Chapter 10

Spatial Organisation of Agriculture

CROPPING PATTERNS

Cropping pattern means the proportion of area under different crops at a given point of time. The crop statistics published by the government are used to denote the cropping patterns. Cropping pattern is however, a dynamic concept as it changes in space and time. The cropping patterns of a region are closely influenced by the geo-climatic, socioeconomic, and political factors. In any region, the prevalent cropping patterns are the cumulative results of the past and present decisions of individuals, communities or government and their agencies. These decisions are usually based on experience, tradition, expected profit, personal preferences and resources, social and political pressure.

The physical environment (physiography, climate, soils, water, etc.) imposes limits on the growth and distribution of plants and animals. The role of man in the cultivation of certain crops in a region is also important. Man, by his technological advancement can ameliorate the physical limits. The cultivation of rice in Punjab, Haryana, and Ganganagar District (Rajasthan) testifies this fact. Nevertheless, in different parts of the world, the physical environment reduces the choice of crops, either by prohibiting the growth of certain crops or by reducing their yield per unit area.

Depending on the geo-ecological conditions and availability of irrigation, the cropping patterns vary from region to region. In those regions where the physical diversity is less, the cropping patterns are less diversified and vice versa. For example, in the rainfall deficient areas of Rajasthan (Thar Desert) the farmers grow *bajra* (bulrush-millet), while in the fertile valley of Brahmaputra, rice has the status of monoculture. Contrary to this the soils of the Indo-Gangetic plains are suitable for the cultivation of numerous crops.

In addition to physical environment, the land ownership, the land tenancy, land tenure, size of holding and fields also influence the cropping patterns. A farmer with small holding prefer the cultivation of *labour intensive* crop, while a large holding farmer goes for the *capital intensive* agricultural practices. Cropping patterns are also affected by the infrastructural, institutional and technological factors (see Chapter 9)

The cropping patterns of a region are determined on the basis of area strength of individual crop. The first, second and third ranking crops of an areal unit may be called as the *dominant crops* of that unit. These crops, if occupying more or less the same percentage of the total cropped area, shall be competing with each other and the farmer will decide which crop may fetch him more profit. In general, for the demarcation of cropping patterns of a region, the minor crops (crops occupying less than one per cent of the total cropped area) are ignored.

The *relative yield index* and the *relative spread index* for the determination of suitability of crop may be calculated with the help of the following formula:

$$\text{Relative Yield Index} = \frac{\text{Mean yield of the crop in a component areal unit}}{\text{Mean yield of the total area}} \times 100$$

$$\text{Relative Spread Index} = \frac{\text{Area of the crop expressed as percentage of the total cultivated area in the areal unit}}{\text{Area of the crop expressed as percentage of the total cultivated area}} \times 100$$

On the basis of these indices the suitability of crop grown in a region may be ascertained. If the relative yield is below 90 per cent, then it may be an inefficient crop and therefore, should not be sown in more area of the cultivated land.

The area under each crop in a given region may be classified under the following four categories:

(i) High yield, high spread
(ii) High yield, low spread
(iii) Low yield, high spread
(iv) Low yield, low spread

On the availability of an alternative, more efficient crop than the existing ones is preferred which leads to new cropping patterns. The cropping patterns may be intensified with the help of short duration *High Yielding Varieties*. Any cropping sequence to be adopted by the cultivator, however, should be flexible. The suitability of a crop and cropping pattern may be judged on the basis of the following:

1. The crop should not accentuate certain diseases as a result of a fixed continuous rotation.
2. The crop should not exhaust on some plant specific nutrients from a particular part of the soil.
3. The crop should be fertility-building and soil-improving.
4. The crop should fetch handsome return to the cultivator and should provide the cultivator employment all the year round.
5. The crop should ensure the optimum utilisation of his resources, particularly inputs like irrigation water, chemical fertilisers, insecticides, pesticides, equipments, power and family labour.

Excluding the areas where Green Revolution is a big success and the areas in which plantation agriculture is being done, Indian farming by and large is subsistence type in character. Consequently food crops occupy over 72 per cent of the total cropped area. Among the cereals, rice and wheat rank first and second in area respectively. The subsistent cropping patterns of India are based on the utilisation of inherent fertility of the soil without much use of modern inputs and technology.

