fast growth of population industrialization and urbanization are putting enormous pressure on arable land.

3. Predominance of Food Grains

In both the *Kharif* (summer) and the *rabi* (winter) seasons, grain crops occupy the greater proportion of the cropped area. In fact, rice, maize, millets, *bajra, ragi*, and pulses are the dominant crops in the *kharif* season, and wheat, gram and barley occupy over three-fourth of the total cropped area in the *rabi* season.

4. Mixed Cropping

In the rain-fed areas of the country, mixed cropping is a common practice. The farmers mix millets, maize and pulses in the *kharif* season and wheat, gram and barley in the *rabi* season. In the areas of *Jhuming* (shifting cultivation), ten to sixteen crops are mixed and sown in the same field. The rationale behind mixing of crops is to get good agricultural return. In case the monsoon is good, the rice crop will give better production and in case of failure of monsoon, the less water requiring crops like maize, millets, bajra and pulses will give good harvest. Mixed cropping is a characteristic of subsistent agriculture.

5. High Percentage of the Reporting Area under Cultivation

In India, about 55 per cent of the total reporting area is under cultivation of crops and pastures. This is much higher when compared with about 4 per cent in Canada, 12 per cent in China, 15 per cent in Japan, and 16 per cent in USA.

6. Small Size of Holdings and Fragmentation of Fields

Over 70 per cent of the holdings are either small or marginal, i.e. less than one hectare. The small size of holdings is mainly due to the law of inheritance and other sociocultural and economic factors. Moreover, the fields are scattered and fragmented. The small size of holdings and fragmented fields are unsuitable for the modern methods of agriculture.

Table 9.3 *Size of Holdings*

Category	*Area (hectares)*	*Percentage of holdings*	*No. of operation holdings (in millions)*	*Percentage of area*	*Measure in hectares*
Marginal	Below one	50.6	30	9.0	15
Small	1–2	20.0	14	11.9	19
Semi-medium	2–4	15.2	—	18.5	—
Medium	4–10	11.3	—	20.7	—
Large	Above 10	04.0	—	30.9	—

Source: ***Statistical Abstracts of India*** 2005–06.

It may be seen from **Table 9.3** that about 51 per cent holdings of the country are marginal farmers having less than one hectare of land. About 20 per cent are in the small category, and 11 per cent in the medium category, while only 4 per cent are the large category farmers, having more than 10 hectares.

7. Limited Intensive Agriculture

In India, only about one-third of the total cropped area is under double and multiple cropping. Increase in the double cropped area is difficult unless heavy investment is made in development of canal and tube-well irrigation.

8. Primitive Technology

Most of the farmers of the country, especially in the rain-fed areas, use draught animals (bullocks, male buffaloes and camels) for ploughing and other agricultural operations. The health and

efficiency of draught animals is low which often retards the timely operations of sowing, weeding, and harvesting.

9. Indian Agriculture is Labour Intensive

In India, agriculture is a labour based enterprise in which most of the agricultural operations, like ploughing, levelling, sowing, weeding, spraying, sprinkling, harvesting, and threshing are carried on mainly by human hands. The use of machinery is still confined only to the rich farmers of Punjab, Haryana, western Uttar Pradesh, plains of Uttarakhand, Bihar, Madhya Pradesh, Gujarat, and Maharashtra.

10. Rain-fed Agriculture

In the greater parts (over 55%) of the country, agriculture is largely dependent on rainfall, especially the summer monsoon. Unfortunately, the behaviour of summer monsoon is highly erratic. Consequently, the variability of rainfall is high which affects the agricultural return adversely. Only about 55 per cent of the total cropped area is under irrigation in which the farmers are more confident about their agricultural returns even at the failure of monsoon, as it happened in 2009.

11. Less Area under Leguminous and Fodder Crops

The nitrogen fixing crops like pulses are getting less area under their cultivation. Consequently, the natural fertility of the soil is depleting and the soils are losing their resilience characteristics. Moreover, less than 4 per cent of the cropped area is under fodder crops. This, together with lack of good pastures, has detrimental effect over the development of dairy farming and milk-production. India has the largest number of cattle in the world, but it occupies an insignificant place in respect of cattle products in the world.

12. Tradition Bound

By and large, the Indian agriculture is tradition bound. Established several centuries ago, the structures of a self-contained rural economy were founded in caste-derived occupational land tenures, made complex by absentee and parasitic landlords. These institutional factors and tradition bound institutions are a major obstacles in the path of innovations and modernisation of agriculture.

13. Low Productivity

One of the main problems of Indian agriculture is its low productivity. In comparison to the other agricultural countries, the Indian agricultural yields are among the lowest in the world (**Table 9.4 and Table 9.5**). The main cause of low yield per hectare is the low fertility of soil and less care to replenish it through green-manure, fertilisers, fallowing, and scientific rotation of crops. The consumption pattern of chemical fertilizers has been shown in **Fig. 9.4**. It may be seen from this figure that Punjab with 175 Kg/ha is the leading consumer of chemical fertilisers followed by Haryana 160 Kg/ha. Uttar Pradesh, Andhra Pradesh, Tamil-Nadu and West-Bengal. In general the fertiliser consumption level is very low in the areas of dry farming.

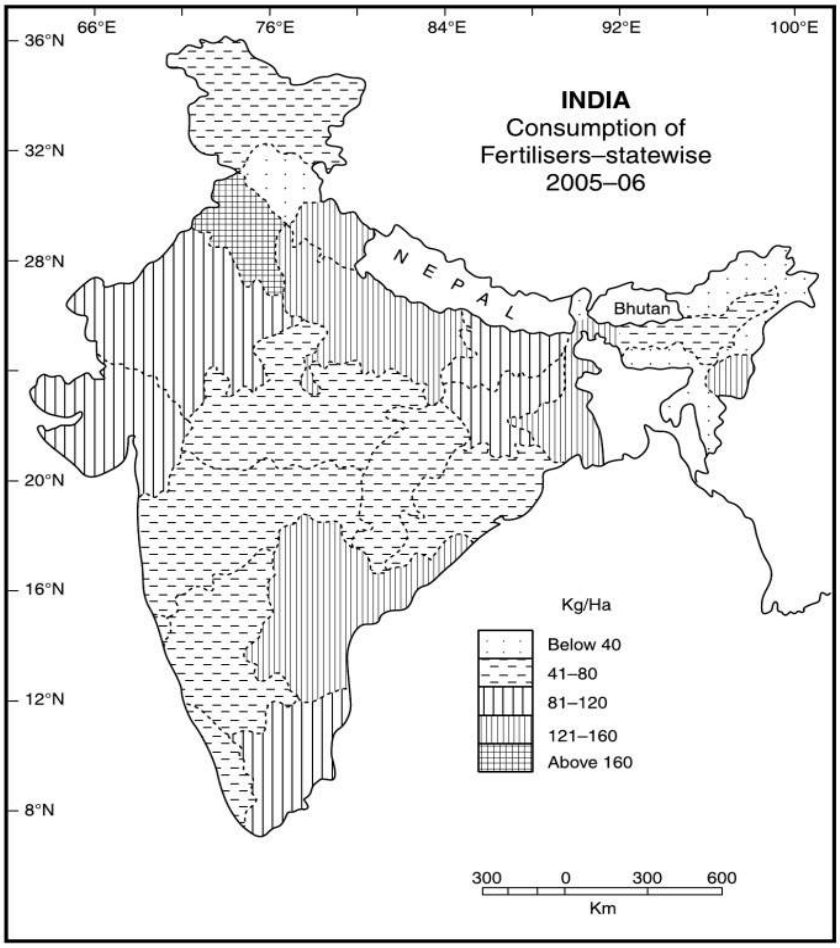


Fig. 9.4 Consumption of Fertilisers (2005–06)

Table 9.4 *International Comparisons of Yield of Rice, 2005–06, (in metric tonnes/hectare)*

Rice/Paddy (in metric tonnes/hectare)	*Yield*	*Rank*
Egypt	9.8	1st
USA	7.3	2nd
Korea	6.73	3rd
Japan	6.42	4th
India	2.9	5th
Thailand	2.63	6th
World	3.96	

Source: ***Economic Survey*** 2006–07, p.160

Table 9.5 *International Comparison of Yield of Wheat, 2004–05, (in metric tonnes/hectare)*

Country	*Yield*	*Rank*
UK	7.7	1st
France	7.58	2nd
China	4.25	3rd
India	2.71	4th
Pakistan	2.37	5th
Iran	2.06	6th
Australia	1.64	7th
World	2.87	

Source: ***Economic Survey 2006–07***, p.160

14. Government Policy

After the First Five-Year Plan, Indian agriculture got a step-motherly treatment. The farming community has been ignored, while there has been more emphasis on industrialisation and urbanisation. The growth rate of agriculture is only about 2.5 per cent, while the overall growth rate of the country is about 9 per cent (2010). The farmers are not getting remunerative prices, most of them are under debts and in several parts of the country, farmers are committing suicides. This dismal picture is the result of continuous careless agricultural land use planning. Much emphasis has however, been laid on the rural and agricultural development in the Eleventh Five-Year Plan to remove the rural, urban inequality. Creation of 580 lakh jobs has also been proposed in this plan to overcome the problem of unemployment and to check the rural-urban migration. The real challenge for the government is in trying to boost food output at home, and increase investment in rural and agricultural infrastructure for the same, while at the same time not letting its guard down on fiscal prudence or inflation management. The severe drought of 2009 over greater part of the country has increased the miseries of the farmers, which is a set-back in the revival of Indian economy.

15. Lack of Definite Agricultural Land Use Policy

In the absence of a definite land use policy, the farmers grow crops according to their convenience. This sometimes leads to excess of production and sometimes scarcity. Many a times the farmers have to burn their sugarcane crop and often get less remunerative price of vegetables (onion, potato and other vegetables).

16. Lack of Marketing and Storage Facilities

Lack of marketing and storage facilities and the role of brokers deprive the farmers to fetch remunerative prices for their agricultural products. Except a few states like Punjab, Haryana, Maharashtra, Gujarat, and Andhra Pradesh, marketing and storage facilities are inadequate. In greater part of the country, farmers are still at the mercy of unscrupulous traders and are easily exploited by secret brokerage, false weights and payment of inflated commissions. Moreover, due to lack of proper pricing policy, farmers fail to obtain fair price for their agricultural products.

17. Low Status of Agriculture in the Society

In greater parts of India, agriculture is not considered as a dignified and honourable profession. This leads to disappointment and lack of enthusiasm among most of the farmers. The younger generation of farmers prefer a petty government job to agriculture. Moreover, rich farmers invest

their agricultural profits in non-agricultural sectors which are more remunerative. In fact, there is a mass exodus of people from rural to urban areas in search of lucrative jobs. There is a constant flow of human and material resources from villages to the cities. This has led to fast growth of urban centres which are infested with slums, ghettoes, and shanty colonies.

18. Land Tenancy

In many parts of the country, there are absentee land lords and the tillers are not having the rights on agricultural land. The big landlords who own big farm houses are rich urbanites. The tillers and share croppers who actually cultivate the land of absentee land lords are not much interested in the development, proper management, utilisation of agricultural land, and modernisation of agriculture. This system leads to lack of interest on the part of the tiller and consequently, the per unit yield of most of the crops is low.

19. Poverty and Indebtedness of the Farmers

Although cultivators indebtedness is universal in subsistent farming, its impact is perhaps nowhere as crushing as in India. Unfortunately, over 85 per cent of all the cultivating families are under debt. It is because of heavy indebtedness that several thousand farmers in Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Odisha, Gujarat, Punjab, and Uttar Pradesh have committed suicide during the last ten years. The small and marginal farmers are still dependent on money-lenders who charge exorbitant interest on loans (25 to 40 per cent per annum). In the case of non-payment, the money-lenders grab their mortgage property making them pauper. Some special provisions have been made in the draft of the Eleventh Five Year Plan to overcome the problem of farmers indebtedness. A scheme of debt waiving for small and marginal farmers and debt relief for other farmers was announced by the government in the Union Budget of 2008–09.

20. Inadequacy of Extension Service

For the diffusion of agricultural innovations both in the irrigated and rain-fed areas, a team of skilled village level workers is required. There is much to be done in this area. Training of workers and their dedication can help the tradition bound farmers to modernise their agriculture.

21. Inadequate Agricultural Research and Education, Training, and Extension

Though enough progress has been made in the field of agricultural research, there is no co-ordination between the farm and research laboratories in the different agro-climatic regions of the country. Hence, gains of new agricultural researches are not reaching the common cultivators, especially the marginal and small farmers. Very little attention is being paid for educating and training farmers for the adoption of new agricultural innovations and techniques to increase their agricultural production.

22. Soil Erosion and Soil Degradation

Soil erosion is a universal phenomenon. It is, however, significantly high in the areas of heavy rainfall with undulating topography and in the areas of scanty rainfall (deserts and semi-desert areas). The indiscriminate felling of trees, cattle grazing, unscientific land use practices have greatly

accelerated the rate of soil erosion in the different parts of the country. Although soil conservation programmes were initiated in 1953, their impact has not been very encouraging. The people's awareness and their active participation in the soil conservation is essentially required.

23. Other Characteristics and Problems

There are numerous other problems also which are affecting the agricultural production and rural economy and society adversely. For example, unscientific methods of agriculture, inadequate irrigation facilities, less use of chemical fertilisers, insecticides, pesticides, less remunerative prices of agricultural products, poverty, hunger, and malnutrition of farmers and lack of infrastructural facilities like roads, water, irrigation, electricity, credit, banking, and crop-insurance.

DETERMINANTS OF AGRICULTURE

The agricultural practices, cropping patterns and their productivity are closely determined by the geo-climatic, socioeconomic, and cultural-political factors. In fact, the agriculture of any region is influenced by the following factors:

1. *Physical factors:* Terrain, topography, climate, and soil.
2. *Institutional factors:* Land-tenure, land tenancy, size of holdings, size of fields and land reforms.
3. *Infrastructural factors:* Irrigation, electricity, roads, credit and marketing, storage facilities, crop insurance and research.
4. *Technological factors:* High Yielding Varieties (new seeds), chemical fertilisers, insecticides, pesticides, and farm machinery.

These factors individually and collectively have their impact on the cropping patterns, level of agricultural development and yield of crops in a region. A brief account of these factors has been given below.

Physical Factors

(a) Terrain, Topography, and Altitude

The agricultural patterns are strictly dependent on the geo-ecological conditions; terrain, topography, slope and altitude. While paddy cultivation requires leveled fields, tea plantations perform well in the undulating topography in which water does not remain standing. Orchards of coconut are found at low altitudes, preferably closer to the sea level, while the apple orchards in the tropical and sub-tropical conditions perform well above 1500 metres above sea level. Moreover, cultivation of crops is rarely done 3500 m above sea-level in the tropical and sub-tropical latitudes. The highly rarified air, low-pressure, low temperature, and shortage of oxygen at high altitudes are the serious impediments not only in the cultivation of crops, but also in keeping dairy cattle. The soils of high mountainous tracts are generally immature which are also less conducive for agriculture. The topographical features also affect the distribution of rainfall. Normally, the windward side gets more rainfall than the leeward side. The amount of rainfall received in a region determines the selection of crops to be sown.

Apart from altitude and aspects of slope, the nature of the surface also affects the agricultural activities. The gullied land is least conducive for cropping. The Chambal ravines in Madhya Pradesh,

Rajasthan, and Uttar Pradesh have put over thousands of hectares of good arable land out of agriculture.

(b) Climate

Of all the physical factors, climate is one of the most significant determinant of agricultural land use and cropping patterns.

(i) Temperature The crops to be grown, their patterns and combinations are closely controlled by the prevailing temperature and precipitation conditions. The agricultural scientists have proved that each crop has a specific zero temperature below which it can not be grown. There is also an optimal temperature in which the crop is at its greatest vigour. For each stage of crop life, i.e. germination, foliation, blossoming or fructification a specific zero and optimum can be observed in temperature.

The upper limit of temperature for plants growth is 60°C under high temperature conditions, i.e. at over 40°C, crops dry up, if the moisture supply is inadequate. In contrast to this, the chilling and freezing temperatures have a great adverse effect on the germination, growth and ripening of crops. Crops like rice, sugarcane, jute, cotton, chilli and tomatoes are killed or damaged at the occurrence of frost. The minimum temperature for wheat and barley is 5°C, maize 10°C, and rice 20°C.

The impact of temperature on cropping patterns may be seen from the fact that the northern limit of the regions in which date-palm bear ripe fruit coincides almost exactly with the mean annual temperature of 19°C. The essential factor in the limit of grape orchards seem to be temperature. Grapes ripen only in those countries in which the mean temperature from April to October exceeds 15° C. Crops like winter-wheat and barley perform well when the mean daily temperature ranges between 15°C and 25°C. Contrary to this, tropical crops like cocoa, coffee, spices, squash, rubber and tobacco require over 18° C temperature even in the coldest months, while crops like wheat, gram, peas, lentil, potato, mustard, and rapeseed require a temprature of about 20°C during the growth and development, stage and relatively higher (over 25°C) during the sowing and harvesting periods.

(ii) Moisture All crops need **moisture**. They take water and moisture from the soil. This moisture may be available from the rains or from irrigation systems. Within wide temperature limits, moisture is more important than any other climatic factor in crop production. There are optimal moisture conditions for crop development just as there are optimal temperature conditions. The excessive amount of water in the soil alters various chemical and biological processes, limiting the amount of oxygen and increasing the formation of compounds that are toxic to plant roots. The excess of water in the soil, therefore, leads to stunted growth of plants. The problem of inadequate oxygen in the soil can be solved by drainage practices in an ill-drained tract.

Heavy rainfall may directly damage plants or interfere with flowering and pollination. Cereal crops are often lodged by rain and this makes harvest difficult and promotes spoilage and diseases. Heavy rainfall at the maturity of wheat, gram, millets, oilseeds, and mustards cause loss of grains and fodder. Indian farmers all over the country have often suffered on account of failure of rains or fury of floods.

(iii) Drought **Drought** has devastating consequences on the crops, their yields and production. Soil drought has been described as a condition in which the amount of water needed for

transpiration and direct evaporation exceeds the amount of water available in the soil. Drought damages the crops when plants are inadequately supplied with moisture from the soil.

The drought prone areas of India lie in the states of Rajasthan, Gujarat, Madhya Pradesh, Chhattisgarh, Jharkhand, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Odisha, Bundelkhand (U.P.), Uttarakhand, H.P., J&K, south-west Punjab and Haryana. In the areas where the average annual rainfall is less than 75 cm, agriculture is considered a gamble on monsoon. In 2009, the erratic monsoon resulted into drought in more than 200 districts of the country.

The incidence of drought and its intensity can be determined from the annual, seasonal and diurnal distribution of rainfall. Moreover, different plants have different moisture requirements. In the drought prone areas of India, dry farming is practiced, while in the more rainfall recording regions, intensive agriculture of paddy crop is a common practice.

(iv) Snow The occurrence of **snow** reduces the ground temperature which hinders the germination and growth of crops. Land under snow cannot be prepared for sowing because of permafrost. Melting of snow may cause hazardous floods in the summer season, affecting the crops, livestock, and land property adversely.

(v)Winds **Winds** have both, direct and indirect effects on crops. Direct winds result in the breaking of plant structure, dislodging of cereals, fodder and cash crops and shattering of seed-heads. Fruit and nut crops may be stripped from the trees in high winds. Small plants are sometimes completely covered by wind-blown dust or sand. The indirect effect of winds are in the form of transport of moisture and heat in the air. In fact, the movement of winds increases evaporation and transpiration.

(c) Soils

In agricultural operations, soil is probably the most important determining physical factor. It determines the cropping patterns, their associations and production. The fertility of soil, its texture, structure and humus contents have a direct bearing on crops and their productivity. In general, the alluvial soils are considered to be good for wheat, barley, gram, oilseeds, pulses, and sugarcane; while the clayey loam gives good crop of rice. *Regur* soil is known for cotton, and sandy soil for *bajra*, guar, pulses (green-gram, black-gram, red-gram, etc.). The saline and alkaline soils are useless from the agricultural point of view unless they are reclaimed by chemical fertilisers and biological manures and fertilisers.

2. Institutional Factors

The institutional factors include land tenancy, land-tenure, and ownership. These factors have their bearing on field size, field patterns, farming type, crop land use, crop associations, and productivity of crops. A brief account of the institutional factors has been given in the following:

(i) Land Tenure and Land Tenancy

The ownership of agricultural land is determined by the law of land tenure and land tenancy. In the primitive societies like those of the shifting cultivators (*Jhumias*), land belongs to the community. Subsequently, in India, the land ownership rights were vested in the king and the government. During the British period, a new system of land tenancy known as *Zamindari, Mahalwari,* and *Royatwari* was introduced to manage the agricultural land and to collect the land revenue. After independence, the Zamindari system was abolished and the rights of the tillers over cultivated land were restored.

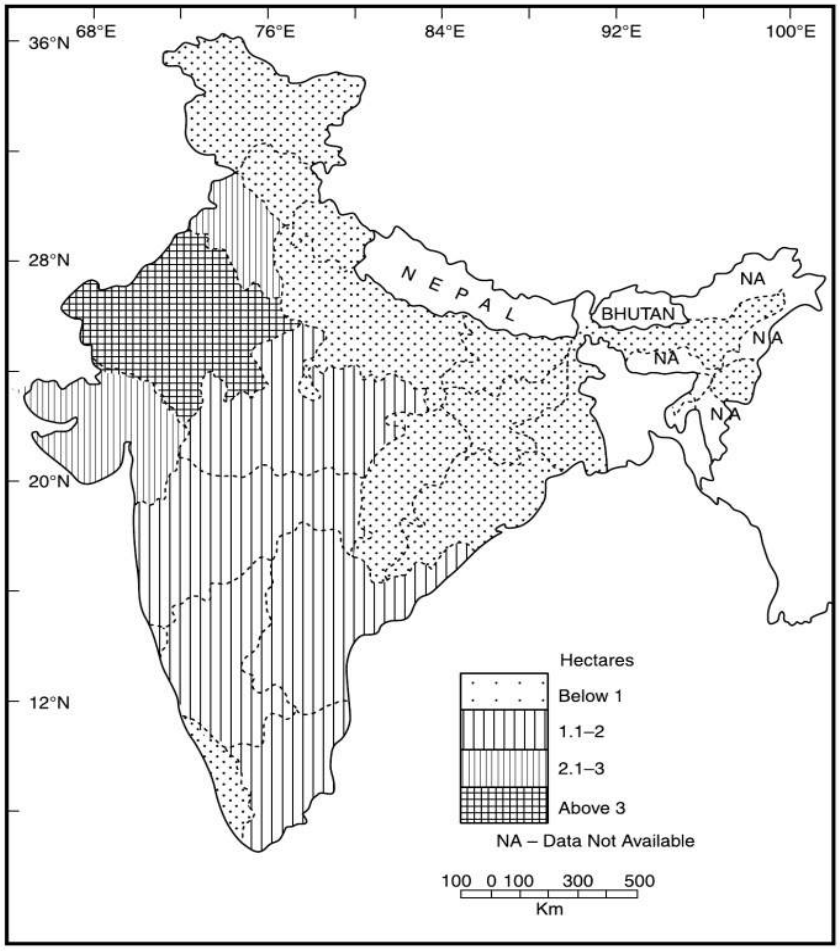


Fig. 9.5 Size of Holdings (2005–06)

After the abolition of Zamindari system, a number of land reform legislations have been passed by the central and state governments, but still there is enough scope to restore the rights of the actual tillers and landless labourers. Still, there are numerous absentee landlords, many of them possessing land more than the ceiling act permits. Only Punjab, Haryana, and Uttar Pradesh are the states in which consolidation of holdings has been completed.