The importance of adoption of suitable cropping patterns in a developing country like India cannot be overemphasised. The horizontal expansion of agriculture in India is not possible without heavy investment in reclaiming the wasteland for agriculture. Only a judicious utilisation of the available agricultural land by adopting more remunerative cropping patterns, scientific rotation of crops and multiple cropping may help in overcoming the problems of shortage of food and agricultural raw materials in the country. A change in the cropping pattern and scientific rotation of crops are imperative to make agriculture more remunerative and sustainable.

CROP CONCENTRATION

Crop concentration means the variation in the density of any crop in a region at a given point of time. The concentration of crops in an area largely depends on its terrain, climate, and soils and agricultural practices of the farmers. Each crop has a maximum, minimum and optimal temperature. The crops have a tendency to have high concentration in the areas of ideal agro-climatic conditions and the density declines as the geographical conditions become less conducive. It is because of these factors that rice has high concentration in east Indian states, wheat in Punjab and Haryana, cotton in black earth region, and *Bajra* in Rajasthan (**Fig. 10.1**).

A number of statistical techniques have been used by agricultural geographers for the demarcation of crop concentration regions. The location quotient method is, however, more reliable as it gives a reliable picture of the relative density of crops.

The Location Quotient Method of Crop Concentration

In the location quotient technique, the regional character of distribution is investigated and determined, first by comparing the proportion of sown area under different crops and ranking them, and secondly, by retaining the crop density in each of the component areal units of the region/country to the corresponding density of the region/country as a whole. This approach makes it possible to measure the regional concentration of the crops objectively. It also helps to identify and differentiate areas that have some significance with regard to the crop distribution within the region.

The location quotient technique may be expressed as under:

$$\text{Crop Concentration Index} = \frac{\text{Area of } x \text{ crop in the component areal unit}}{\text{Area of all crops in the component area unit}} \Bigg/ \frac{\text{Area of } x \text{ crop in the entire region/country}}{\text{Area of all crops in the entire region/country}}$$

By adopting the above technique, if the index value is greater than unity, the component areal unit accounts for a share rather than it would have had if the distribution were uniform in the entire region, and, therefore, the areal unit has a concentration of greater significance. After ascertaining the index values for the crops in the component areal unit, they are arranged in an ascending or descending order. The index scale is calculated by dividing the array into three equal parts to distinguish the high, medium and low concentration. In general, higher the crop concentration index, higher is the level of interest in the production of that crop.

The main advantage of the location quotient technique for the demarcation of crop concentration lies in the fact that it enables the geographers and planners to understand the areas of specialisation of different crops grown in the region at a given point of time. The continuous cultivation of a particular crop in a unit or region, however, leads to progressive reduction in yield. This leads to the depletion of soil fertility as the particular crop exhausts certain nutrients from the soil. Rotation of crops with diverse choice in which leguminous crops are included needs to be practiced by the farmers. A scientific rotation of crops not only makes agriculture more remunerative and dignified occupation, it also makes the agro-ecosystem more resilient and sustainable.