(ii) Land Holding

In India the size of holding is too small. Due to the rapid growth of population during the last few decades and the existing law of inheritance, the agricultural land is divided equally among the male children of the deceased farmer. At present, the per capita available land is only about 0.10 hectare which is much below the world average of about 4.50 hectares. Over 75 per cent of the land holdings are less than one hectare. Such small holdings are not economically viable. In fact,

small holdings can not produce enough to meet the costs of irrigation, improved seeds, chemical fertilisers, insecticides, pesticides and farm machinery. The average size of holdings and their percentage share in India have been given in the **Table 9.6** (**Fig. 9.5**).

Table 9.6 *The Average Size of Land Holdings in the Selected States of India, 2005*

State	*Size of holdings (hectares)*	*State*	*Size of holdings (hectares)*
Rajasthan	4.00	Himachal Pradesh	1.15
Maharashtra	2.40	Bihar	0.70
Gujarat	2.85	Assam	1.15
Madhya Pradesh	2.75	Tamil Nadu	1.00
Haryana	2.45	West Bengal	0.80
Karnataka	2.15	Uttar Pradesh	0.72
Punjab	3.45	Jammu & Kashmir	0.75
Andhra Pradesh	1.50	Kerala	0.30
Odisha	1.30	India	1.50

Source: ***Agricultural Statistics of India, 2005***.

An examination of **Table 9.6** shows that the average size holding in India is about 1.50 hectares which is too small for mechanisation and application of modern technology. The largest size of operation holdings is in Rajasthan being 4.00 hectares, followed by Punjab at 3.45 hectares, and Gujarat at 2.85 hectares. The lowest size of land holding is in Kerala, being only 0.3 hectares and Uttar Pradesh 0.72 hectares. In rest of the states, it varies between 0.8 to 2.50 hectares. On the whole, in most of the states, the size of holdings is not economically viable.

LAND REFORMS

The basic objective of land reform is to do social justice with the tillers, land owners, landless labourers, and rural community with the set objective to provide security to the cultivators, to fix a rational rent, the conferment of title to the tiller and to increase the agricultural productivity. The entire concept of land reforms aims at the abolition of intermediaries and bringing the actual cultivator in direct contact with the state. The scheme of land reforms includes:

(i) abolition of intermediaries,
(ii) land tenancy reforms, i.e. regulation of rent, security of tenure for tenants, and confirmation of ownership on them,
(iii) ceiling on land holdings and distribution of surplus land to landless labourers and small farmers,
(iv) agrarian reorganisation including consolidation of holdings and prevention of subdivision and fragmentation,
(v) organisation of co-operative farms, and
(vi) improvement in the system of land record keeping.

1. Abolition of Intermediaries

During the British period, three categories of land tenure systems, namely, *Zamindari, Mahalwari,* and *Ryotwari* came into existence.

Zamindari System

Under the Zamindari system , which was introduced by Lord Cornwallis in 1793 in Bengal, land was held by one person or at the most by a few joint owners who were responsible for the payment of land revenue (*Malguzari*). Under the Zamindari system of tenure, these revenue collectors were raised to the status of land owners. The Zamindari settlements were of two types: (i) permanent with fixed land revenue in perpetuity, and (ii) temporary in which land revenue used to be assessed for a period ranging between 20 to 40 years and was subject to revision. Thus, between the state and the actual tiller, there grew an intermediary who was interested in land only to the extent of extraction of exorbitant rent. So Zamindari symbolised oppression and tyranny and agriculture was degraded to subsistence farming with low productivity.

Mahalwari System

Under the Mahalwari tenure, the village agricultural lands were jointly held by the village communities, the members of which were jointly and severally responsible for the payment of land revenue. The system was first introduced in Agra and Oudh and later in undivided Punjab. Here, the village *Lumbardar* collected revenue for which he received 5 per cent as commission.

Ryotwari System

Under the Ryotwari tenure, the individual holder was directly responsible to the state for the payment of land revenue. This form of tenure was first introduced in Madras in 1872 and later in Bombay, Berar, and Central India. The Ryot was at liberty to enjoy permanent rights over land and to sub-let it so long as he paid the land revenue to the government.

In order to stop the tyranny and exploitation by Zamindars and to restore tiller's right over the land, measures were taken for the abolition of intermediaries after independence. The Zamindari Abolition Acts were passed in different states of the country between 1948 and 1955. As a consequence, over 260,000 Zamindars were abolished.

Due to several loopholes in the Zamindari Abolition Act, the land could not be transferred to the actual tillers and the landless agricultural labourers. In certain parts of the country, the intermediaries are yet to be abolished, i.e. water rights in Bhagalpur (Bihar), Jotdari in Meghalaya, Communided in Goa, Trust Estate (Zamindari of religious institutions) in Odisha, and Devasthan Enam in Maharashtra.

2. Tenancy Reforms

During the British period, the *Zamindari, Mahalwari*, and *Ryotwari* systems, tenancy cultivation was quite common in India. The small and marginal farmers as well as the landless labourers were interested in doing cultivation in the fields of Zamindars. There were three types of tenants, namely: (i) occupancy or permanent tenants with permanent and heritable rights, (ii) tenants at will or temporary tenants, and (iii) sub-tenants or *Shikmi-kisan*. The condition of temporary and sub-tenants was adhoc and they were subject to ruthless exploitation. Frequent enhancement of rent, eviction on petty grounds and *begari* (free service) were some of the prevalent ways of exploitation. In India about 20 per cent of the agricultural land is devoted to share-cropping (*batai*), where 50 per cent of the produce is the normal rent. On several occasions, the peasant have to forego even two-thirds of the produce as rent. Under the land tenancy reforms, more than 11.5 million cultivators have been given tenancy rights. The tenancy reforms cover the following points:

(i) regulation of rent,
(ii) security of tenure, and

(iii) conferment of ownership on tenants. States have made the following provisions to achieve the third objective:
   (a) All tenants have been given full security of tenure, without giving the owners the right of personal cultivation.
   (b) Owners have been given the right to resume a limited area (not more than a family holding in any case) subject, however, to conditions that a minimum area is left with the tenant.
   (c) A limit has been placed on the extent of land with a land-owner may resume, but the tenant is not entitled to retain minimum area of cultivation in all cases.

3. Rent Control

At the time of independence the rate of rent on agricultural land was 50 per cent or more of the agricultural produce. It was too high for ordinary farmers. Hence, legislation were enacted to bring down the rate of rent to 20 to 30 per cent in Andhra Pradesh, 33 per cent in Punjab and Haryana, and 33 to 40 per cent in Tamil Nadu. Since the Fourth Five-Year Plan, the system of payment of rent in agricultural produce was fully abolished and the same was replaced by the system of cash payment.

4. Ceiling of Landholdings

Under the land reforms programme, it was envisaged that beyond a certain specified limit, all lands belonging to the landlords would be taken over by the state and allotted to small proprietors to make their holdings economic or to landless labourers to meet their demand for land. Ceiling on landholdings is, therefore, an effective measure for redistribution of land and achieving the goal of social justice. The land ceiling limits, both in the irrigated and dry lands, vary from state to state have been given in **Table 9.7:**

Table 9.7 *India—Ceiling Limits on Land Holdings in Hectares*

State	*Irrigated with two crops*	*Irrigated with one crop*	*Dryland*
As Suggested in National Guidelines of 1972	5.05–7.28	10.93	21.85
Actual Ceiling			
Andhra Pradesh	4.05–7.28	6.07–10.93	14.16–21.85
Assam	6.74	6.74	6.74
Bihar	6.07–7.28	10.12	12.14–18.21
Gujarat	4.05–7.28	6.07–10.93	8.09-21.85
Haryana	7.25	10.90	21.80
Himachal Pradesh	4.05	6.07	12.14–28.33
Jammu & Kashmir	3.6–5.06	...	21.85
Karnataka	7.28	10.93	21.85
Kerala	4.86–6.07	4.86–6.07	4.86–6.07
Madhya Pradesh	7.28	10.93	21.85
Maharashtra	7.28	10.93–14.57	21.85
Manipur	5.00	5.00	6.00
Odisha	4.05	6.07	12.14–18.21

(*Contd.*)

(*Contd.*)

Punjab	7.28	10.93	21.85–70.82
Rajasthan	4.86	12.14	24.28
Tamil Nadu	5.06	...	20.23
Sikkim	5.06	...	20.23
Tripura	4.00	4.00	12.00
Uttar Pradesh	7.30	10.95	18.25
West Bengal	5.00	...	7.00

Source: ***Agricultural Statistics at a Glance***—Ministry of Agriculture.

It may be observed from **Table 9.7** that in J&K and Kerala, only 3.6 and 4.86 hectares respectively are the ceiling limits of irrigated agricultural land, while in Uttar Pradesh and Haryana it is about 7.30 hectares. The unirrigated agricultural land ceiling limit is over 24 hectares in Rajasthan, over 20 hectares in Tamil Nadu, about 22 hectares in Jammu and Kashmir state and over 21 to about 71 hectares in Haryana and Punjab, respectively.

5. Consolidation of Holdings

Consolidation of holdings was one of the important steps towards land reforms. It was envisaged with the set objective to increase the agricultural efficiency and production of all category of farmers. Consolidation of holdings means to bring together in compact block, all the fields of land of a farmer which are well scattered in different parts of the village. Under the scheme, all land in the village is first pooled into one compact block and it is divided into smaller blocks called *chaks*, and allotted to individual farmer. This is a useful scheme which helped in overcoming the problem of fragmentation of holdings. But unfortunately, the scheme has not been implemented in all the states of the country. There are many hurdles in the implementation of consolidation of holdings in some of the states. Some points which are coming in the way of implementation of consolidation of holdings are as under.

(i) Farmers are emotionally attached to their ancestral land, and therefore, they are not willing to take advantage of the scheme of consolidation of holding.
(ii) Those farmers who own good quality of land do not like the scheme for fear of getting the inferior and poor quality of land after the consolidation.
(iii) Consolidation of holdings is a cumbersome process. The government officials who implement the scheme are generally slow and often corrupt.
(iv) In general, the scheme did not receive the desired support and co-operation from the farmers.
(v) The scheme has paved way for litigation and court cases, many of which are pending in different courts for a long time. This vitiates the serene atmosphere of the rural areas.
(vi) Under the existing law of inheritance, the fields continue to be smaller and fragmented.
(vii) In every consolidation, about 5 to 10 per cent of the village land is taken out for providing house sites to the weaker sections of society, approach roads (*chak-roads*) and village utility services. Hence, if the process is repeated three or four times, a sizable portion of the agricultural land would go out of agriculture.
(viii) The cost of consolidation is realised from the farmers which has adverse effect on their resources and economy.
(ix) It has been observed that the small farmers are generally allotted inferior quality of land, and due to lack of money power, they are neither able to please the officials nor get justice in the court.

Looking at these drawbacks, efforts should be made to remove these barriers and pitfalls in the scheme of consolidation of holdings to modernise the system of keeping revenue records. In the Seventh Five-Year Plan emphasis was laid on (i) scientific survey of the un-surveyed land, (ii) registering the name of tenant and share cropper in land records, (iii) strengthening the revenue system at the lowest level, and (iv) providing training facility to revenue officials to improve their efficiency. During the Eighth Five-Year Plan, it was decided to use computer and new techniques for keeping and maintaining and updating revenue records, proper recording of land rights, tenancy and causes of rural unrest and restriction on the sale and purchase of agricultural land for non-agricultural purposes. Land reforms also include computerisation of records of rights with maps, and land passbook.

Thus, a number of legislations have been enacted in the country for land reforms after independence, but due to socioeconomic and cultural complexities, loopholes in the land reform laws, laxity in implementation, and political and legal interference, these land reforms have not been able to achieve the desired success.

6. Computerised Land Records

The centrally sponsored scheme on computerisation of land records was started in 1988–89. At present, the scheme has been implemented in 582 districts out of the 640 districts of the country, leaving those districts where there are no proper land records.

INFRASTRUCTURE AND AGRICULTURAL INPUTS

Provision of quality and efficient infrastructure is essential to realise the full potential of agriculture. In other words, infrastructural development is imperative for the agricultural development of a country/region. Infrastructure includes the facilities of irrigation, availability of electricity, roads, marketing credit facilities and crop insurance.

Irrigation

The process of supplying water to crops by artificial means such as canals, tube wells, tanks, etc. is known as irrigation. In greater part of India, agriculture is rain-fed. In the incidence of failure of monsoon, the crop fails. The behaviour of Indian monsoon is highly erratic. Excess rainfall may cause floods, but scanty rainfall may reduce the crop yield substantially, and in acute cases the crop may be a complete failure. This problem may be solved by increasing the irrigated area in the country. Irrigation helps in bringing the new area under cultivation on the one hand, and increases the double and multiple cropping on the other. Moreover, the per hectare yield of the irrigated area is much higher to that of the unirrigated areas. About 84 per cent of the water resources of India is used for irrigation. The irrigation potential of India is about 102 million hectares of the total potential created, however, only about 87 million hectares is actually utilized (India 2010, pp.998–1002).

Sources of Irrigation

Depending on the availability of surface and underground water, slope of the land, nature of the soil and the types of crops grown in a region, a number of sources of irrigation are utilised. The main sources of irrigation used in different parts of the country are: (i) canals, (ii) wells and tube-wells, (iii) tanks, and (iv) other sources (springs, *kuhls*, *swing-basket, dhenkli*, *dongs*, and *bokka*, etc.). The areas irrigated by the different sources have been plotted in **Fig. 9.6** while **Table 9.8** gives the temporal changes in the irrigated area under different sources.

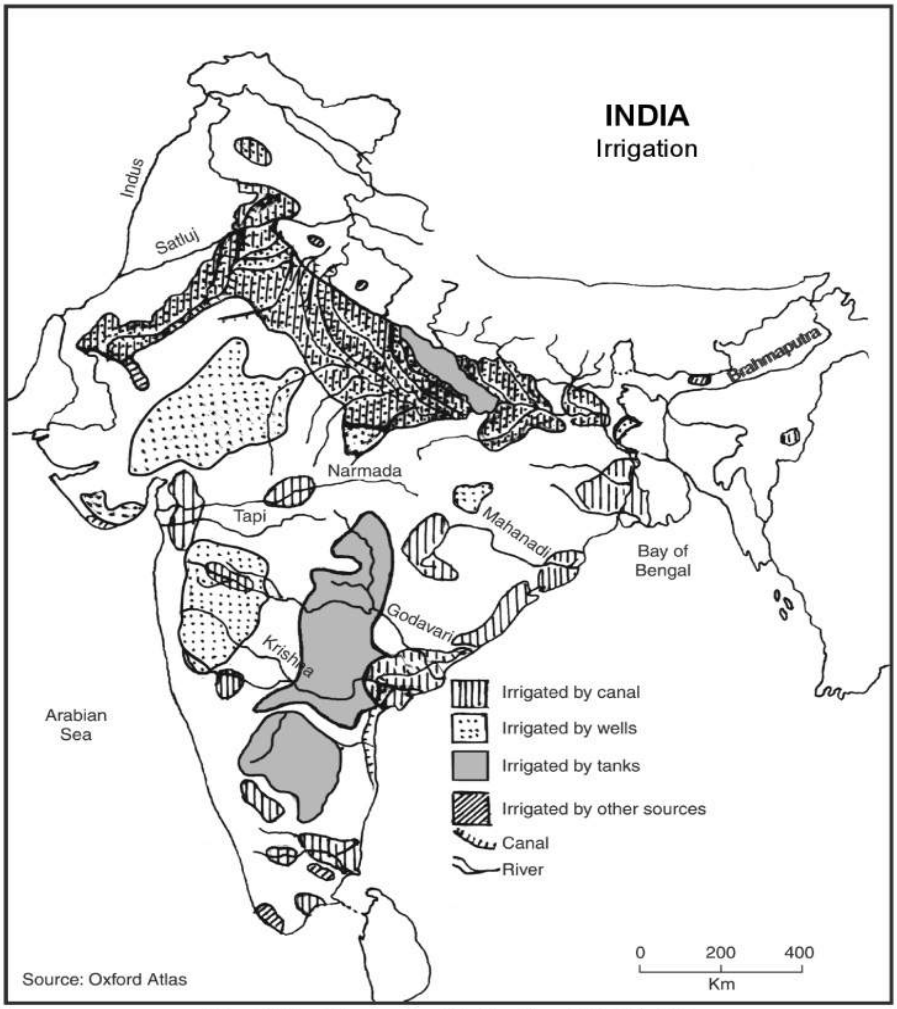


Fig. 9.6 Sources of Irrigation (2005–06)

Table 9.8 *Area and Sources of Irrigation (area in thousand hectares)*

Year	*Canals*	*Wells, including tube-wells*	*Tanks*	*Other sources*	*Total*
1950–51	8295	5980	3610	970	18,855
	(44.0%)	(31.7%)	(19.1%)	(5.20%)	(32.0 %)
1990–91	16,560	34,580	2575	3050	56,765
	(29.17%)	(60.91%)	(4.53%)	(5.37%)	(55.7%)
2000–01	15,790	33,275	2525	2900	54,490
	(28.98%)	(61.07%)	(4.63%)	(5.32%)	(100.00%)

Source: ***Statistical Abstracts of India, 2005–06***.

It may be seen from **Table 9.8** that only 18,855 thousand hectares of the cropped area was under irrigation in 1950–51 which increased to 54,490 thousand hectares in 2000–01, an increase of almost three times. While the canal area has been doubled over the given period, the area under wells and tube-well irrigation has increased by more than ten times. Despite these achievements, a lot of area of the agricultural land of the country is un-irrigated and needs a controlled and assured supply of moisture to the crops through irrigation.

The statewise net sown area under irrigation has been plotted in **Fig. 9.7**. An examination of **Fig. 9.7** shows that Punjab and Haryana have the highest percentage of irrigated area (over 85 per cent) followed by Uttar Pradesh and Tamil Nadu—between 50 to 75 per cent. In the remaining states the irrigated area is below 50 per cent (**Fig. 9.7**).

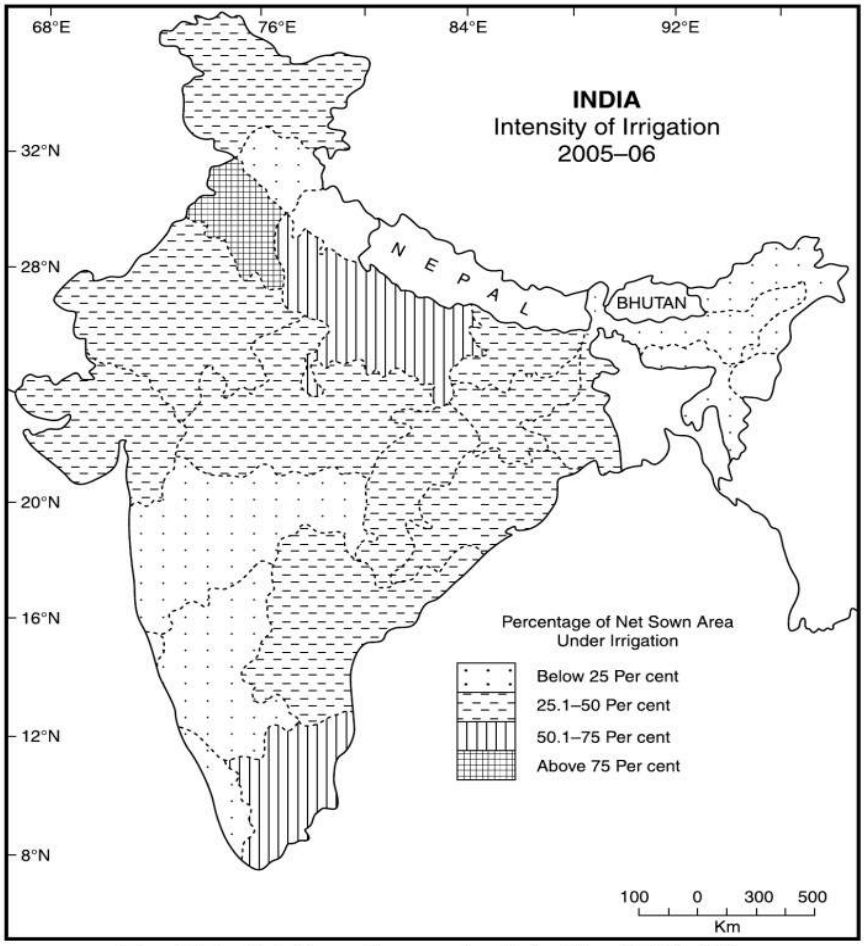


Fig. 9.7 Net Sown Area under Irrigation (2005–06)

Canal Irrigation Canals used to be the main source of irrigation in 1950–51, irrigating almost 50 per cent of the total irrigated area, but in the Third and Fourth Five-Year Plans, there was a

tremendous increase in the tube-well irrigated area. Consequently, the percentage of canal irrigated area declined to less than 29 per cent and in 2000–01, wells and tube-wells emerged as the major source of irrigation, covering over 61 per cent of the irrigated area.

Canals are an effective source of irrigation in the areas of low and leveled relief, productive plain areas where perennial source of surface drainage is available. These conditions are ideally found in the Northern Plains of India, Kashmir and Manipur Valleys and the Eastern Coastal Plains of India. The main concentration of canals in India is found in Uttar Pradesh, Punjab, Haryana, and western Rajasthan. After the construction of multi-purpose projects, a number of small canals have been dug in the Damodar, Mahanadi, Godavari, Krishna, Kaveri, Narmada, Tapi rivers, and their tributaries. Some of the important irrigation projects have been shown in **Fig. 9.9**.

Table 9.9 *Net Area under Canal Irrigation—(2000–01)*

S. No.	*State*	*Net area under canal irrigation ('000 hectares)*	*Percentage of canal irrigated area to net irrigated area of the state/country*	*Percentage of canal irrigated area in the state to total irrigated area of India*
1	Uttar Pradesh	3090	25.42	21.33
2	Andhra Pradesh	1650	36.42	10.83
3	Haryana	1475	49.89	9.68
4	Rajasthan	1355	27.59	8.90
5	Bihar	1135	31.34	7.45
6	Maharashtra	1050	35.38	6.89
7	Karnataka	975	36.55	6.40
8	Odisha	875	24.38	5.74
9	Tamil Nadu	830	28.81	5.44
10	Madhya Pradesh	825	19.49	5.41
11	Chhattisgarh	800	68.90	4.25
12	Punjab	675	18.76	4.43
13	Gujarat	495	16.52	3.25
	India	15,230	29.24	100.00

Source: ***Statistical Abstracts of India-2003.***

It may be seen from **Table 9.9** that in India, about a little over 29 per cent of the total irrigated area was under canal irrigation. Uttar Pradesh with 3090 thousand hectares under canals has the first rank in canal irrigation, followed by Andhra Pradesh with 1650 thousand hectares and Haryana with 1475 thousand hectares. The states of Rajasthan and Bihar rank fourth and fifth in canal irrigated area. The rank of Punjab was however, 12th in canal irrigation, followed by Gujarat (**Table 9.9**).

The existing irrigated area and the sources of irrigation are not adequate to meet the growing demand. There are a number of problems Indian agriculture is facing. There is a gap between the developed and utilised irrigation potential. Moreover, in the case of big irrigation projects like canals, there are interstate disputes. There is wastage of water, water-logging in canal command areas and other ecological problems. Hence, there is a need for a judicious and scientific development of irrigation, full utilisation of its potential and rational pricing of irrigation water.

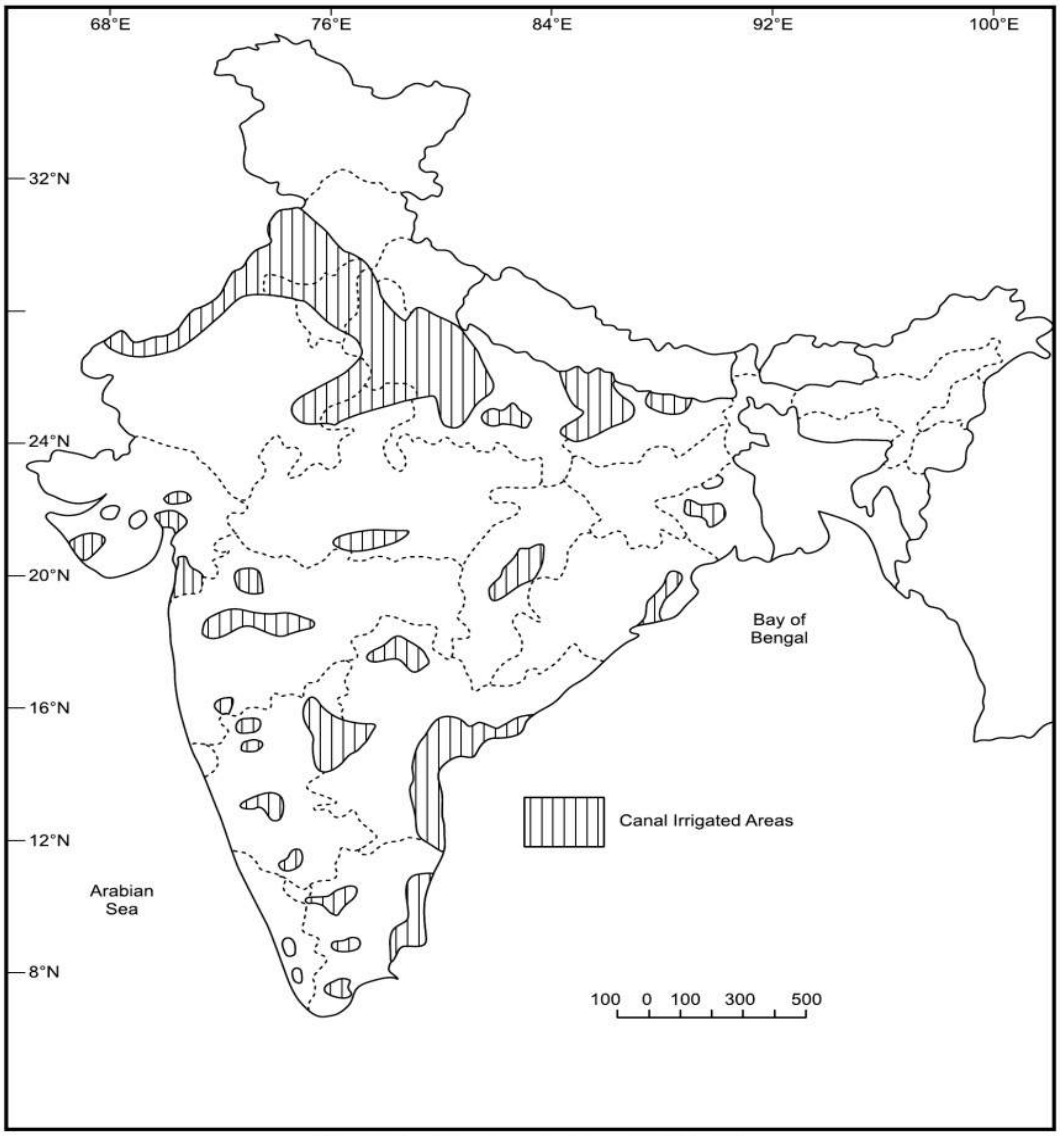


Fig. 9.8 Canal Irrigation (2005–06)

Wells and Tube-Wells This type of irrigation has been practised in India since the time immemorial. The widely used methods for the utilization of underground water are persian-wheel *Rahat*, *Charas*, or *mot* and tube-wells. Out of these, tube-well irrigation is more popular in the Satluj-Ganga plains. Tube-well irrigation accounts for more than 61% of the total irrigated area of the country.

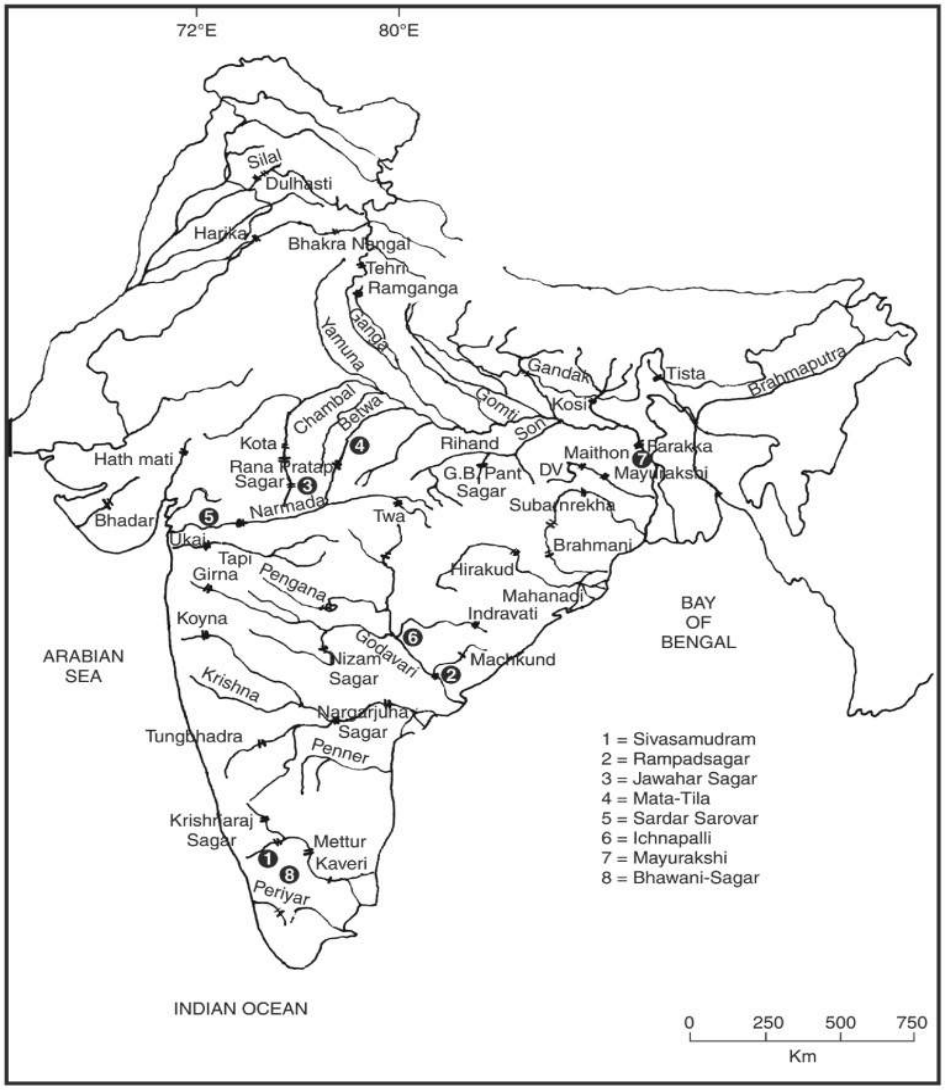


Fig. 9.9 Major Irrigation Projects

Tube-well irrigation is the easiest source of irrigation. It can be installed in a short duration of time. It is however, expensive and diminishes the underground watertable, especially in the years of drought like 2009. The most important problem of tube well irrigation is the high energy costs for pumping groundwater because of farmers dependence on diesel and electricity. The prices of these energy resources have increased rapidly. The largest area under tube-well irrigation is in Uttar Pradesh followed by Rajasthan, Punjab, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh and Haryana.

Tank Irrigation In some parts of the country, especially in the peninsular India tank is an important source of irrigation. About 4% of the total irrigated area is under tank irrigation. Andhra Pradesh (32%) has the largest area under tanks followed by Tamil Nadu (28%), West Bengal (14%), Karnataka (9.3%), U.P. (7%), M.P. (6.5%), Odisha and Maharashtra. Many of the tanks however, dry up during the summer season when more irrigation is required. It is an expensive and time-consuming technique which can command only small area.

Power Availability of electric power is also an important determinant of cropping patterns and agricultural productivity. In general higher the supply of electricity for irrigation, higher is the yield of crops.

Roads A well knit and co-ordinated network of metalled roads play a significant role in the agricultural development of a region. In India, the road density is the highest in Punjab, Haryana and Kerala these states have higher yields of cereals to that of the national average.

Credit The cultivator needs credit for a variety of purposes and for different periods. Firstly, he needs short-term credit (up to 15 months) for the purchase of requirements of current production. (seeds, fertilisers, insecticides, pesticides, electricity, diesel, cattle-feed, repair of farm implements, wages to hired labourers, etc.) and to meet the consumption needs of his family till the harvest of the crop. Secondly, he requires medium-term finance (up to 5 years) for such purposes as buying cattle and implements, undertaking digging of wells or other minor irrigation works, and effecting substantial improvement to land. Finally, he requires long term finance (for over 5 years) for such purposes as purchase of land, substantial investment in tube-wells, farm machinery and orchards, and the repay of old loans.

In the absence of this facility, the cultivators mostly used to borrow from the private money lenders, traders, commission agents and relatives. The All India Credit Survey 1951–52 showed that of the total rural credit secured by the cultivators, money lenders accounted for almost 70 per cent, relatives 14.2 per cent, traders and commission agents 5.5 per cent, co-operatives 3.1 per cent, government agencies 3.3 per cent, and others 4.2 per cent. This led to a lot of exploitation of the cultivators by money lenders charging exorbitant interest, illegally and fraudulently grabbing the property of the borrower and forcing him to act as bonded labour. At present, farmers are getting agricultural credit facilities through co-operatives, commercial banks and regional rural banks.

The National Bank for Agricultural and Rural Development (NABARD) founded on 2nd July, 1982 took over the functions of the erstwhile Agriculture Credit Development, Rural Planning, and Credit Cell of the Reserve bank of India and Agriculture Refinance and Development Corporations. The NABARD was established for providing credit for promotion of agriculture, small scale industries, handicrafts and other economic activities in rural areas. It has been emphasised that the largest proportion of the agricultural credit should go to marginal and small farmers.

Research and Extension Development of new seeds and extension service also enhance significantly aggricultural productivity. According to agronomists the HYVs become outdated after every three years. The old seeds need to be replaced by new varieties, for which research and extension services are required.

Crop Insurance

Crop insurance was introduced by the government of India in 1985. It is operated through the General Insurance Corporation of the State Government. The Government of India in

co-ordination with the General Insurance Corporation of India (GIC), had introduced a scheme called the National Agricultural Insurance Scheme from Rabi-1999–2000 season. The main objectives of the crop insurance are:

(i) to provide financial support to farmers in the event of crop failure on account of natural calamities,
(ii) to enable farmers affected by a crop failure to restore their eligibility for fresh borrowing from the institutional credit institutions,
(iii) to protect farmers against losses suffered by them due to crop failure on account of natural calamities, such as drought, flood, hailstorm, cyclone, fire, pest/diseases,
(iv) to stimulate production of cereals, pulses and oilseeds.

The sum insured is 100 per cent of the crop loan or a maximum of Rs.10,000 per farmer. The insurance premium is 2 per cent of the sum insured for rice, wheat, and millets and 1 per cent for pulses, and oil seeds which is deducted at the time of disbursement of the loan. Small and marginal farmers pay only 50 per cent of the insurance premium, the balance is paid as subsidy by the Centre and the States. The crop insurance policy has however, not paid much dividends to the marginal, small, and medium farmers.

Technological Factors Moderisation of agriculture requires appropriate machiney for ensuring timely field operations, effective application of agricultural inputs and reducing drudgery in agriculture. Traditionally, farmers in Inia have been using manual and animal operated farm equipment but due to increased cropping intensity, this power is no longer adequate to ensure timeliness. The research institutions and industries together have helped the farmers in development suitable farm machinery to mechanised field operations. The farm mechanisation increases cropping intensity, timely operations increases crop productivity and profitability. Technological factors include HYVs, chemical fertilisers, insecticides and pesticides tractors and other agricultural machinery. The use and availability of these inputs also enhance the agricultural productivity of a region.

Green Revolution in India

Green Revolution is a term coined to describe the emergence and diffusion of new seeds of cereals. Norman-e-Burlaug is the Father of Green Revolution in the world, while Dr. M.S. Swaminathan is known as the Father of Green Revolution in India.The new cereals were the product of research work and concentrated plant breeding with the objective of creating High Yielding Varieties (HYVs) of use to the developing countries. New varieties of wheat were first bred in Mexico in the 1950s and that of rice, like IR-8 (miracle rice) at the International Rice Research Institute, Manila, (Philippines in the 1960s). The increase in the yield from the new seeds has been spectacular as during the last forty years, agricultural production, particularly of wheat and rice, has experienced a great spurt and this has been designated as the Green Revolution.

The Green Revolution has been used to mean two different things. Some experts of agriculture use it for referring to a broad transformation of agricultural sector in the developing countries to reduce food shortages. Others use it when referring to the specific plant improvements, notably the development of HYVs. Whatsoever the meaning of Green Revolution may be taken as, the adoption and diffusion of new seeds of wheat and rice has been considered as a significant achievement as it offered great optimism. In fact, these varieties of seeds have revolutionised the agricultural landscape of the developing countries and the problem of food shortage has been reduced.

In India, hybridisation of selected crops, i.e. maize, *bajra* (bulrush millets), and millets began in 1960. The Mexican dwarf varieties of wheat were tried out on a selected scale in 1963–64. Exotic

varieties of rice such as Taichung Native I were introduced in India in 1964. The diffusion of HYVs, however, became fully operational in the country in the *Kharif* season of 1965–66. The diffusion of the new seeds was mainly in the Satluj-Ganga Plains and the Kaveri Delta. Subsequently, a number of varieties of wheat and rice were developed by the Indian scientists and adopted by the Indian farmers.

Merits of the High Yielding Varieties

The High Yielding Varieties have certain advantages over the traditional varieties of cereals which are given as under:

1. Shorter Life Cycle

The High Yielding Varieties have shorter life cycle, thereby enabling the farmers to go for multiple cropping. For example, the new seeds of rice and wheat complete their life cycles in about 100 and 110 days respectively. Contrary to this, the traditional varieties of rice and wheat take about 130 to 150 days respectively to harvest. The new seeds thus enable the farmers to economise on land.

2. Economise on Irrigation Water

The High Yielding Varieties need a lot of water for better returns. The yield of these varieties per unit area is significantly high. If it is considered in terms of water required per quintal of wheat and rice, the new seeds require less water as compared to traditional varieties. Thus, the new seeds economise on water also as the crop remains in the field for a shorter period of time.

3. Generate more Employment

The High Yielding Varieties under optimal conditions require more labour per unit area and thus, help in generating more employment. Prior to the introduction of the new seeds, the farmers over greater parts of the country, especially in the Northern Plains of India, were largely dependent for their agricultural operations on the arrival of monsoon. In fact, they used to remain unemployed during the summer months (April to mid-June), i.e. after the harvest of the *rabi* crops (wheat, gram, etc.). But now, the farmers and the dependent labourers get work in various agricultural operations throughout the year.

4. The High Yielding Varieties are Scale Neutral

One of the main advantages of the High Yielding Varieties is that they benefit all category of farmers in the same proportion. In other words, the new seeds are not biased towards the big and the small farmers.

5. Easy to Adopt

The adoption of High Yielding Varieties does not require any special skill for adoption. The farmers of different socioeconomic and cultural backgrounds can adopt the new seeds without any difficulty. Only a minor adjustment in the dates of sowing of wheat is required as the new seeds require relatively cool temperature at the time of sowing. Being short duration, the wheat crop is to be sown late in the month of November and December instead of October.

When the new seeds were diffused in the mid-sixties, it was expected that the problems of food shortage, unemployment, poverty, hunger, malnutrition, undernourishment, and regional inequalities will be largely solved. But these objectives could not be fully achieved. The geographical conditions required for the successful cultivation of High Yielding Varieties have been given in brief in the following section:

Geographical Constraints in the Adoption of New Seeds

The new seeds are undoubtedly land substituting, water economising, more labour using, and employment generating innovations. Nevertheless, they are very delicate and therefore, require a great deal of care for obtaining a successful harvest. For example, the new seeds are less resistant to droughts and floods and need an efficient management of water, chemical fertilisers, insecticides and pesticides. Any lapse on the part of the farmer in the application of these inputs may reduce the production substantially. In order to obtain a satisfactory agricultural return, the farmer should be in a position to arrange the costly inputs on time for which sufficient surplus capital should be available. The conditions required for the good harvest of new seeds have been described below:

1. Irrigation

Irrigation is the most important input required for the successful cultivation of new seeds. The new seeds need copious irrigation. Adoption of High Yielding Varieties and intensification of agriculture in a country like India without the availability of irrigation is not possible. The new seeds need controlled irrigation, i.e. they need irrigation at the specific periods of growth, development and flowering in the prescribed quantity. Over irrigation and under-irrigation, both are injurious to the crop. Thus, the timings of irrigation and the quantity of water supplied are decisive for the satisfactory performance of the crop. In the case of wheat for example, appropriate timing and spacing of irrigation raise the yield as much as 50 per cent even if other inputs (fertilisers, etc.) are not applied. The first irrigation of wheat around the third week of sowing alone raises the yield as much as 30 per cent. Moreover, the associated inputs like chemical fertilisers, insecticides and pesticides also perform satisfactorily only if timely irrigation is provided to the crop. Without irrigation, a surfeit of other inputs would be to no avail. In the absence of controlled irrigation, the farmer may not get even a reasonable return from their fields.

2. Availability of Chemical Fertilisers

The natural fertility of the soil decreases with the passage of time. In a region like the Great Plains of India, in which agriculture is being carried out for the last five thousand years, the soils are generally depleted and are increasingly losing their resilient characteristics. For the recuperation of fertility, the soils need to be rested in the form of fallowing or they have to be enriched by applying manures (cowdung, compost, and green) and chemical fertilisers.

The High Yielding Varieties give rise to short stemmed, stiff-straw plants that respond well to heavy doses of fertilisers. These dwarf varieties are known as the hungry varieties which need more energy in the form of chemical fertilisers. Contrary to this, the traditional varieties, if given heavy doses of fertilisers, get lodged at the occurrence of rains. The lodging of the crop reduces the yield per unit area.

In the areas of controlled irrigation, the recommended dose of chemical fertiliser for the new seeds of wheat and rice in terms of NPK is 90-45-45 kg. per hectare. Some of the well off farmers of Punjab, Haryana, and western Uttar Pradesh are applying the chemical fertilisers to the crop in the prescribed quantity. The all India average fertilizer consumption is 129 kg per hectare per annum in 2009–2010. India is the third largest producer of fertilizer after China and USA and the second largest consumer after China in the world. All India fertilizer consumption in 2010-11 was about 140 kg/ha of NPK nutrients. There is a wide variation in consumption of fertilizer from state to state. It is about

238 kg/ha in Punjab, 225 kg/ha in Andhra Pradesh, 2010 kg/ha in Haryana and 205 Kg/ha in Tamil Nadu. The lowest consumption is in Arunachal Pradesh and Nagaland with 5 kg/ha (2010-11).

3. Plant Protection Chemicals

The new seeds are very delicate and highly susceptible to pests and diseases. The irrigated fields enriched with heavy energy input (fertilisers-NPK) create a micro climate (hot and humid) in the field which helps in the fast growth of plants. The same environment is conducive for the fast growth and multiplication of insects and pests. These insects and pests attack the crop, hamper their growth and reduce the yield substantially. The danger of pests and insects may be reduced by using plant protection chemicals. The problem may be tackled either by developing the disease resistant seeds or by spraying insecticides and pesticides at the appropriate time prescribed or advised for different crops.

The problems of crop disease and pests may also be tackled by timely application of insecticides and pesticides. Thus, the farmer must have adequate knowledge of plant disease and their controlling chemicals. At the outbreak of a disease in the crop, the entire area should be sprayed. If the timely spray of the insecticides and pesticides is not done, the crop of the entire village/region may vanish. Since the plant protection chemicals are quite expensive, and often adultrated, they are generally out of reach of the small and marginal farmers. And if the crops by small and marginal farmers are not sprayed, the insects may creep in the neighbouring fields and the disease may adversely affect the larger area. At present plant protection is available to only 34 per cent of the total cropped area (2009–2010).