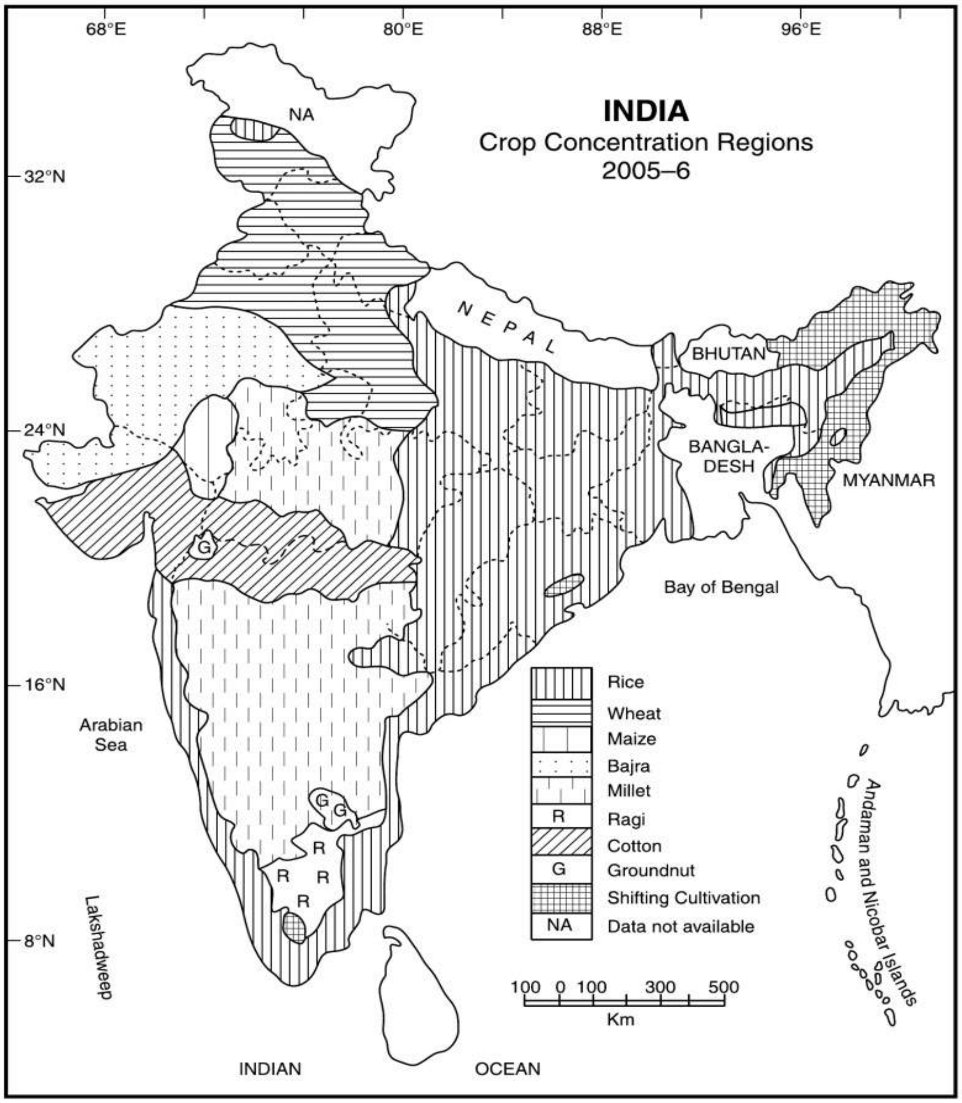

Fig. 10.1 Crop Concentration Regions (2005–06)

AGRICULTURAL PRODUCTIVITY

Agricultural productivity is a synonym for agricultural efficiency. The *yield per unit area* is known as agricultural productivity. Agricultural productivity is generally the result of the physical, socio-economic, and cultural factors. It is also affected by the managerial skill of the farmer. Agricultural productivity, however, is a dynamic concept which changes in space and time.

Agricultural productivity of a region is closely influenced by a number of physical (physiography, terrain, climate, soils, and water), socioeconomic, infrastructural institutional, and organisational factors. Agricultural productivity also depends on the managerial skill of the farmer, his attitude, and aspirations for the better standard of living.

The delineation of agricultural productivity has great significance in the planning of agriculture of a region. The main advantages are:

(i) It helps in ascertaining the relative productivity of the component areal units of a region.
(ii) It helps in identifying the weaker areas which are lagging behind in agricultural productivity.
(iii) The existing patterns of agricultural productivity is a reliable index to assess the agricultural development of the past.
(iv) It provides a sound base for the agricultural development planning.

Agricultural geographers and economists have developed a number of methods for the measurement of agricultural productivity. Some of the important methods used by the geographers are given as under:

1. Output per unit area.
2. Production per unit of farm labour.
3. Agricultural production as grain equivalent (Buck, 1967).
4. Input-output ratio (Khusro, 1964).
5. Ranking Coefficient Method (Kendall, 1939, Stamp, 1960).
6. Carrying capacity of land in terms of population (Stamp 1958).
7. Determining a productivity index on the basis of area and yield (Enyedi, 1964, Shafi 1972).
8. Determining an index of productivity with the help of area and production under various crops in the areal units and converting them in a uniform scale.
9. Converting total production in terms of money (Husain, 1976)
10. To assess the net income in Rupees per hectare of the cropped area (Jasbir Singh, 1985).
11. Assessing net income (farm business income) in Rupees per hectare of cropped area or per adult male unit of farm work-force (Tiwari, Roy, and Srivastava, 1997).