4. Capital Constraint

Availability of capital is also a vital constraint in the adoption and successful cultivation of the High Yielding Varieties. The farmer must have sufficient capital for the purchase of seeds, installation of tube-wells, drilling of pumping sets, chemical fertilisers, plant protection chemicals, tractors, harvesters, threshers, sprayers, and other accessories of agriculture. In case the farmer does not possess the operational capital, he should have an easy access to credit. In India, most of the farmers have no surplus over consumption, and therefore, no saving or operational capital at their disposal. The agrarian institutions like banks and co-operative credit societies have great responsibilities. They should advance loans to the farmers at a reasonable rate of interest. Unfortunately, the credit agencies in India, generally, serve the big farmers who are economically well off and politically well connected. The poor and the small farmers are thus deprived of the required inputs, so essential for the successful cultivation of High Yielding Varieties of crops like wheat and rice. Thus, there is a need of strengthening credit disbursting agencies.

5. Mechanisation

Modern farming tools and technology like tractors, leveller, seeder, planter, threshers, harvesters, winnower and sprayers are also imperative for the successful cultivation of the High Yielding Varieties. These varieties require adequate arrangements of controlled irrigation. Raising of two or three crops from the same field is possible only if the modern technology is available to the farmer. The indigenous plough and bullock/buffalo carts are less efficient to complete the agricultural operations on time. Machinery like tractors, threshers, sprayers, tillers, chaff cutters, leveller, pumping sets, etc., are required for the timely operations of sowing, weeding, spraying, and harvesting. The

mechanisation of agriculture also helps in the judicious utilisation of complementary inputs like chemical fertilisers, insecticides and pesticides. For example, a farmer with a tractor and blade-terracer manages to grade his field to much better level in the course of time as compared to a farmer not having the similar equipments at his disposal. Among many useful aids which increase the efficiency of the farmers are seed-cum-fertiliser drills, well designed plant protection equipments, dunlop-cart, trolley, threshers, sprayers and tractors. Availability of electric power which is the nucleus of all technological development, is imperative for multiple cropping and intensification of agriculture. As a matter of fact, electric power has a vital role in the development and diffusion of High Yielding Varieties. It supplies the mechanical power to tube-wells, pumping sets, threshers, crushers, grinders and chaff-cutters. Availability of cheap power for agriculture helps in the adoption of new technology. At present in India, tractors are being used for tillage, of 22.78 per cent of total arable area and sowing 21 per cent of total area (2010–2011).

6. Marketing and Storage Facilities

The infrastructural facilities, like roads, marketing and storage facilities are also very crucial for the successful cultivation of High Yielding Varieties. It is the transportation cost which determines the cropping pattern and crop intensity in given region. Once a village is linked with a town/market by a metalled (*pucca*) road, its economy undergoes a remarkable transformation. The farmers can market their produce with ease and are also able to purchase fertilisers, plant protection chemicals, and other agricultural equipments from the neighbouring town. Cultivation of perishable commodities like vegetables, fruits, flowers and dairy products can also be done efficiently and profitably if adequate transport and marketing facilities are available.

7. Extension Service

For the successful adoption and spread of High Yielding Varieties, there should be an efficient extension service which may guide and help the farmers about the various agricultural operations and precautions. The fuller use of inputs may be made only if proper guidance to the farmers is available. The cultivation of delicate and highly sensitive varieties needs the services of qualified and dedicated extension agents. In the tradition bound society of India, the efficiency of extension machinery determines largely the efficiency of the farmers. There should, therefore, be a perfect understanding and co-ordination between farmers, extension agents, farm supervisors, researchers, and agricultural scientists. Any slackness in the work of agricultural machinery may make agriculture a less profitable pursuit. It is a well-established fact that investment in research brings ten times profit to the investor.

8. Human Factor

In the adoption of High Yielding Varieties, the role of human factor is also very important. As a matter of fact, in many cases, man behind the machine becomes more important than the machine itself. Within an agricultural community, individuals vary in their receptivity to innovations and new agricultural techniques. The personal qualities of the farmers, education, progressiveness, attitude towards life, aspirations, life style and family values determine his capacity to adopt the new agricultural technology. There are innovative and progressive farmers within a village who perform better than their orthodox and less progressive brothers. In other words, in all societies, there are rational and irrational farmers. The progressive farmers have largely

improved their production and thereby their standard of living, while the conservative and less hard working farmers could not adopt the new agricultural technology successfully and they are in the grip of poverty and undernourishment.

The life style of the farmers and their aspirations for better standard of living also determine their efficiency. It is mainly because of the human factor that the agricultural income of the farmers, having almost the same size of holdings in a village, vary from each other. Human development of cultivators by focusing on education health and skill programmes is required at a priority basis.

Performance of the High Yielding Varieties

Green Revolution performed well in Punjab, Haryana and western Uttar Pradesh where the High Yielding Varieties were adopted first. The introduction of the High Yielding Varieties have increased the production of cereal crops substantially. For example, the total food production in 1950–51 was 97.3 million tonnes which rose to about 241.5 million tonnes in 2010–11. The production of rice was estimated 95.32 million tonnes and wheat 85.93 million tonnes (2010-2011). Thus, there was a substantial increase in the production of wheat and rice after the diffusion of the High Yielding Varieties in Indian agriculture.

Rice is the staple food for about 60 per cent of the total population of India. It is grown under diverse climatic and soil conditions. It, however, does not perform satisfactorily if the temperature falls below 20°C. Availability of moisture either from rains or from irrigation is, however, the main determinant of its cultivation. Rice cultivation is carried on in almost all parts of India except the un-irrigated tracts of Rajasthan, Malwa, Maharashtra and Gujarat. After the adoption of High Yielding Varieties, its cultivation has assumed great significance in the cropping structure of Punjab, Haryana, and western Uttar Pradesh (**Fig. 9.10 and Fig. 9.11**).

A comparison of **Fig. 9.10 and Fig. 9.11** shows that rice cultivation has been diffused substantially in the regions of Punjab, Haryana and Western Uttar Pradesh. Interestingly enough, the highest yields of rice are being obtained by the farmers of Punjab who are doing its cultivation with the help of canal and tube-well irrigation. In fact, controlled irrigation in these regions is helpful in achieving high yields per unit area. The percentage change in the area of rice, wheat and other main crops has been shown in **Table 9.10**.

Table 9.10 *Cropping Pattern in 2010–11*

Crops	*Area in million hectares*	*Percentage*
Rice	45.0	26.43
Wheat	29.25	16.10
Jowar	10.4	6.11
Bajra	8.8	5.16
Maize	6.4	3.76
Gram	6.3	3.70
Pulses	21.1	12.40

Source: ***Government of India, Ministry of Information: Production Division***, India (2012), New Delhi, pp. 71–78.

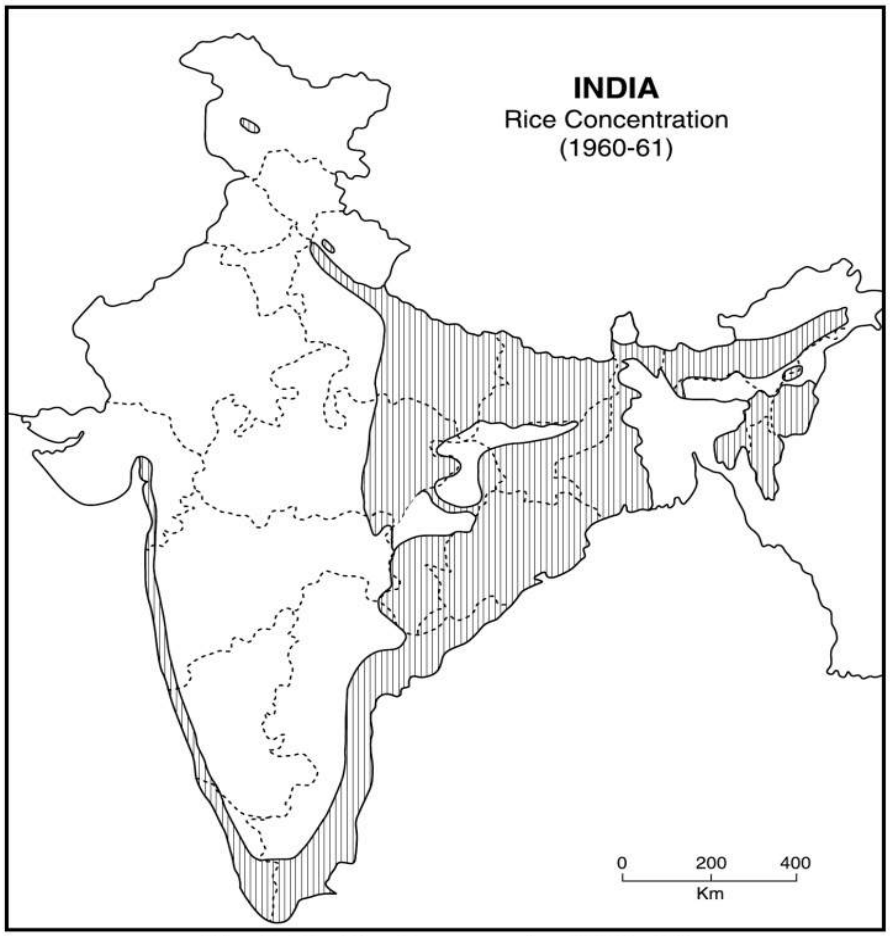


Fig. 9.10 Rice Concentration (1960–61)

It may be seen from **Table 9.10** that over 26 per cent of the total cropped area was under rice and 16 per cent under wheat in 2005–06. *Jowar* (millet), *bajra* (bulrush-millet), and *maize* occupied about 6%, 5%, and about 4% of the total cropped area respectively, while the share of pulses was over 12 per cent.

A comparative picture of cereals production in 1950–51 to 2005–06 has been given in **Table 9.11**:

Table 9.11 *Production of Cereals, 1950–51 to 2010–11 (in million tonnes)*

Crops	*1950–51*	*1970–71*	*2010–11*
Rice	30.8	37.6	95.32
Wheat	9.7	18.2	85.93
Pulses	12.5	13.4	28.0

(*Contd.*)

(*Contd.*)

Coarse-grains	15.5	31.4	30.0
Total cereals	78.2	101.7	341.0
Total food grains	97.3	124.3	241.56

Source: ***Ministry of Agriculture and Economic Survey***, 2010–11, and India 2012.

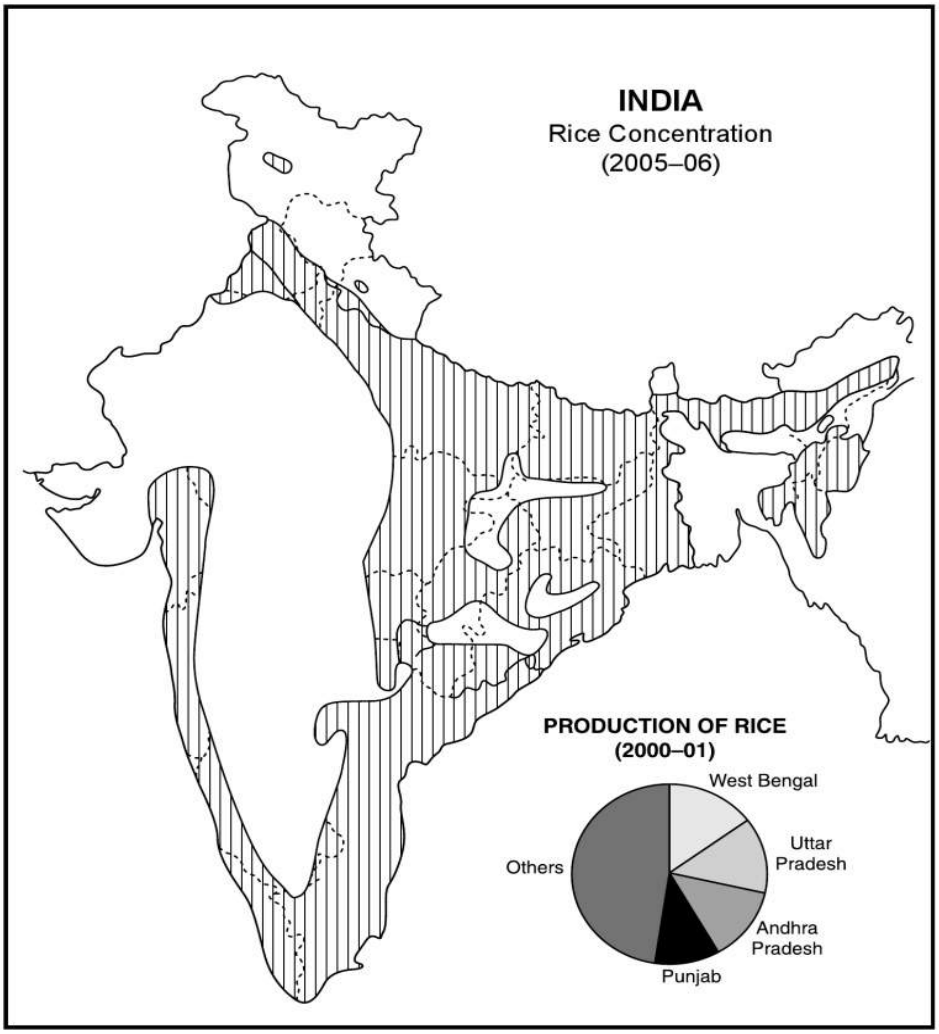


Fig. 9.11 Rice Concentration (2005–06)

It may be seen from **Table 9.11** that the production of rice in the country has increased from 30.8 million tonnes in 1950–51 to about 95.32 million tonnes in 2010–11. Although, the production of rice has increased in all the states of the country, it has recorded a phenomenal increase in the states of Punjab and Haryana, mainly because of the adequate and controlled irrigation which are imperative for its cultivation.

Recently, the Indian Rice Research Institute has discovered new varieties of rice that are capable of producing 6–7 tonnes of rice per hectare. This is about three times the average production of rice per hectare.

Wheat is the second most important staple food in India after rice. It contributes about 34 per cent of the total food grain production in the country. The regional distribution of wheat during the Pre-Green Revolution and Post-Green Revolution periods have been shown in **Fig. 9.12 and Fig. 9.13,** while **Table 9.11** shows the growth of its production.

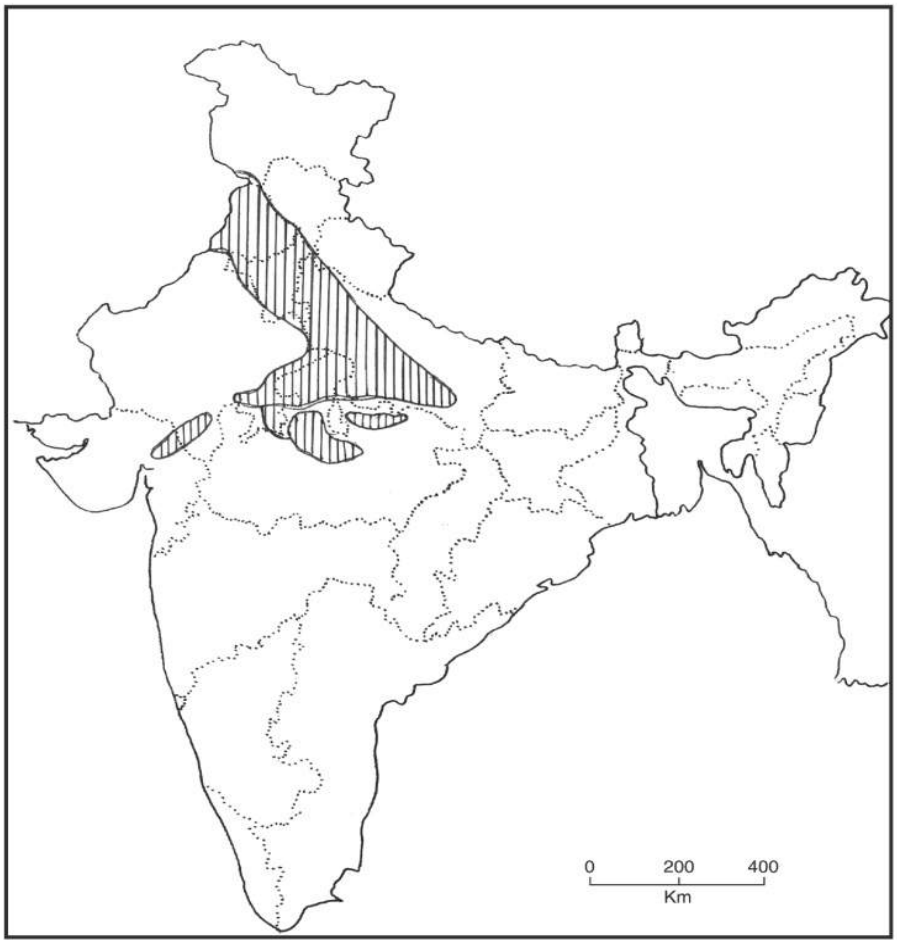


Fig. 9.12 Wheat Concentration (1960–61)

It may be observed from **Table 9.11** that wheat is the only crop in which the production has increased to the maximum. The production of wheat has gone up 85.93 million tonnes in 2010–11 as against only 9.7 million tonnes in 1950–51.

The regional pattern of wheat distribution shows an overall expansion of wheat area from the Ganganagar District of Rajasthan in the west to Dimapur (Nagaland) in the east, and from the Suru and Nubra Valleys (tributaries of the Indus in Ladakh) in the north to Maharashtra, Andhra Pradesh, and even Karnataka in the south **(Fig. 9.12).**

Looking at the spread of wheat and its excellent performance in the Satluj-Ganga Plains, it may be said that Green Revolution is most successful in the case of wheat. It is because of its high production that wheat has become a commercial crop in Punjab, Haryana and Western Uttar Pradesh.

It may be observed from the **Fig. 9.14** that Punjab, Haryana, and western Uttar Pradesh have emerged as the areas of major concentration of rice, while wheat has been diffused in all the directions from its traditional heartland of the north-west India.

Among the other crops, the area yield and production of maize and *bajra* have gone up. The area and production of pulses have, however, could not have any significant impact of Green Revolution.

Green Revolution and Rotation of Crops

In India, rotation of crops is practiced by most of the farmers. The main objective of rotation of crops is to obtain higher agricultural returns on the one hand and to maintain the soil fertility on the other. Thus, rotation of crops helps in making agriculture sustainable. The importance of rotation of crops is more in the areas where the farmers grow two or more than two crops in a year in the same field.

Prior to the Green Revolution most of the Indian farmers were subsistent in character, growing crops mainly for the family consumption. In the areas, where Green Revolution is a success, agriculture has become agri-business and market oriented in which the farmers are concentrating on a few number of crops. Most of the farmers are devoting their lands in the Green Revolution areas to rice in the kharif season and wheat in the rabi season. Both these staple crops are soil exhaustive. The area under leguminous crops has shrunk and the farmers have given up their empirical practice of fallowing to recuperate soil fertility. The rotation of crops of some of the villages from western Uttar Pradesh and Haryana, where Green Revolution is a success have been given in **Table 9.12**.

Table 9.12 *Traditional Rotation of Crops (1960–65) in Banhera (Tanda) Village, District Hardwar*

Year	*Kharif Season (Mid-June to Mid-October)*	*Rabi Season (Mid-October to Mid-April)*	*Zaid Season (April-June)*	*No. of days land left fallow*
1960	Millet/fodder/rice	Gram	Fallow	90
1961	Fallow	Wheat	Fallow	210
1962	Millet/fodder/rice	Gram	Fallow	90
1963	Fallow	Wheat	Fallow	210
1964	Millet/fodder/rice	Gram	Fallow	90
1965	Fallow	Wheat	Fallow	210

Source: ***Field work by the author,*** 1960–65.

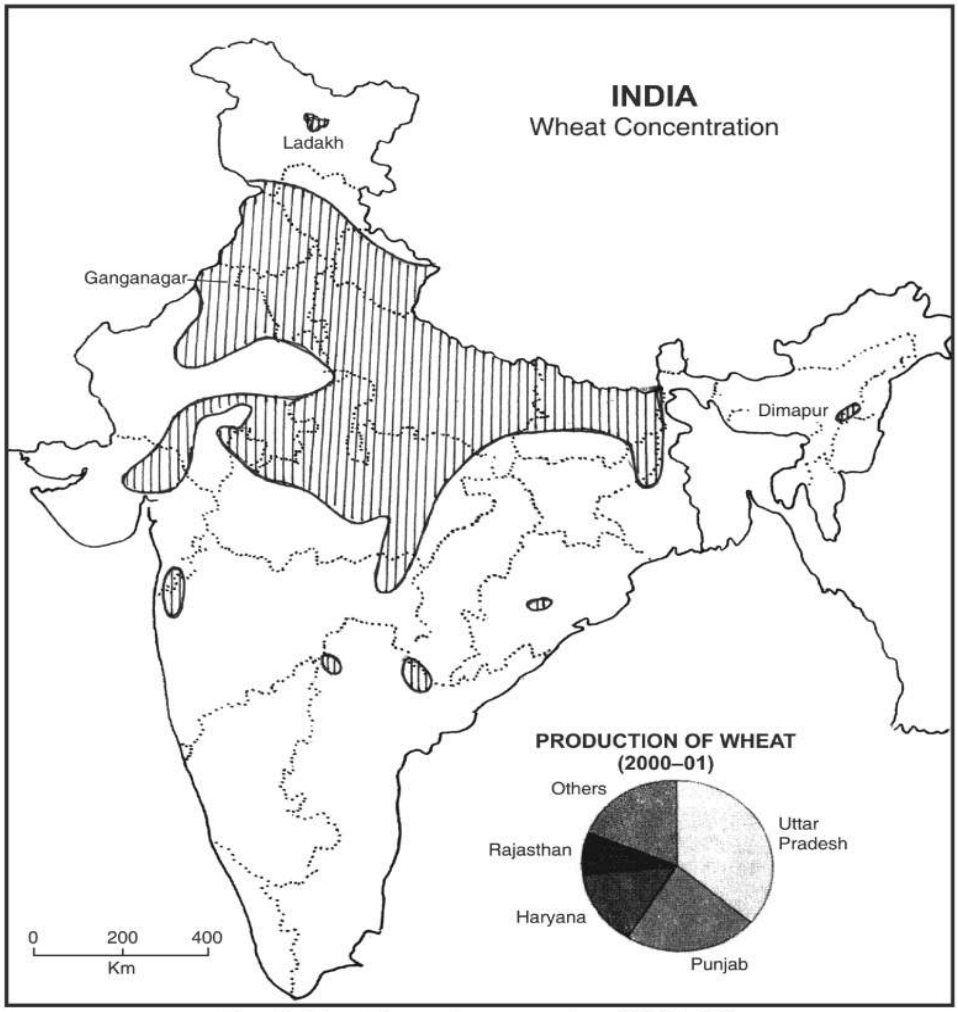


Fig. 9.13 Wheat Concentration (2005–06)

It may be observed from **Table 9.12** that fallowing was an important practice each year in Western Uttar Pradesh before the adoption of the High Yielding Varieties. Moreover, wheat and gram (a leguminous crop) used to be sown in the same field in alternate years. This type of rotation of crops was helpful in maintaining the fertility of the soil.

Under the pressure of growing population on arable land, the adoption of new seeds have resulted in a new pattern of rotation of crops, which has been given in **Table 9.13.**

In the new rotation of crops, the farmers are largely concentrating on the cultivation of High Yielding Varieties of rice and wheat, and depending on the circumstances, they grow a cash crop of sugarcane. All these crops are soil exhaustive. Moreover, the fallowing practice has been abandoned.

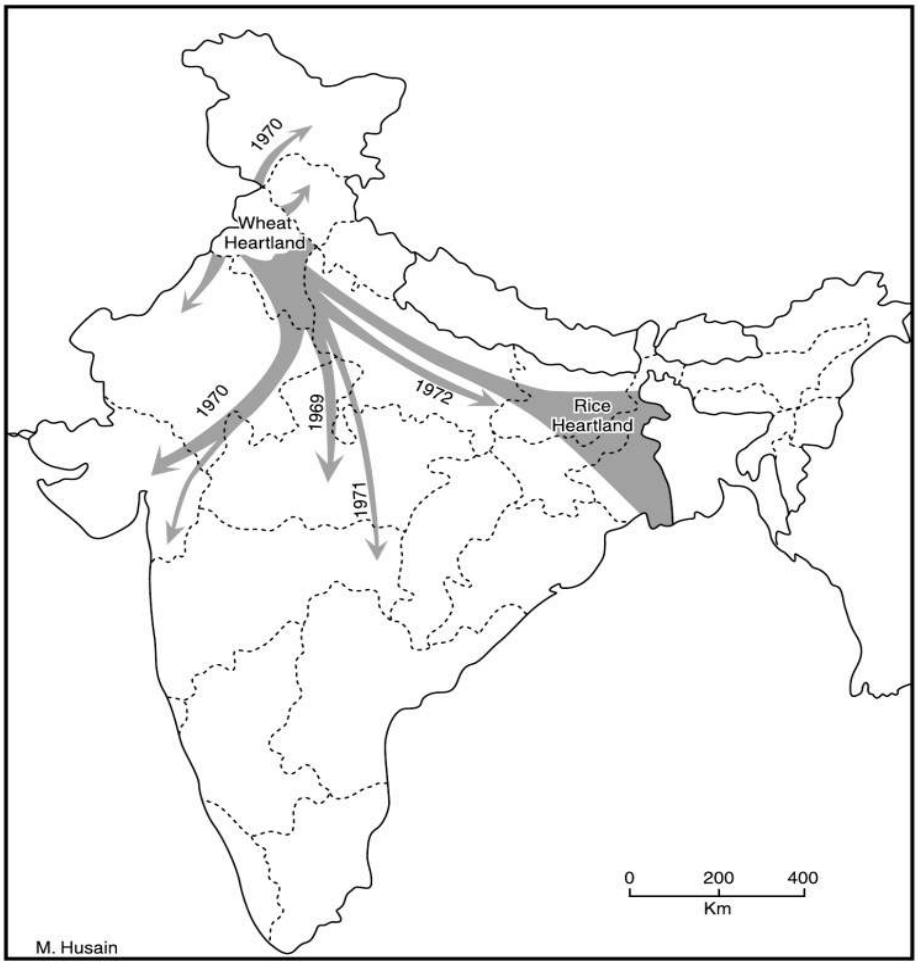


Fig. 9.14 Diffusion of High Yielding Varieties of Rice and Wheat

Table 9.13 *Rotation of Crops in 2005–06 in Village Banhera (Tanda) Village, District Hardwar*

Year	*Kharif*	*Rabi*	*Zaid*	*No. of Fallow Days*
2000	Rice	Wheat	Fodder	20
2001	Rice	Wheat	Fodder	5
2002	Rice	Wheat	Fodder	20
2003	Rice	Wheat	Fodder	5
2004	Sugarcane	Sugarcane	Sugarcane	20
2005	Sugarcane	Sugarcane	Sugarcane	5
2006	Rice	Wheat	Fodder	20

Source: ***Field work by the author,*** 2000–06.

Green Revolution and Regional Inequalities

The High Yielding Varieties adopted under the new agricultural strategy are quite delicate and highly sensitive which require the timely application of costly inputs (water, fertilisers, insecticides, and pesticides). Moreover, they perform better in the areas where infrastructural facilities (electricity, irrigation, and roads) are adequately available. Contrary to this, the areas of extreme climate (precipitation and temperature) where controlled irrigation is not available the new seeds are not performing satisfactorily. This has created regional imbalances in the agricultural development in the irrigated and unirrigated parts of the country.

Intra-Regional Inequalities

The adoption of High Yielding Varieties have created intra-regional inequalities also. All the farmers, even in the states of Punjab, Haryana, western Uttar Pradesh and Kaveri Delta have not been benefited equally. It is the large, progressive and educated farmers who gained much from the High Yielding Varieties. The early adopters reaped much dividends from the new seeds. By the time the majority came to adopt the new seeds, income gains realised by the early adopters generally disappeared. The average, small and marginal farmers could not gain much, while the late adopters gained almost nothing.

Thus, the High Yielding Varieties have had a discriminatory impact in which the large and early adopters were benefited and the small and marginal farmers who adopted these seeds late could not achieve much.

Intercrop Disparities

The production and productivity of wheat, rice, maize and bajra have gone up. There are however, several cereal and cash crops (pulses, small millets, barley, oilseeds) which are not performing satisfactorily. It is in the case of *kharif* pulses where the performance needs much improvement. Development of High Yielding Varieties of pulses for each of the agro-climatic region is the pressing need of the day.

Impact of Green Revolution on Farmers and Landless Labourers

When the package programme for the development of agriculture to increase agricultural production was introduced in the mid-sixties, it was expected that the new seeds will be neutral to the scale. This assumption has, however, been proved wrong as the new seeds are no longer scale neutral.

In India, there are four categories of farmers, i.e. (i) large farmers, (ii) medium farmers, (iii) small farmers, and (iv) marginal farmers. Each one of them has not been equally benefited from the new seeds. It would be worthwhile to examine the impact of Green Revolution on the various categories of farmers and the dependent labourers.

Large Farmers

The definition of large farmer differs from state to state in India. For example, a farmer having 10 acres in Kerala is a large farmer, while in Rajasthan, Punjab and Haryana he falls under the category of medium or small farmer. All the studies conducted in areas where Green Revolution is a success show that the large farmers have been the main gainers of the package programme. In the initial phase of the Green Revolution, the large farmers were able to adopt the High Yielding Varieties easily. The new varieties increased their savings, both to buy machinery that can

displace labour and to purchase more land of the marginal and small farmers. This trend increased the income base of those who were already relatively well off and better placed in society. The large farmers, in fact, are in a position to make the best use of tractors, threshers, and sprayers. They installed tube-wells and pumping sets for an effective utilisation of underground water. For the purchase of agricultural machinery and installation of tube-wells and other costly inputs, credit was necessary. Since the large farmers have more risk taking capacity, they could modernise their agriculture easily. Small and marginal farmers being constrained by financial resources could not adopt the High Yielding Varieties in the early phase of their diffusion. Consequently, they lagged behind in the adoption of new seeds.

In general, the complexity of farming increases with multiple cropping as more inputs and timely operations are required for good harvests. Intensification of agriculture and multiple cropping means more risk on the part of the cultivator. The agrarian institutions, credit agencies, and extension service, generally serve the large and powerful farmers as a result of which the small and marginal farmers are deprived of adequate inputs so essential for the successful cultivation of High Yielding Varieties. The big farmers who have close connections with the money economy and influential political persons are able to complete their agricultural operations more easily than the small farmers who rely on family labour for agricultural operations. This process accentuated the income inequalities in the rural society and led to polarisation of rural masses.

Small Farmers

The small farmers generally have less than two acres of land in most of the states of India. These farmers are not well placed technologically and financially. Moreover, they do not have an easy access to the credit agencies. For the irrigation of their crops, they have to depend on the tube-wells of large farmers. It has been observed that at the time of peak irrigation demand, the tube-well owners (large farmers) either do not give water to the small farmers or they charge exorbitantly for the water, which is often beyond the reach of small farmers. In the absence of timely irrigation, the crops of the small farmers suffer adversely. Over a period of time, small and marginal farmers, by taking the advantage of rising land prices, sell out their land and attempt a new start in life.

Moreover, the agrarian institutions which are supposed to assist the small and marginal farmers, are not very helpful. The credit agencies as stated above, are serving largely the big farmers who are economically well off and politically powerful. The big farmers could easily pre-empt for their own use the bulk, if not, the entire supply of costly inputs like electricity, water, fertilisers, insecticides, and pesticides. Thus, the poor farmers have been deprived of enough inputs so essential for the successful cultivation of the High Yielding Varieties of crops.

Tenant Farmers

The diffusion of High Yielding Varieties also affected the tenant farmers adversely. In general, the tenant farmers have a low tendency to adopt the new innovations in their cropping patterns as they are not very sure for how long the land will be available to them for cultivation. The difficulties of tenant farmers have multiplied by the astronomical rise in the value of land in recent decades. The tenants want to lease more land while land owners are reorganising the gains to be achieved by direct management of their fields. Under these circumstances, the landlords are reluctant to get into a position where their tenants might be given title of the land. Numerous evasive tactics have been adopted by the landlords. Some of them have directly evicted their tenants from establishing

security of tenure by shifting them frequently. In the absence of more effective land reforms, the prospect is for large number of tenant farmers to join the rank of landless labourers. Compelled by financial constraints, they migrate to big cities in search of employment and to start a new career.

Landless Labourers

One of the assumptions of the High Yielding Varieties that they will generate more employment could also not be achieved. Undoubtedly, the wages of the unorganised agricultural workers have risen by about 20 times. In the areas where Green Revolution is a success, the labourers are finding employment throughout the year, while in many areas the rural employment has declined. The main cause of decline in labour employment is the natural growth of labour and mainly because of the mechanisation of agriculture by the big farmers which displaces labour.

The impact of Green Revolution has been shown in **Table 9.14.** It may be observed from this Table that the large farmers who have better risk taking capacity adopted High Yielding Varieties quickly. They installed tube-wells and pumping sets in their fields and purchased tractors, threshers and harvesters, etc. from the loans they got from the funding agencies and co-operative societies. Consequently, their production and productivity went up substantially. Better income helped them in improving their food and nutrition. Improvements also occurred in their housing. Realising the importance of education, many of them sent their children to the English medium schools of the neighbouring towns and cities. The economic prosperity also made them increasingly conscious about health and sanitation. It was at this stage that some of the big farmers started desiring small families. These steps led to a decline in the fertility rate of big farmers which ultimately reduced their dependency ratio.

Moreover, the economic prosperity and interaction with the well-off urban people inspired them to construct elegant and spacious *pucca* houses. They started consuming more comfort and luxury goods, which in a sense, brought consumerism in the rural society of the regions of successful green revolution.

The traditional farmer became economic farmer who stated thinking all the time in terms of optimising his profit. Being too busy and conscious of the value of his time, he started ignoring the interest of the neighbours and small farmers. On the other hand, he started purchasing the agricultural land of the small and marginal farmers. This broke the well establish reciprocal aid system and *bhai-chara* (brotherhood) in the village community. With better agricultural income, the standard of living of the farmers went up, their longevity increased and life became more enjoyable.

Contrary to this, the small and marginal farmers, having less risk-taking capacity, could not adopt the High Yielding Varieties rapidly as they did not like to mortgage their lands for obtaining loans from the funding agencies and the money lenders. Their production and productivity increased only marginally. Consequently, there was no improvement in their food, nutrition, education, sanitation and health. Being poor, they could not afford to bear the expenses of school education and thought it better to engage their children in agriculture. Realising the importance of additional hands, these farmers have no desire of small families and did not adopt family planning. Being under debt, poor nutrition, and mental stress they could not maintain their health and many of them, unfortunately, committed suicide.

Under the changed socioeconomic conditions, the income gap between the big and small farmers increased. This broke the traditional rural society and divided them into the rich and the poor. The social tension increased leading to the polarisation of the society. The social implications of Green Revolution has been given in a tabular form in **Table 9.14:**

Table 9.14 *Impact of Green Revolution on Big and Small Farmers*

Big Farmers	*Small and Marginal farmers*
Fast adoption of High Yielding Varieties	Slow adoption of High Yielding Varieties
Rapid increase in agricultural productivity and production	Little increase in agricultural productivity and production
Improvement in:	*Little or no improvement in:*
Food and nutrition	Food and nutrition
Housing	Housing
Education	Education
Sanitation	Sanitation
Health	Health
Some of the big farmers went for family planning	No or little desire for smaller family
Decrease in dependency ratio	Little or no family planning Increase in dependency ratio
Increase in the consumption of comfortable and luxury goods	Little or no improvement in consumption
Multiplication of immovable assets	Decrease in immovable assets
Better standard of living	Decline in standard of living
Increase in longevity	Little or no increase in longevity
Big farmers became rich	Small farmers became poor
Polarisation of the rural society	Small farmers united
Increase in social tension	Increase in social tension

Source: ***Fieldwork by the author***, 1962-63 and 2011-12.

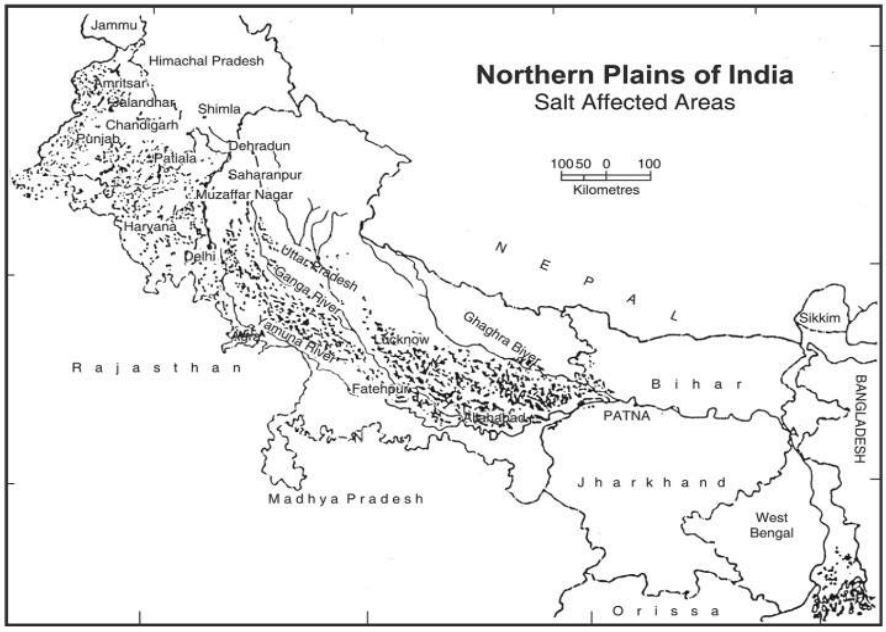
Environmental and Ecological Implications of Green Revolution

Some of the environmental and ecological problems that emerged out of the cultivation of the High Yielding Varieties are depletion of forests, reduction in pastures, salination, water-logging, depletion of underground water-table, soil erosion, change in the soil chemistry, reduction in bio-diversity, decline in soil fertility, silting of rivers, increase in weeds, emergence of numerous new plant diseases, and health hazards. An overview of these environmental and ecological problems has been given here.

1. Salination

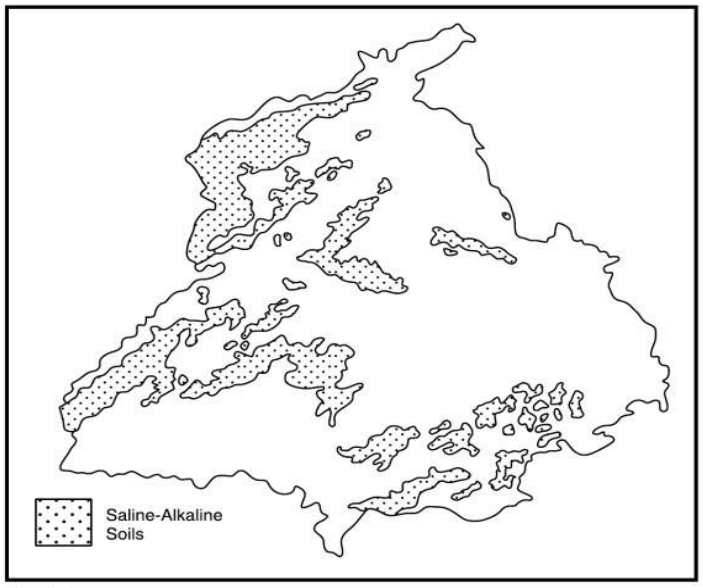
The High Yielding varieties of rice and wheat require several waterings, especially in an area like Punjab and Haryana in which the average annual rainfall is about 65 cm. The continuous supply of moisture through irrigation during the summer and winter seasons have changed the soil chemistry. In the arid and semi-arid areas, owing to capillary action, the soils are becoming either acidic or alkaline. The saline and alkaline affected tracts, locally known as *kallar* or *thur* in Punjab and *kallar* or *reh* in Uttar Pradesh have expanded and increased in area. According to one estimate, about 50 per cent of the total arable land of Punjab and Haryana has been harmed by soluble salts. The saline and alkaline affected areas have been shown in **Fig. 9.15 and Fig. 9.16.**

It may be observed from **Fig. 9.15 and Fig. 9.16** that some of the best agricultural tracts have been adversely affected and rendered useless from the agricultural point of view**.** If the existing pattern of crops and their rotation is not changed more agricultural land may become unproductive.



Source: Waste Land Map of India, 1980–82 Prepared by N.R.S. a Govt. of India

Fig. 9.15 Satluj–Ganga Plain: Salt Affected Land



Source: Punjab Agri Univ. Ludhiana

Fig. 9.16 Punjab—Soil Salinity

The problem of salinity and alkalinity can be solved by use of manure (cowdung, compost, and green manure) and by a judicious selection of leguminous crops in the rotation. Cultivation of salt tolerant crops like barley, sugar-beet, salt grass, asparagus, spinach, and tomato may also help to a great extent and may improve the fertility of such lands.

2. Waterlogging

Water logging is the other major problem associated with over-irrigation. In all the canal irrigated areas of Punjab, Haryana, and western Uttar Pradesh, waterlogging is a serious problem. The Indira Gandhi Canal command area is a recent example in which waterlogging is progressively becoming a serious menace to the arable land. Several thousand acres of productive agricultural land and pastures in the districts of Ganganagar, Bikaner, and Jaisalmer (Rajasthan) have been submerged under water (**Fig. 9.17**). The progressive and ambitious cultivators of the irrigated areas of these districts have changed their cropping patterns and have introduced rice and wheat in place of bajra, pulses, cotton, and fodder. Repeated irrigation of these crops in the summer and winter seasons have resulted into waterlogged condition, especially along the canals.

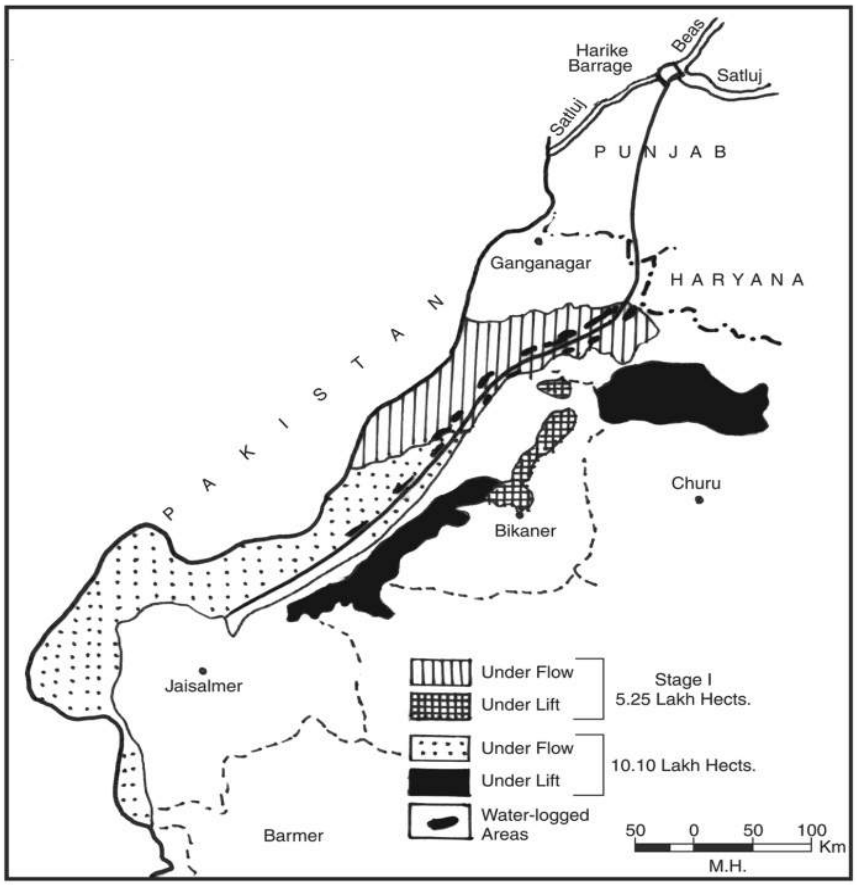


Fig. 9.17 Indira Gandhi Canal Command Area

3. Soil Erosion

Soil erosion is a universal phenomena. It may be observed to some extent in all parts of the country, its intensity, however, is more in the arid, semi-arid, and mountainous areas. The presence of forests reduces the danger of soil erosion significantly. In recent years, the agricultural area has been expanded by indiscriminate felling of trees. The increase in the rate of soil erosion is not only damaging the agricultural lands, it is also affecting adversely the areas where the eroded soil is deposited.

In order to minimise the danger of soil erosion, afforestation is imperative. Moreover, the farmers should apply more manures and develop wind breakers in the desert areas. Development of terraces in the hills, leveling of gullies, and contour ploughing in the hilly areas can also go a long way in reducing soil erosion.

4. Pollution

The High Yielding Varieties perform better if heavy doses of chemical fertiliser, insecticides, and pesticides are applied. Application of heavy doses, of these inputs destroy the micro-organisms which are so necessary to maintain the fertility of the soil. The use of manures in place of chemical fertilisers can go a long way in overcoming the problem of soil pollution.

5. Lowering of the Underground Water-Table

The High Yielding Varieties of rice and wheat are water-relishing crops. Rice, being sown in the low rainfall recording area of Punjab and Haryana, demands several irrigations and same is the case with wheat crop. The continuous lifting of water through tube-wells and pumping sets has lowered the water Table in the eastern districts of Haryana (**Fig. 9.18**). Many farmers have to lower their tube-wells in the years of inadequate monsoon rainfall. If the cropping pattern is not changed, and irrigation of rice and wheat continues at the present level, the underground water-table may not be sufficiently recharged and may get substantially depleted. In opposition to this, the underground

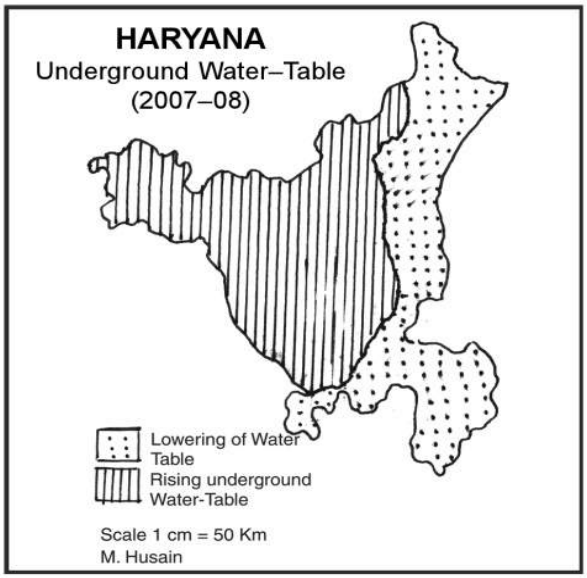


Fig. 9.18 Haryana Green Revolution and Underground Water-Table (2007–08)

water-table in western Haryana is rising as there is a gypsum layer in that part of the state which does not permit the percolation of water through this layer. The watertable in the Jhajjar District of Haryana has risen significantly. The crops of millets, bajra, arhar are damaged. In fact, people in this district pray for drought so that the waterlogged areas may be sown. Consequently, there are water-logged conditions in several tracts in the western parts of Haryana. This rise in the water-table is resulting into capillary action, leading to the occurrence of saline and alkaline formations.

6. Deforestation

There had been heavy felling of trees to bring the forest area under cultivation. In Punjab and Haryana, less than 5 per cent of their area is under forest. This is affecting the environment and ecology adversely.

7. Noise Pollution

The change in the agricultural technology, the use of tractors, terracers, harvesters, threshers, and crushers have increased noise pollution which have disturbed the rural tranquility.

8. Health Hazards

Application of heavy doses of insecticides, pesticides, and chemical fertilisers are health hazards. The application of these poisons on vegetables, fruits and grasses are health hazards. The Indian Council of Medical Research established that traces of lead, zinc and copper are found in the milk and vegetables on which the fertilisers, insecticides, and pesticides are sprayed.

The recurrence of malaria in irrigated tracts of arid and semi-arid regions of Rajasthan and Punjab is the result of heavy irrigation and water-logged tracts along the canal which have become the breeding grounds for mosquitoes **(Fig. 9.19).**

Green Revolution—Achievements

The diffusion of High Yielding Varieties has transformed the rural landscape. The main achievements of Green Revolution may be summarised as under:

1. The production and productivity of wheat, rice, maize, and *bajra* has increased substantially.
2. India has become almost self sufficient in the matter of staple foods.
3. The double cropped area has increased, thereby intensification of the Indian agriculture has increased.
4. In the areas where Green Revolution is a success, the farmers have moved from subsistent to market oriented economy, especially in Punjab, Haryana, western Uttar Pradesh, and the plain districts of Uttarakhand (Hardwar and Udhamsinghnagar).
5. The adoption of High Yielding Varieties under the Green Revolution has generated more rural and urban employment.
6. Green Revolution has increased the income of farmers and landless labourers, especially that of the big farmers and the semi-skilled rural workers. Thus Green Revolution has increased rural prosperity.
7. Green Revolution has created jobs in the areas of biological (seed fertilisers) innovations, and repair of agricultural equipments and machinery.

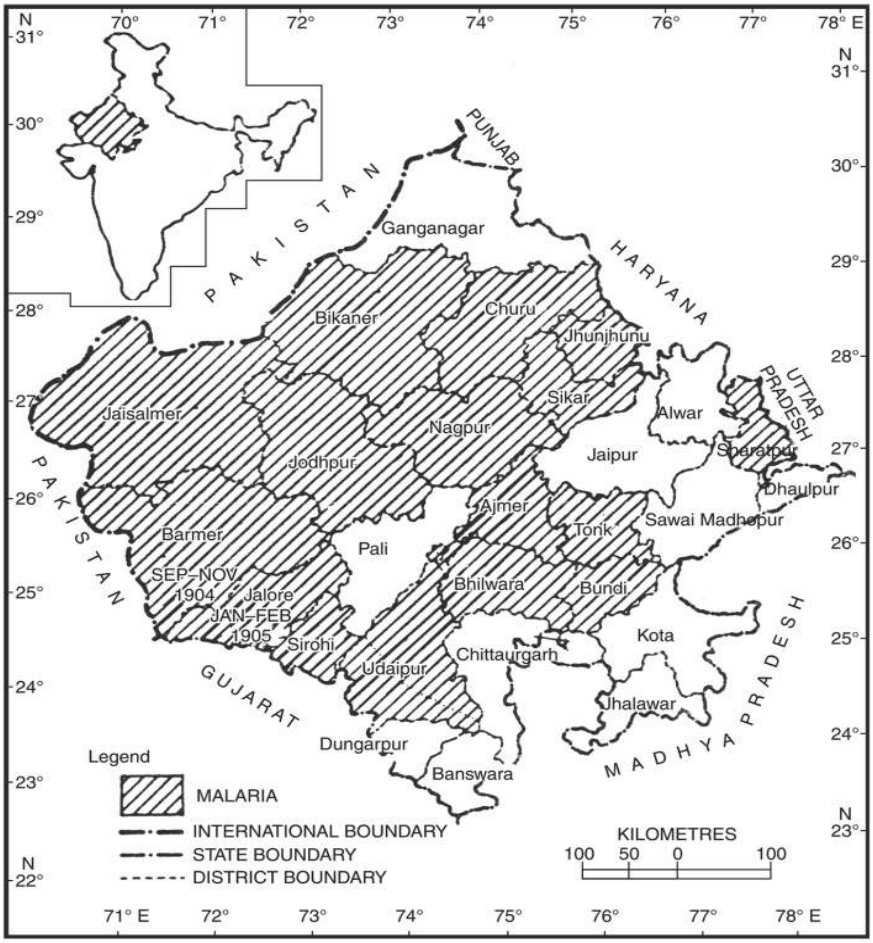


Fig. 9.19 Rajasthan—Malaria Affected Areas

Green Revolution—Problems and Prospects

1. Depletion of soil owing to the continuous cultivation of soil exhaustive crops like rice and wheat.
2. Depletion of underground water table due to over-irrigation of more moisture requiring crops like rice and wheat.
3. Green Revolution has increased the income disparity amongst the farmers.
4. Green Revolution led to polarisation of the rural society. It has created three types of conflicts in the rural community, namely, between large and small farmers, between owner and tenant farmers, between the employers and employees on agricultural farms.
5. Green Revolution has displaced the agricultural labourers, leading to rural unemployment. The mechanical innovations like tractors have displaced the agricultural labour.
6. Agricultural production in the Green Revolution areas is either stationary or has shown declining trend.

7. Some valuable agricultural lands have submerged under water (water-logging) or are adversely affected by salinity and alkalinity.
8. Green Revolution is crop specific. It could not perform well in the case pulses and oil-seeds.
9. The traditional institution of *Jijmani system* has broken. Consequently, the barbers, carpenters, iron-smith, and watermen have migrated to the urban areas.
10. The soil texture, structure, soil chemistry, and soil fertility have changed.
11. About 60 per cent of agricultural land in the country remains unaffected by Green Revolution.
12. Green Revolution technologies are scale neutral but not resource neutral.
13. Punjab feeds the nation but farmers in the state, especially in the Malwa region fall prey to cancer. The take 'Cancer Train' to Bikaner for cheap treatment.

SECOND GREEN REVOLUTION

The overall production of the cereal and non-cereal crops has reached almost the plateau stage. The growth rate of agricultural sector is only about two per cent. Looking at the growing demand of agricultural produce, there is an urgent need for undertaking agriculture to a higher trajectory of four per cent annual growth rate. In order to achieve these objectives, various governments have undertaken important steps towards agricultural reforms. These reforms aim at efficient use of resources and conservation of soil, water and ecology on a sustainable basis, and in holistic framework. The main objectives of the second Green Revolution are: (i) To raise agricultural productivity to promote food security (ii) More emphasis on bio-technology (iii) To promote substainable agriculture (iv) To become self sufficient in staple food, pulses, oil seeds, and industrial raw material (v) To increase the per capita income of the farmers and to raise their standard of living. The holistic framework, thus, must incorporate financing of rural infrastructure such as irrigation, roads and power.

The Eleventh Five-Year Plan has aptly highlighted such a holistic framework and suggested the following strategy to raise agricultural output:

1. Doubling the rate of growth of irrigated area.
2. Improving water management, rainwater harvesting, and watershed development.
3. Reclaiming degraded land and focusing on soil quality.
4. Bridging the knowledge gap through effective extension.
5. Diversifying into high value outputs, e.g. fruits, vegetables, flowers, herbs and spices, medicinal plants, bamboo, bio-diesel, but with adequate measures to ensure food security.
6. Providing easy access to credit at affordable rate of interest.
7. Improving the incentive structure and functioning of markets, and
8. Refocusing on land reforms issues.
9. Laying emphasis on the cultivation of pulses. With the limited availability of pulses overseas, development of hybrid varieties becomes a pre-requisite for increasing domestic production.
10. Focusing on the development of area specific seeds and their application.
11. Attention has to be focused on areas such as rainfed, drought-prone crops, and drought resistant crops, and those amenable to biotechnological application.

The National Commission on Farmers has already laid the foundation for such a framework. Moreover, the National Agricultural Innovation Project initiated in July, 2006, for enhancing livelihood security in partnership mode with farmers' groups, Panchayati-Raj institution and private sector would go a long way in strengthening basic and strategic research in frontier agricultural sciences.

WHITE REVOLUTION

The package programme adopted to increase the production of milk is known as White Revolution in India. The White Revolution in India occurred in 1970, when the National Dairy Development Board (NDDB) was established to organise the dairy development through the co-operative societies. Prof. Verghese Kuerin was the father of White Revolution in India. The dairy development programme through co-operative societies was first established in the state of Gujarat. The co-operative societies were most successful in the Anand District of Gujarat. The co-operative societies are owned and managed by the milk producers. These co-operatives apart from financial help, also provide consultancy. The increase in milk production has also been termed as ***Operation Flood***. Varghese Kurien (1921-2012) who is considered as the 'Father of White Revolution in India' was one of world's great agricultural leaders of the 20th century.

Objectives

1. The main objectives of the co-operative society is the procurement, transportation, storage of milk at the chilling plants.
2. To provide cattle feed.
3. The production of wide varieties of milk products and their marketing management.
4. The societies also provide superior breeds of cattle (cows and buffaloes), health service, veterinary treatment, and artificial insemination facilities.
5. To provide extension service.

The technology of White Revolution is based on an extensive system of co-operative societies. Milk, after being collected at a village collection centre, is promptly transported to the dairy plant at the milk chilling centre. Timing of collection is rigidly maintained by the village society, truck operators, and the quick transport to the dairy plants. Milk tankers, each, normally carry 14,000 litres of milk. The chilling centres are managed by producers' co-operative unions to facilitate the collection of milk from producers who live at some distance from the chilling centres and thus, the middlemen are eliminated.

Phases of the White Revolution

The White Revolution may be examined under the following three phases:

Phase I (1970–81)

During this period, the dairy development programme was set up in ten states to provide milk to the cosmopolitan cities, i.e. Mumbai, Kolkata, Delhi, and Chennai. The important step in this phase was the setting up of 4 Mother Dairies in Mumbai, Kolkata, Delhi, and Chennai.

Phase II (1981–85)

During this phase, the dairy development programme was extended in the states of Karnataka, Madhya Pradesh, and Rajasthan. In this phase, within 25 contiguous milk-shed areas (in 155 districts) a cluster of milk producers' union was established. The Research Institute at Hyderabad developed a vaccine called 'Raksha' to control cattle diseases. The programme also involved the improvement in milk marketing in 144 more cities of the country. The Dairy Co-operative societies were set up in 35,000 villages and the membership exceeded 36 lakhs.

Phase III (1985–2000)

A number of co-operative societies were set up in most of the major states of the country and the number of co-operatives went up by 1,35,439 with a membership of 14 million. The following table 9.16 shows the spurt in milk production in India.

Table 9.15 *The Phenomenal Increase in Milk Production in India—1950–51 to 2005–06*

Year	*Milk Production in million tonnes*	*Per capita availability grams/day*
1950–51	17.0	124
1960–61	20.0	126
1970–71	22.0	128
1980–81	31.6	128
1990–91	53.9	176
2000–01	80.6	220
2005–06	97.1	241
2009–10	112.54	263

Source: ***Govt. of India, India 2012***, p. 109.

Achievements

White Revolution is as important to dairy development as Green Revolution has been to grain production. Its outcome is based on the improvement in cattle breeding and adoption of new technology.

Today, India has earned the first position in milk production in the world. In 2009–10, livestock sector produced 112.54 million tonnes of milk as compared to 54 million tonnes in 1990-91. (**Table 9.15**). Dairying has become an important role in providing employment and income generating opportunities. The contribution of milk alone in 2005–06 was over 1.25 trillion, which is much higher than that of paddy (0.75 trillion). The statewise distribution of milk production has been shown in **Fig. 9.20**. It may be observed from this figures that Gujarat, Maharashtra, U.P., Punjab, Haryana, Madhya Pradesh, Rajasthan, West Bengal, Andhra Pradesh, Karnataka, and Tamil Nadu are the main milk-producing states of the country.

Some of the important achievements of the White Revolution are as under:

1. The White Revolution made a sound impact on rural masses and encouraged them to take up dairying as a subsidiary occupation.
2. India has become the leading producer of milk in the world. The milk production that was about 17 million tonnes in 1950–51 rose to over 112 million tonnes in 2009–10. The production of milk has gone up by more than six times when compared with that of the Pre-Independence situation.
3. The per capita availability of milk per day at present is about 263 gm as against 125 grams before the White Revolution.
4. The import of milk and milk production has been reduced substantially.
5. The small and marginal farmers and the landless labourers have been especially benefitted from the White Revolution. About 14 million farmers have been brought under ambit of 1,35,439 village level dairy co-operative societies. At present (2012), there are 200 million litres across India producing 20 million litres of milk every day.
6. To ensure the success of Operation Flood Programme, research centres have been set up at Anand, Mehsana, and Palanpur (Banaskantha). Moreover, three regional centres are

functioning at Siliguri, Jalandhar, and Erode. Presently, there are metro dairies in 10 metropolitan cities of the country, beside 40 plants with capacity to handle more than one lakh litres of milk.

7. Livestock Insurance Scheme was approved in February 2006 and in 2006–07 on a pilot basis in 100 selected districts across the country. The scheme aims at protecting the farmers against losses due to untimely death of animals.
8. To improve the quality of livestock, extensive cross breeding has been launched.
9. For ensuring the maintenance of disease-free status, major health schemes have been initiated.
10. The government implemented livestock insurance on pilot basis in 2005–06.

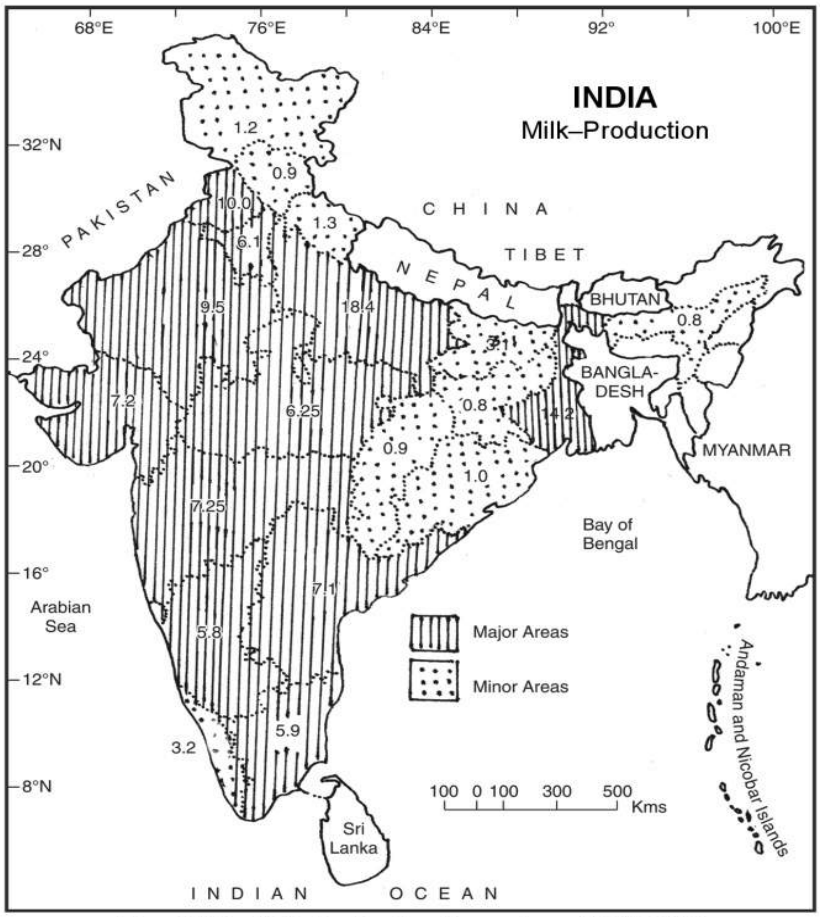


Fig. 9.20 Milk Production Percentage (2007–08)

The All India Summary Reports of the 17th Livestock Census released in July 2006 points out that India possesses the largest livestock population in the world after Brazil. It accounts for about 56 per cent of the cattle population of the world's buffalo population and 14 per cent of the cattle population. It ranks first in respect of buffalo and second in respect of cattle population, second in goat population and third in respect of sheep in the world.

Problems and Prospects

Some of the important problems of the White Revolution are as under:

1. Collection of milk from the remote areas is expensive, time consuming, and not viable economically.
2. In most of the villages the cattle are kept under unhygienic conditions.
3. There are inadequate marketing facilities. The marketing infrastructure needs much improvement.
4. The breeds of cattle is generally inferior.
5. The extension service programme is not effective.

In India, dairy development has a great future. It should take the advantage of liberalisation in the global trade and should try to capture international market. Many corporate sector firms like Indana (plants at Nagpur, Hyderabad, and Bangalore), The Sheel International and Milk and Food, and the Amrut Industries are taking advantage of the existing situation of liberalisation and globalisation. The government has constituted Technology Mission for dairy development and Amul Model Co-operatives are being promoted to cover about 60 per cent of the total area of the country.

BLUE REVOLUTION

Blue Revolution means the adoption of a package programme to increase the production of fish and marine products. The Blue Revolution in India was started in 1970 during the Fifth Five-Year Plan when the Central Government sponsored the Fish Farmers Development Agency (FFDA). Subsequently, the Brakish Water Fish Farms Development Agency were set up to develop aquaculture. The Blue Revolution has brought improvement in aquaculture by adopting new techniques of fish breeding, fish rearing, fish marketing, and fish export. Under the Blue Revolution programme, there had been a tremendous increase in the production of shrimp. Andhra Pradesh and Tamil Nadu have developed shrimp in a big way. The Nellore District of Andhra Pradesh is known as the '**Shrimp Capital of India'**.

There are more than 1800 species of fish found in the sea and inland waters of India, of which a very few are commercially important. The important sea fish include catfish, herring, mackerels, perches, mullets, Indian salmon, shell fish, eels, anchovies, and dorab. Similarly, the main fresh water fish include catfish, loaches, perches, eels, herrings, feather backs, mullets, carps, prawns, murrels, and anchovies. The production of fish in the country has been shown in **Table 9.16**, while **Fig. 9.21** shows the statewise percentage– production of fisheries.

Table 9.16 *India—Fish Production (production in million tonnes)*

Year	*Marine Fish*	*Inland Fish*	*Total*
1950–51	0.535	0.240	00.75
1970–71	10.86	6.75	17.56
1990–91	23.00	15.36	38.36
2000–2001	28.11	23.23	56.75
2010–2011	29.89	48.62	78.51

Source: ***India 2012,*** pp 118-119.

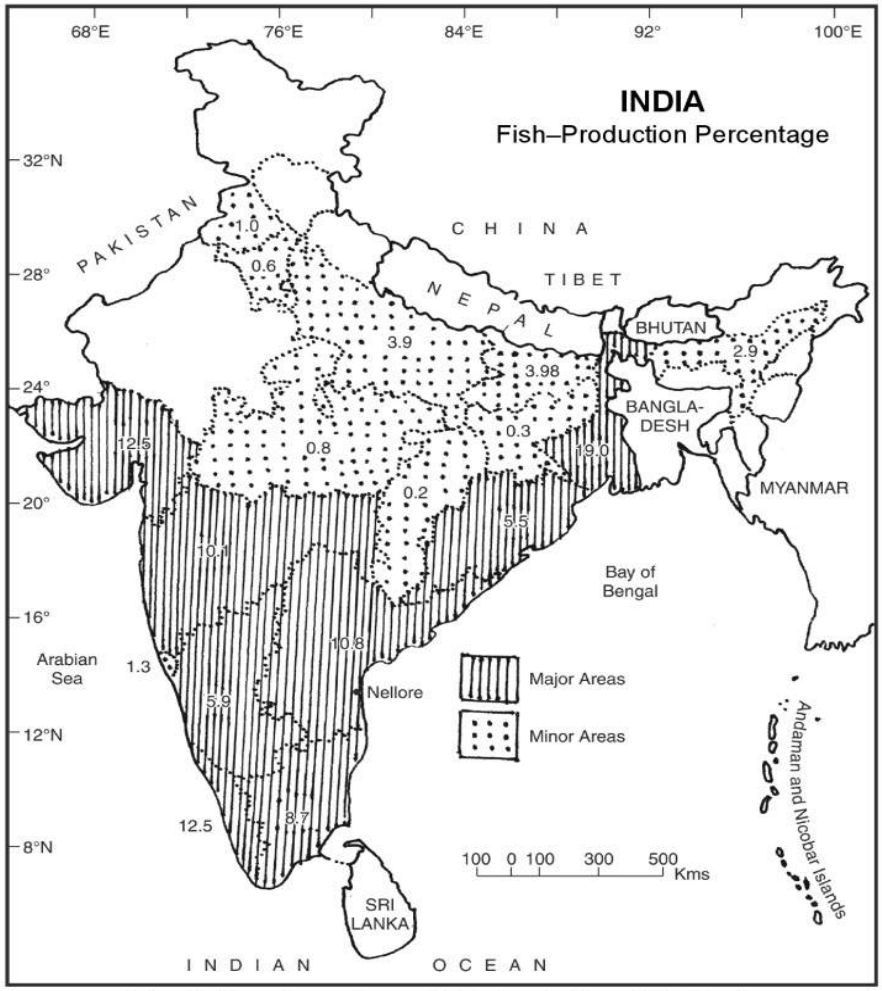


Fig. 9.21 Percentage of Fish Production (2005–06)

It may be observed from **Table 9.16** that the fish production in the country has increased from 0.75 million tonnes in 1950–51 to 68.69 million tonnes in 2006–2007. Fishing, aquaculture and a host of allied activities, a source of livelihood to over 14 million people as well as a major foreign exchange earner, in 2005–06 contributed about one per cent of the total GDP and 5.3 per cent of the GDP from agriculture sector.

The geographic base of Indian marine fisheries has 8118 km coastline, 2.02 million sq of Exclusive Economic Zone including 0.5 million sq km of continental shelf, and 3937 fishing villages. There are 189 traditional fish landing centres, 59 minor fishing harbours, which serve as bases for about 2,80,000 fishing craft consisting of 1,81,000 non-motorised traditional craft and 54,000 mechanised boats. Out of 180 deep sea fishing vessels, only 60 are in operation at present.

About 50 per cent of the country's total fish production comes from the inland fisheries including the freshwater fisheries like ponds, tanks, canals, rivers, reservoirs, and fresh water lakes.

Marine fisheries contribute about 50 per cent of the total fish production of the country. Kerala is the leading producer followed by Maharashtra, Karnataka, Gujarat, and Goa. The fishing season extends from September to March. The higher fish production in the Arabian Sea is due to the broader continental shelf. The important fish varieties include sardines, mackerel and prawn.

The East Coast contributes about 28 per cent of the total production of marine fish in the country. The fishing activity along the East coast is mainly carried on from Rameswaram in the south to Ganjam in the north, with fishing season from September to April along the Coromandal Coast.

The National Fisheries Development Board has been set up to realise the untapped potential of fishery sector with the application of modern tools of research and development including biotechnology.

Strategies for the Fisheries Development

1. The Indian Council of Agricultural Research has established eight fisheries research institutes. These institutes are developing strategies for the exploitation of various aquatic resources.
2. Refrigeration and cold storage facilities have been provided in Chennai, Cuddalore, Kochi, Kollam, Kozhikode, Mumbai, Pune, Ratnagiri, and Thiruvananthapuram.
3. Training centres for fishermen have been established at Satpati (Maharashtra), Veraval (Saurashtra), and Kojan and Tutukandi (Tamil Nadu).
4. Fishing farm docks have been established at Cuddalore, Royapuram (Tamil Nadu), Kandla, Veraval (Gujarat), Vijinjam (Kerala), and Port Blair.
5. Various programmes have been launched by the government for the development of inland fisheries. Over five hundred fish farms have been established by the central government in collaboration with the state governments.
6. The Indian Council of Agricultural Research (ICAR) has established 422 district level Fish Farms in different parts of the country with due emphasis on development.
7. Under the Jawahar Rozgar Yojna, village panchayats have been authorised to carry out fisheries development programmes in respective villages.
8. Under the programme of Development of Model Fishermen Villages, basic civic amenities such as housing, drinking water and construction of community halls for fishermen villages are provided.
9. Brackish Fish Farmers Development Agencies (BFDA) functioning in the coastal areas of the country are providing a package of technical, financial and extension support to shrimp farmers.
10. Insurance facilities have been extended to fishermen for the insurance and security of their life.
11. The government is collecting data on the micro-climates of various water bodies to promote fisheries in the country.
12. Development of Fishing Harbours: Six majors fishing harbours (Cochin, Chennai, Vishakhapatnam, Roychowk, Paradwip and Mumbai), 62 minor fishing harbours and 194 fish landing centres have been constructed in various coastal states (India, 2012, p. 120).

Problems and Prospects

Despite tremendous success in the development of fisheries in the country during the last four decades, pisciculture is facing a number of problems.

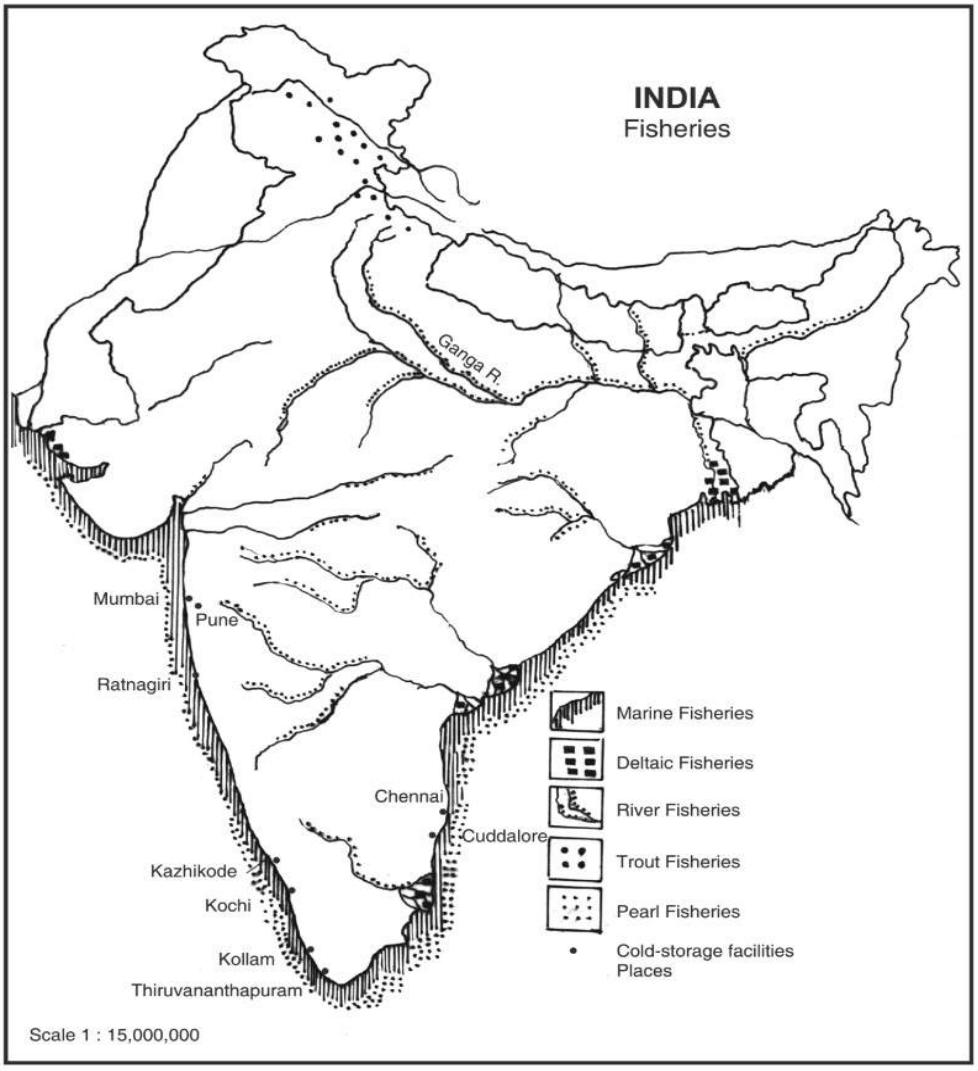


Fig. 9.22 Inland and Marine Fisheries

1. Most of the fishermen are poor. They are not able to purchase good equipment to improve the harvest of fish.
2. The water bodies (rivers, lakes, ponds, and coastal areas of the seas) are increasingly polluted.
3. The area of paddy fields in which fisheries used to be kept is also decreasing under the impact of fast growth of population, industrialisation, and urbanisation.
4. Adequate information about the environment of water-bodies (ponds, lakes, rivers, and sea is not available).

5. Unpredictable nature of monsoon as a result of which the inland fisheries suffer adversely.
6. Problem of marketing, storage, and transportation.
7. Inadequacy of research and extension service facilities.
8. There is need of Pink Revolution (Prawns) in the coastal regions of the country.

AQUACULTURE

Aquaculture is the cultivation of aquatic organisms. Unlike fishing, aquaculture, also known as aquafarming, implies the cultivation of aquatic populations under controlled conditions. Mariculture refers to aquaculture practiced in marine environments. Particular kinds of aquaculture include agriculture (the production of kelp, seaweed, and other algae), fish farming, shrimp farming, shellfish farming, and growing of cultured pearls.

Growth and Development of Aquaculture

Aquaculture has been used in China since circa 2500 BC. The practice of aquaculture gained prevalence in Europe during theMiddle Ages since fish were scarce and thus expensive.Americans were rarely involved in aquaculture until the late 20th century but California residents harvested wild kelp and made legal efforts to manage the supply starting circa 1900, later even producing it as a wartime resource.In contrast to agriculture, the rise of aquaculture is a contemporary phenomenon.

Types of Aquaculture

1. Algaculture

Algaculture is a form of aquaculture involving the farming of species of algae.The majority of algae that are intentionally cultivated fall into the category of microalgae, also referred to as phytoplankton, microphytes, or planktonic algae.

Macroalgae, commonly known as seaweed, also have many commercial and industrial uses, but due to their size and the specific requirements of the environment in which they need to grow, they do not lend themselves as readily to cultivation on a large scale as microalgae and are most often harvested wild from the ocean.

2. Fish Farming

Fish farming is the principal form of aquaculture, while other methods may fall under mariculture. It involves raising fish commercially in tanks or enclosures, usually for food. Fish species raised by fish farms include salmon, catfish, tilapia, cod, carp, trout, and others.

Increasing demands on wild fisheries by commercial fishing operations have caused widespread overfishing. Fish farming offers an alternative solution to the increasing market demand for fish and fish protein.

3. Freshwater Prawn Farming

A freshwater prawn farm is an aquaculture business designed to raise and produce freshwater prawn or shrimp for human consumption. Freshwater prawn farming shares many characteristics with, and many of the same problems as, marine shrimp farming. Unique problems are introduced by the development life cycle of the main species (the giant river prawn, *Macrobrachium rosenbergii*).

4. Integrated Multi-Trophic Aquaculture

Integrated Multi-Trophic Aquaculture (IMTA) is a practice in which the by- products (wastes) from one species are recycled to become inputs (fertilisers, food) for another. Fed aquaculture (e.g. fish, shrimp) is combined with inorganic extractive (e.g. seaweed) and organic extractive (e.g. shellfish) aquaculture to create balanced systems for environmental sustainability (biomitigation), economic stability (product diversification and risk reduction), and social acceptability (better management practices).

5. Mariculture

Mariculture is a specialised branch of aquaculture involving the cultivation of marine organisms for food and other products in the open ocean, an enclosed section of the ocean, or in tanks, ponds or raceways which are filled with seawater. An example of the latter is the farming of marine fish, prawns, or oysters in saltwater ponds. Non-food products produced by mariculture include fish meal, nutrient agar, jewelleries (e.g. cultured pearls), and cosmetics.

6. Shrimp Farming

A shrimp farm is an aquaculture for the cultivation of marine shrimp for human consumption. Commercial shrimp farming began in the 1970s, and production grew steeply, particularly to match the market demands of the US, Japan, and Western Europe.The total global production of farmed shrimp reached more than 1.8 million tonnes in 2005, representing a value of nearly 9,500 million US dollars. About 75% of farmed shrimp is produced in Asia, in particular in China and Thailand.The other 25% is produced mainly in Latin America, where Brazil is the largest producer.The largest exporting nation is Thailand. Shrimp farming on modern lines is being done in Andhra Pradesh (Nellore District), a state of India (see Blue Revolution)

APICULTURE (BEEKEEPING) OR GOLDEN REVOLUTION

Apiculture is the science and culture of honeybees and their management. Beekeeping (or apiculture, from Latin *apis*, a bee) is the practice of intentional maintenance of honey bee colonies, commonly in hives, by humans. A beekeeper (or apiarist) may keep bees in order to collect honey and beeswax, or for the purpose of pollinating crops, or to produce bees for sale to other beeskeeper. A location where bees are kept is called an apiary.

History of Beekeeping

Globally, there are more than 20,000 species of wild bees, many of which are solitary or which rear their young in burrows and small colonies, like mason bees or bumblebees. Beekeeping, or apiculture, is concerned with the practical management of the social species of honey bees which live in large colonies of upto 100,000 individuals.

Wild Honey Harvesting

Robbing honey from wild bee colonies is one of the most ancient human activities and is still practiced by aboriginal societies in parts of Africa, Asia, Australia, and South America.

Domestication of Wild Bees

At some point humans began to domesticate wild bees in artificial hives made from hollow logs, wooden boxes, pottery vessels, and woven straw baskets or '*skeps*'.

Invention of the Moveable Comb Hive

Early forms of honey collecting entailed the destruction of the entire colony when the honey was harvested.The wild hive was crudely broken using smoke to suppress the bees, the honeycombs were torn out and smashed up, along with the eggs, larvae, and honey they contained.The liquid honey from the destroyed brood nest was crudely strained through a sieve or basket.This was destructive and unhygienic but for honey-gathering societies this did not matter since the honey was generally consumed immediately and there were always more wild colonies to exploit.

Traditional Beekeeping

Fixed Frame Hives

There are considerable regional variations in the type of hive in which bees are kept.A hive is a set of rectangular wooden boxes filled with moveable wood or plastic frames, each of which holds a sheet of wax or plastic foundation. The bees build cells upon the sheets of foundation to create complete honeycombs. Foundation comes in different sizes: 'worker foundation' which enables the bees to create small, hexagonal worker cells, and 'drone foundation' which allows the bees to build much larger cells—the drone cells for the production of male bees.

The bottom box, or brood chamber, contains the queen and most of the bees ; the upper boxes, or supers, contain just honey.Only the young nurse bees can produce wax flakes which they secrete from between their abdominal plates; they build honeycomb using the artificial wax foundation as a starting point, after which they may raise brood or deposit honey and pollen in the cells of the comb.These frames can be freely manipulated and honey supers with frames full of honey can be taken and extracted for their honey crop.

Modern Beekeeping

Movable Frame Hives

In the USA, the Langstroth hive is commonly used. The Langstroth was the first successful top-opened hive with movable frames, and designs of hive have been based on it. Langstroth hive was, however, a descendant of Jan Dziezon's Polish hive designs. In the United Kingdom, the most common type of hive is the British National Hive, but it is not unusual to see some other sorts of hive(Smith, Commercial, and WBC, rarely Langstroth). Straw skeps, bee gums, and unframed box hives are now unlawful in most US states, as the comb and brood cannot be inspected for diseases. However, straw skeps are still used for collecting swarms by hobbyists in the UK, before moving them into standard hives.

Top Bar Hives

A few hobby beekeepers are adopting various top bar hives of the type commonly found in Africa. These have no frames and the honey-filled comb is not returned to the hive after extraction, as it is in the Langstroth hive. Because of this, the production of honey in a top bar hive is equal to only about 20% of the production of a Langstroth hive, but the initial costs and equipment requirements

are far lower. Top-bar hives also offer some advantages in interacting with the bees and the amount of weight that must be lifted is greatly reduced. Top Bar Hives are being widely used in developing countries in Africa and Asia as a result of 'Bees For Development' programme.

Types of Beekeepers

Beekeepers generally categorise themselves as:

- Commercial beekeeper—Beekeeping is the primary source of income.
- Sideliner—Beekeeping is a secondary source of income.
- Hobbyist—Beekeeping is not a significant source of income.

The Colony of Bees

A colony of bees consists of three classes of bee: a queen, which is normally the only breeding female in the colony; a large number of female worker bees, typically 30,000–50,000 in number; and a large number of male drones—ranging from thousands in a strong hive in spring to very few during death or cold season

The production and consumption of honey in some of the selected countries of the world has been given in **Table 9.17**

Table 9.17 *World Honey Production and Consumption in 2005*

Country	*Production (1000 metric tonnes)*	*Consumption (1000 metric tonnes)*
Russian Federation	52.13	54
United States of America	79.22	163
Argentina	93.42	3
China	299.33	238
Turkey	82.34	66
India	52.23	45

Source: ***Food and Agriculture Organisation of the United Nations.***

It may be seen from the **Table 9.17** that China is the largest producer and consumer of honey in the world with a production of about 300 thousand metric tonnes annually. Argentina stands second with an annual production of 93.42 thousand metric tonnes, followed by Turkey, USA, and India. India produced over 52 thousand metric tonnes in 2005.

SERICULTURE

Sericulture or silk farming is the rearing of silkworms for the production of raw silk. Although there are several commercial species of silkworms, *Bombyx mori* is the most widely used and intensively studies. According to Chinese records, the discovery of silk production from *mori* occurred about 2700 BC making the start of history of silk. Today, China and Japan are the two main producers, together manufacturing more than 50 per cent of the world production each year. India has a unique distinction of producing all the five known varieties of silk viz. mulberry, Oaktsar, tropical tsar, eri and muga.

Production

Silkworm larvae are fed on mulberry leaves and after the fourth molt, they climb a twig placed near them and spin their silken cocoons. The silk is a continuous-filament fibre consisting of fibroin protein, secreted from two salivary glands in the head of each larva, and a gum called *sericin*, which cements the two filament together. The sericin is removed by placing the cocoons in hot water, which frees silk filaments and readies them for reeling. The immersion of cocoons in hot water also kills the silkworm larvae.

In India, silk worms thrive on the leaves of mulberry, *mahua, sal, ber,* and *kusum* trees. India ranks third among the silk producing countries of the world. In India, about 4.5 lakh hectares of area is under mulberry cultivation. Silk production is mainly confined to areas between 15° and 34° N latitudes. About 55 lakh people are engaged in this industry.

The state of Karnataka is the largest producer of raw silk (65%) follwed by Andhra Pradesh (17%) West Bengal (8%), Tamil Nadu (5%), Assam (2.5%) and Jammu & Kashmir (1.2%), Limited quantity of mulberry silk is also produced in Arunachal Pradesh, Chhattisgarh, Himachal Pradesh, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Manipur, Odisha, Punjab, Tripura, Uttarakhand and Uttar Pradesh.

The growth pattern of mulberry cultivation has been given in **Table 9.18.**

Table 9.18 *Trend in Raw Silk Production*

Year	*Silk (lakh kg.)*
1950–51	52.50
1960–61	78.32
1970–71	231.90
1980–81	459.30
1990–91	114.85
2000–01	165.00
2005–06	167.00

Source: ***Statistical Abstracts India***, 2005–06.

It may be seen from the Table 9.18 that in 1950–51 the raw silk production was 52.50 lakh kg. which rose to 167 lakh kg. in 2005–06. Silk production has a great future in India.

POULTRY FARMING (SILVER REVOLUTION)

Poultry farming is the practice of raising poultry, such as chickens, turkeys, ducks, geese, as a subcategory of animal husbandry, for the purpose of farming meat or eggs for food. It requires small capital and provides additional income and job opportunities to a large number of rural population in the shortest possible time. The vast majority of poultry are farmed using factory farming techniques; according to the Worldwatch Institute, 75 per cent of the world's poultry meat, and 70 per cent of eggs are produced in this way.

The contrasting method of poultry farming in free range and friction between the two main methods, has led to long term issues of ethical consumerism. Opponents of the factory farming argue that it harms the environment and creates health risks, as well as abuses animals. In contrast, proponents of factory farming highlight its increased productivity, stating that the animals are looked after in state-of-the art confinement facilities and are happy; that it is needed to feed the growing global human population; and that it protects the environment.

Poultry Farming in India

Poultry farming in India is quite old. At present, more than three million people are directly or indirectly employed in poultry farming. It produced around 2.4 million tonnes of chicken meat in 2010–11. Between the 1970 and 2011, the annual per capita availability of eggs has quadrupled from 10 to 45, while the corresponding increase in chicken meat has been faster from, 145 grams to 1.6 kgs. India produces more than 59.84 billion eggs per year (India 2012, p. 109).

Poultry sector besides employment generation and subsidiary income increase provides nutritional security especially to the rural poor. Further, landless labourers derive more than 50 per cent of their income from livestock, especially poultry.

While India's share of world trade in the poultry and poultry production continues to be very small in the last decade the value of such exports has increased from 11 crore in 1990–91 to Rs. 350 crore in 2010–11. Exports of products such as live poultry, eggs, hatching eggs, frozen eggs, egg powder, and poultry meat to countries including Bangladesh, Sri Lanka, South West Asia, Japan, Denmark, Poland, USA, and Angola augurs well for industry. The value of output from poultry sector is nearly Rs. 20,000 crore.

In India, there are over 260 million hens in the country which laid down about 30 billion eggs during 2010–11. The largest number of poultry population is in Andhra Pradesh followed by Bihar, West Bengal, Tamil Nadu, Maharashtra, Assam, Karnataka, Kerala, Odisha, Madhya Pradesh, Uttar Pradesh, Punjab, and Haryana. Most of the important poultry farms are being developed around almost all the important urban centres like Mumbai, Kolkata, Delhi, Chennai, Hyderabad, Bangalore, Pune, Nagpur, Shimla, Bhubaneshwar, Ajmer, Chandigarh, and Bhopal.

Uninterrupted supplies of feed as well as *avian influenza* are critical for the continued robust growth of the poultry sector. The first outbreak of avian influenza occurred in India in the state of Maharashtra in the Nandurbar district on 18th Feb. 2006. The Government of India initiated immediate steps to control and contain the outbreak.

The Central Poultry Development Organisation has been playing a pivotal role in the implementation of the policies of the Government with respect to poultry as a tool for alleviating nutritional hunger and palliating the impecuniosities of the resource-poor farmers, especially the women. The mandate of the Central Poultry Development Organisation has been specifically revised, by restructuring all poultry units of this Department to focus on improved indigenous birds, which lay on an average 180–200 eggs per annum and have a vastly improved FCR ratio in terms of feed consumption and weight gain. The Central Poultry Development Organisations have been entrusted with the responsibility of producing excellent germplasm in the form of day-old chicks and hatching eggs of these varieties like Nierbheek, Hitkari, Vanaraja, Shyama, Cari, Chabro, etc. Besides, these organisations are also playing a crucial role in analysing feed samples.

These Organisations, besides conducting the activities stated above, also work for scaling-up of diversification of other avian species like Ducks/Turkeys/Guinea fowl/Japanese Quail, and upgrading of Training Unit into International Tropical Avian Management Institutes in which private-public partnership is envisaged. Presently these Organisations are also supporting and hand-holding the Centrally-sponsored Schemes related to assistance to state poultry farms.

A new Centrally-sponsored scheme called Assistance to State Poultry, is being implemented during the Tenth Plan where one time assistance is provided to suitably strengthen the farms in terms of hatching, brooding, and rearing of birds with provision for feed mill and their quality monitoring and in-house disease diagnostic facilities.

A new scheme, Dairy/Poultry Venture Capital Fund, has been launched during the 2004–05, wherein there is a provision to grant subsidy on interest payment. The nodal agency for the

implementation of this scheme is NABARD through nationalised commercial bank. In 2005–06, a total of 49 poultry units involving 2.17 crore was approved.

HORTICULTURE

Horticulture is a branch of agriculture relating to the cultivation of fruits, vegetables and ornamental plants. Horticulture is a capital and labour intensive agriculture. India is bestowed with varied agro-climates, which is highly favourable for growing large number of horticultural crops such as fruits, vegetables, spices, root tuber, ornamental, aromatic plants, medicinal species and plantation crops like coconut, arecanut, cashew and cocoa. Presently, horticulture crops occupy about 10 per cent of the gross cropped area of the country, producing about 160 million tonnes. India is the second largest producer of fruits and vegetables. The total production of fruits has been estimated at about 63 million tonnes from 5.7 million hectares. Vegetables occupy an area of 7.8 million hectares with a production of 125 million tonnes (India 2009, p. 183). India's share in world fruit and vegetable production is 10 per cent and about 13.25 per cent respectively.

Fruits

Indian climate favours the development of a large range of varieties of fruits. Indians' share in the total fruit production of the world is 10 per cent. Mango, banana, citrus, pineapple, papaya, guava, sapota (*cheekoo*), jackfruit, litchi, and grapes, among the tropical and subtropical fruits; apple, pear, peach, plum, apricot, almond, walnut, among the temperate fruits; and aonla, ber, pomegranate, fig, phalsa, among the arid fruits are important. India leads the world in the production of mango, banana, sapota (*cheekoo*) and nimboo (*acid lime*), and in productivity of grapes per unit land area.

India is the largest producer of mango, banana, sapota, and acid-lime. About 40 per cent of world's mango and 23 per cent of world's banana are produced in the country. In grapes, India has recorded the highest productivity per unit area in the world. The overall production of the horticulture crops registered an increase of 8 per cent during 2004–05 as compared to 2003–04, while the percentage increase in fruit production has been about 1.5 per cent during the same period.

Vegetables

More than 40 kinds of vegetables are grown in India. Important vegetable crops grown in the country are potato, tomato, onion, chillies, carrot, raddish, turnip, beans, ladiesfinger, guard, letuce, brinjal, cabbage, cauliflower, spinach, okra, and peas.

India is next only to China in area and production of vegetables, and occupies the first position in the production of cauliflower, second in onion, and third in cabbage in the world. The area and production of major vegetables during 2004–05 is estimated at 6.30 million hectares with a production of 93 million tonnes and average productivity of 14.8 tonnes per hectare.

Flowers

Though flower cultivation has been practised in India since times immemorial, floriculture has blossomed into a viable business only in recent years. The increased growing of contemporary cut-flowers like rose, gladiolus, tuberose, carnation, etc. has led their use for bouquets and arrangements for gifts, as well as decoration of both home and workplace. A growing market, as a result of improvement in the general level of well-being in the country and increased affluence,

particularly among the upper and the middle classes, has led to transformation of the activity of flower growing into a well developed industry. Availability of diverse agro-climatic conditions in the large country, facilitates production of all major flowers throughout the year in some part or the other, and improved transportation facilties, have increased the availability of flowers all over the country.

India has made noticeable advancement in the production of flowers. Floriculture is estimated to cover an area of 1.14 lakh hectares with a production of 670,000 million tonnes of loose flowers and 13,010 million tonnes of cut flowers.

A major programme, namely National Horticulture Mission (NHM) was launched in the country during the Tenth Five Year Plan with effect from 2005–06. The main objectives of the Mission are to enhance horticulture production through area based regionally differentiated strategies to improve nutritional security and income support to farm households, and to promote and disseminate technologies.

DRY FARMING

The spread of the dry farming is in the regions where the average annual rainfall is less than 75 cm and irrigation facilities are not available. About 60% of the net-cultivated area is under dryland and rainfed cultivation in India, which contributes 40% of the total agricultural production. In these areas the rainfall is scanty and uncertain, where hot and dry conditions prevail. It is not only that the average annual rainfall is low, the variability of rainfall in these areas varies between 25 to 60 per cent. Agriculture in the dry farming regions belongs to fragile, high risking and low productive agricultural ecosystem. The areas in which more than 75 cm of average annual rainfall is recorded are known as the areas of rain-fed agriculture (**Fig. 9.23).**

In India dry-lands cover about 32 million hectares or about 60 per cent of the net arable land. The dry farming areas cover the greater parts of Rajasthan and Gujarat. Moreover, there are small tracts of dry land farming in Punjab, Haryana, Maharashtra, Andhra Pradesh, Karnataka, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Odisha, Uttarakhand, Uttar Pradesh, West Bengal and Tamil Nadu. These areas having scanty rainfall and high variability of rainfall are adversely affected by erratic precipitation, frequent droughts, high temperature, and high wind velocity resulting in soil erosion.

Significant Features of Dry Farming

Dry farming in India is characterised by the following:

1. Moisture conservation is basic to dry farming. In order to achieve this objective, the field is ploughed repeatedly, especially during the rainy season.
2. Sowing of crops in alternate years or fallowing of land after each harvesting of crop. The fallowing of agricultural land helps in the recuperation of soil fertility.
3. Pulverisation of the soil before sowing.
4. Regular hoeing and weeding of the crop to control weed growth and to conserve moisture. Hoeing is generally done before sun-rise so that the night dew may be mixed into the soil to provide moisture to the crops.
5. Covering of the land with straw to prevent evaporation of the soil moisture and to control soil erosion.
6. Livestock keeping and dairying are also important allied agricultural activities in the dry farming regions.

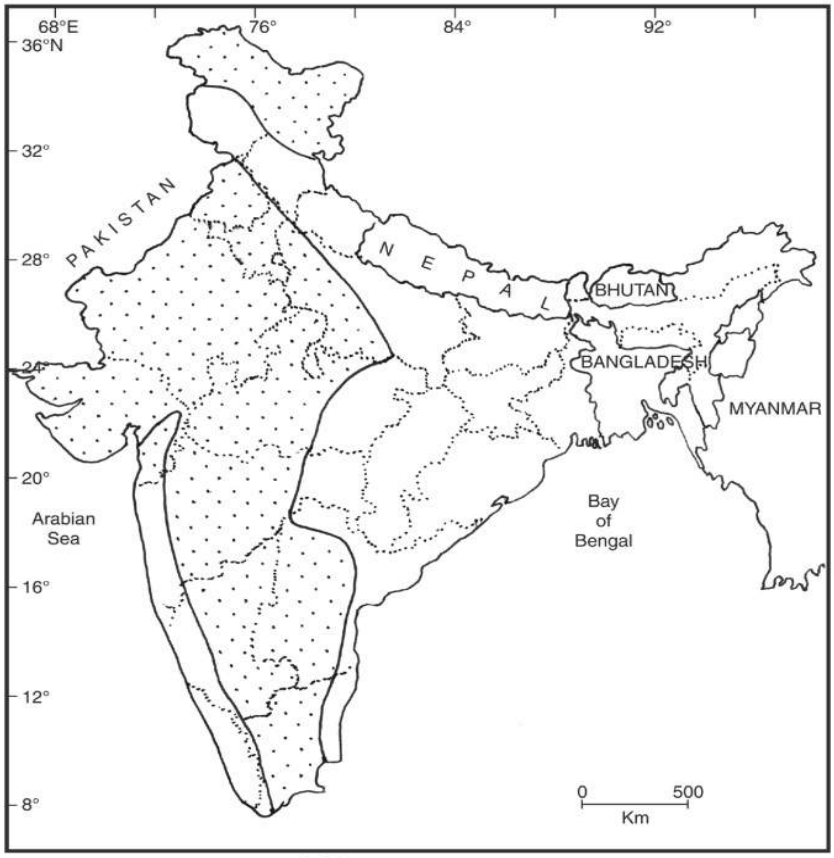


Fig. 9.23 Dry Farming Areas

7. Where ever possible, thrifty use of water.
8. Development and efficient use of solar energy.

Crops

The main crops grown in the dry farming areas are coarse, grains (maize, millets, bajra), wheat, barley, pulses, groundnut, oilseeds and fodder. Though 75 per cent of the total population of dry-farming regions are directly or indirectly dependent on agriculture, their per capita income, and standard of living are significantly low.

The cropping patterns and their combinations in the dry-farming regions of India have been given in **Fig. 9.24.**

Main Problems of Dry Farming

The main problems of dry farming agriculture are as under:

1. Scarcity of precipitation, erratic occurrence of rains leading to famines, droughts, and floods.
2. The soils, being sandy, lack in humus and organic nutrients.

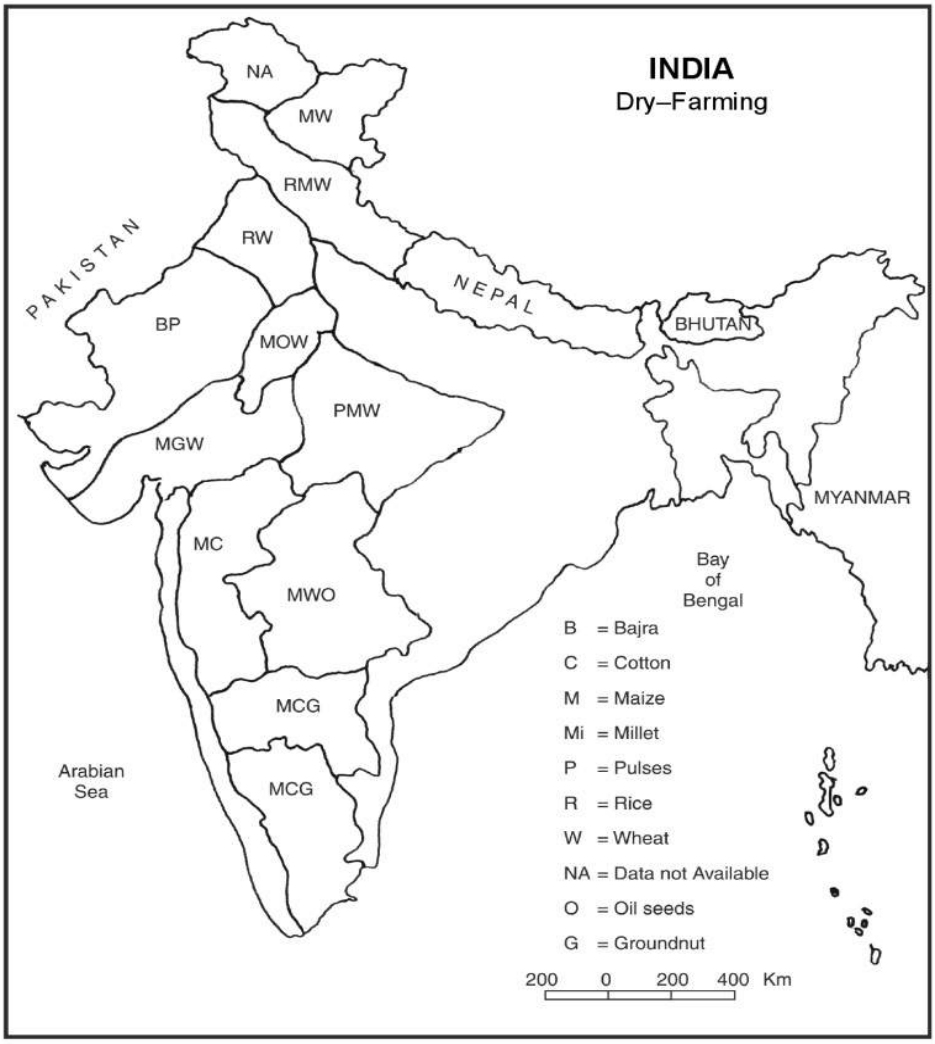


Fig. 9.24 Dry Farming Areas Crop Combination (2005–06)

3. The dry farming areas are highly vulnerable to soil erosion.
4. These are low yields per unit area.
5. In the absence of moisture and irrigation, the use of High Yielding Varieties and new technology is not possible.
6. Most of the farmers in the dry farming regions being poor, are not able to apply the new costly inputs.
7. These areas are not having the basic irrigation and other infrastructural facilities, like roads, marketing and storage.

Strategy for Development

As stated earlier, agriculture is a highly vulnerable occupation in the scanty rainfall recording areas in which dry farming is practiced.

1. In dry farming areas, water harvesting should be done. The government and other non-government agencies should provide the necessary guidance to the people.
2. Seeds of food crops which are drought resistant should be provided to the farmers at a subsidised rate.
3. Efforts should be made to check soil erosion by adopting soil conservation practices.
4. The farmers should space their crops at a wide gap and there should be regular weeding and hoeing.
5. Seeds of the quick and short duration maturing crops should be developed.
6. Cultivation of crops requiring more moisture should be done in the low lying areas, especially in the lower parts of the catchment.
7. Cotton should be grown only in the areas where rainfall is more dependable or sprinkle irrigation is available.
8. Soil fertility should be enhanced by applying cowdung and compost manures.
9. Repeated tilling of the field is required during the rainy season.
10. Research should be promoted in the dry land farming.

In addition to these, there are many other practices like contour-ploughing, contour-bunding, and field-bunding that help water conservation measures. Practice like mulching prevents evaporation from the soil. Deep placement of manures and fertilisers would help the roots to penetrate deep layers. This, along-with weed control, will help in increasing the yield. The latest advance technology of dry farming is to lay stress on soil moisture and its conservation. It should be noted that in the dry areas, soils suffer from nutrient deficiency, particularly nitrogen. Band placement of fertilisers in sub-soil layers is a good method of helping the roots to go deep for exploiting the conserved moisture. The World Congress on Conservation Agriculture was organised in February 2009 at New Delhi in order to address the issues of improving efficiency, equity and environment in which the problems and prospects of dry farming were also discussed.

AGRIBUSINESS

Agribusiness means agriculture for commercial purpose. Johnston and colleagues have defined agri-business as farming organisation applying modern management techniques and accounting methods with the aim of maximising final profit. The concept is applied differently in USA and Western Europe. In USA, agribusiness has grown as a result of increased involvement by food processing companies in the actual production of their own raw material inputs. Such companies have purchased farms and run them as subsidiary elements within their overall production system, while in Western Europe such integration of farm production with processing is less common. In Western Europe and also in some developing countries like India, agribusiness constitutes large farming companies independent of food processors. But there are certain characteristics which are common to all agribusiness. More specifically, that part of modern national economy devoted to production, processing, and distribution of food and fibre products and by-products falls under the category of agribusiness.

Characteristics of Agribusiness

Agribusiness essentially has the following characteristics:

1. Hierarchical system of management—financial administrators and accountants with farm managers to carry out day-to-day business
2. Large farms
3. Farming operations organised in sizeable production units
4. An extension of the plantation system

In highly industrialised countries, many activities essential to agriculture are carried out at places away from the farm. These include the development and production of equipment, fertilisers, and seeds. In some countries, the processing, storage, preservation, and delivery of agricultural products have also been separated from basic farming. In consequence, farming itself has become increasingly specialised and business-like. Some business firms even raise crops, as in the case of winery, that operates its own wine-yards, or large commercial producers who maintain their own farms. Many of these farms are extensively mechanised with computer technology to increase production.

In recent years, conglomerate companies that are involved in non-agricultural business have entered into agri-business by buying and operating large farms. Some food processing farms that operate farms have begun to market fresh produce, under their land resources.

India has recently entered into agribusiness, which consists of processed and unprocessed agricultural products. In the processed category are processed fruits and vegetable juices, meat, and meat and fish products, sugar and molasses, coffee and tobacco, spices, and wheat, tea, and rice. Entry into agribusiness requires polishing and parboiling. Commodities like fruits, vegetables, and eggs are sorted out according to size, shape, and colour. Canning of fruits and vegetables constitute an important part of agribusiness. However, there is need in India to develop facilities for research to evolve new techniques and standardised recipes and methods of manufacture of fruits and vegetable products.

It is also necessary to develop sophisticated allied industries such as manufacture of containers and closures (covers) equipments and machinery used by fruits and vegetable processing. Further, grant of subsidies and incentives like the removal of duty on tin plates, sugar, and railway freight to processors is necessary to encourage exports.

India can have good agribusiness in mango products and other processing industries based on fruits like apple, pineapple, oranges, lemon, lime, *aonla* (*Phyllanthus emblica sp.*), and guava, and vegetables like peas, tomato, and potatoes (canned). Other fruits and vegetables which are exported to some extent in the processed form are apricot, *bel* (*Aegle marmelos*), peach, plum, strawberry, ladies finger, brinjal, cabbage, carrot, *karela* (bitter gourd), *tinda* (*citrullus volgaris*), mustard green, *parwa*l, spinach, turnip, chillies, and ginger.

NATIONAL COMMISSION ON FARMERS

The National Commission on Farmers (NCF) chaired by Dr. M.S. Swaminathan gave the following recommendations to improve the conditions of farmers. The recommendations include:

1. Assest reforms covering land, water, livestock, and bio-resources
2. Farmer-friendly support services covering extension, training and knowledge
3. Credit and insurance

4. Assured and remunerative marketing
5. Inputs and delivery services
6. Bringing agriculture in Concurrent List of the Constitution
7. Setting up of a National Food Security and Sovereignty Board
8. Universalisation of Public Distribution System
9. Setting up of an India Trade Organisation
10. Launch of a Rural-Non-farm Livelihood Initiative (when implemented would be able to absorb higher number of people dependent on agriculture)

INDIAN AGRICULTURE—CHALLENGES AND PROSPECTS

Agriculture, the dominant economic activity of India, faces a number of challenges on various fronts. Some of the important challenges Indian agriculture is facing at present are given below:

1. **Stunted Yield:** The yield of most of the crops has not improved substantially and in some cases (wheat, gram, pulses, sugarcane, and bajra) fluctuated downward. Therefore, there is a need to focus on improving productivity. At the same time there is a need to speed up the growth of allied activities.
2. **Dry Farming:** Agriculture in the dry-farming areas is highly vulnerable to drought. In such areas, micro-irrigation system needs to be developed. Watersheds management, water harvesting and participatory approach can be of great importance in such areas.
3. **Inadequate Marketing Facilities:** In the greater parts of the country, including the areas of Green Revolution, the farmers are not getting remunerative prices. There is a need to narrow the gap between producer prices and consumer prices through proper marketing support. The development of marketing infrastructure and storage and cold-chains and spot markets that are driven by modern technology may go a long way in providing good returns to the farmers.
4. **Inadequate Formal Sources of Credit:** As per the report of the committee on Financial Inclusion (January 2008), more than 73 per cent of the farmer households have no access to formal sources of credit. Under the debt pressure of private money lenders, thousands of farmers have committed suicide. To exempt the full or part of the loan of the marginal, small, and medium farmers is an immediate need of the hour.
5. **Mismanagement of Public Distribution System:** The Public Distribution System is not working satisfactorily. The weaker section of the society, especially the people below the poverty line, should be provided sufficient quantity of food at a highly subsidised rate.
6. **Sustainability of Agriculture:** After the diffusion of the High Yielding Varieties, especially in Punjab, Haryana, and western Uttar Pradesh, the farmers have adopted rice and wheat crop combination. Both these crops, however, are soil exhaustive, damaging the soil fertility and degrading the environment.
7. **Soil Erosion:** Soil erosion, water-logging, reduction in underground watertable are some of the serious problems of Indian agriculture. These problems are causing ecological imbalances. In brief, while the challenges faced by the agriculture and the allied sector are numerous, the possibilities for new investment, the use of new technologies are imperative. These issues of the meso and micro levels deserve to be addressed immediately.

NEW NATIONAL AGRICULTURAL POLICY

The Government of India announced the new agricultural policy on 25th July, 2000. The aim of the new policy is to achieve the target of 4 per cent per annum growth in agriculture. The main features of the policy are as follows:

(i) Efficient use of resources and technology.
(ii) Timely and adequate credit is to be provided to farmers.
(iii) Private sector investment in agriculture would be encouraged.
(iv) To protect the farmers against the adverse effects of implementation of WTO agreement.
(v) To protect the farmers against fluctuations in agricultural prices.
(vi) The restrictions on the movement of agricultural commodities throughout the country would be removed.
(vii) Excise duties on agricultural machinery, fertilizers, etc. will be reduced.
(viii) Package insurance policy for the farmers.
(ix) Rural electrification, rural roads and development of irrigation to be encouraged.
(x) Strengthening agriculture marketing infrastructure.
(xi) Remunerative prices for agricultural products.
(xii) Focus on horticulture, floriculture, animal husbandary and fisheries.

REFERENCES

Bansil, P.C. *Agricultural Problems of India.* New Delhi: Vikas Publishers, 1977.
Deshpande, C.D. *India—A Regional Interpretation.* New Delhi: Northern Book Centre, 1982.
Farmer, B.H. *Green Revolution.* London: Macmillan, 1977.
Frankel, F.R. *India's Green Revolution—Political Cost of Economic Growth.* Princeton University Press, 1971.
Government of India, *Five Year Plans.*
Griffin, Keith B. *The Political Economy of Agrarian Change—An Essay on the Green Revolution.* Harvard University Press, 1974.
Husain, M. *Agricultural Geography.* New Delhi: Inter India Publications, 1992.
Husain, M. *Systematic Agricultural Geography.* Jaipur: Rawat Publications. 2007
Johnston, R.J. *A Dictionary of Human Geography.* Basil and Blackwell, 1985.
Khusro, A.M. *The Economics of Land Reforms and Farms Size in India.* Chennai: Macmillan, 1973.
Handbook of Agriculture, 2012, 6th ed. Indian council of Agricultural Research, New Delhi.
India—2010. Government of India. Publication Division, New Delhi.
Muthiah, S. *A Social and Economic Atlas of India.* New Delhi: Oxford University Press, 1987.
Poheketr, G.S. *Studies in Green Revolution.* United Asia Publication, 1970.
Sen, B. *The Green Revolution in India : A Perspective.* New Delhi: Wiley Eastern, 1974.
Shafi, M. *Agricultural Geography.* New Delhi: Pearson Education, 2006.
Singh, J. *Agricultural Geography.* New Delhi: Tata McGraw-Hill Education, 1984.
Symons, L.. *Agricultural Geography.* London, 1968.
The New Encyclopedia Britannica, Vol.I, London, 153–154.
Tiwari, R.C. *Geography of India.* Allahabad: Prayag Pustak Bhavan, 2003.
Vyas, A.K., 2011, *Introduction to Agriculture*, 5th ed. New Delhi, Jain Brothers.