Each of the methods and techniques adopted by the agricultural geographers has its own merits and demerits. None of the techniques, however, gives satisfactory results at the national and/or global level. Some of the techniques are cumbersome and time-consuming to apply for the delineation of agricultural productivity regions. The Kendall's technique of ranking coefficient used by many of the leading geographers for the demarcation of agricultural productivity regions has been illustrated below.

Ranking Coefficient Method of Agricultural Productivity

The ranking coefficient method adopted by Kendall is quite simple and easy to apply. In this technique, the component areal units are ranked according to the per hectare yield of crops and the arithmetical average rank, called the *ranking coefficient* for each of the component areal units is obtained. It is obvious that a component areal unit with relatively high yields will have low ranking coefficient, indicating a high agricultural productivity. In other words, if a component areal unit (district in India) was at the top of every list of crops, it would have a ranking coefficient of one and thus having the highest agricultural productivity. Opposite to this if the areal unit was at the bottom of every list, it would have a ranking coefficient equal to total number of units considered, showing the lowest agricultural productivity among the constituent units.

The ranking coefficient method can be illustrated with the help of an example. Suppose, in a region, there are 80 component areal units (district/tehsil). In a district 'x', on the basis of average yields, wheat ranks 5^{th}, rice 12^{th}, gram 20^{th}, cotton 21^{st}, barley 24^{th}, and sugarcane 38^{th}, pulses 40^{th} and mustard 54^{th}. The average rank, called the ranking coefficient of the district x' would be:

$$\text{Agricultural Productivity} = \frac{5 + 12 + 20 + 21 + 34 + 38 + 40 + 54}{8 \text{ crops}} = 28$$

The average ranked position of all the units of the region is, thus, calculated and arranged in an ascending order or descending array. The array is divided into three equal parts to ascertain the low, medium and high agricultural productivity. With the help of the index scale, the agricultural productivity of each unit can be ascertained and plotted. The Kendall's technique was applied to determine the agricultural productivity of India at the district level. The agricultural data for each of the districts were computed for the years 2003 to 2006. The ranking coefficients thus obtained were plotted in **Fig. 10.2.**

High Agricultural Productivity

It may be observed from **Fig. 10.2** that high agricultural productivity is found in the Satluj-Ganga Plain, the Brahmaputra Valley, the delta regions of Godavari, Krishna, and Kaveri rivers. In these areas either the irrigation facilities are well developed or there is adequacy of rainfall over greater part of the year. Wheat, rice, maize, pulses, sugarcane, and oilseeds are the main crops grown in the high agricultural productivity regions. The farmers, especially that of Punjab, Haryana, and western Uttar Pradesh are no longer subsistent as most of them are doing agriculture as agri-business.

Medium Agricultural Productivity

The medium agricultural productivity is found in scattered areas and in isolated patches in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Odisha, parts of Rajasthan, Tamil Nadu, and West Bengal. In these areas the irrigation facilities are not well developed and the double cropped area varies between 5 and 20 per cent. The main crops of the regions in which medium productivity is found are rice, wheat, coarse grains (millets), pulses, and oilseeds. The agriculture in these regions is mainly subsistent. Non-availability of irrigation is a major barrier in the enhancement of agricultural productivity.

Low Agricultural Productivity

The regional patterns of agricultural productivity plotted in **Fig. 10.2** show that the state of Jharkhand, Chhattisgarh, parts of Madhya Pradesh, Andhra Pradesh, Gujarat, Maharashtra, Rajasthan, parts of Kerala, Jammu & Kashmir, hilly areas of Uttarakhand, western Rajasthan, northern Gujarat, and the north-eastern hill states have low agricultural productivity. These areas are deficient in irrigation and characterised with low rainfall conditions. In fact most of these areas are susceptible to droughts or floods, and are the less rainfall recording areas. The main crops of these areas are rice, maize, coarse grains, pulses, and oilseeds. The intensification of agriculture in these states is low. Agriculture is mainly rain-fed practiced to meet the family requirements. It is in these areas where the agrarian community is generally at a low level of subsistence and many of them are committing suicides. Special programmes need to be launched to enhance the agricultural productivity of the farmers of these regions.

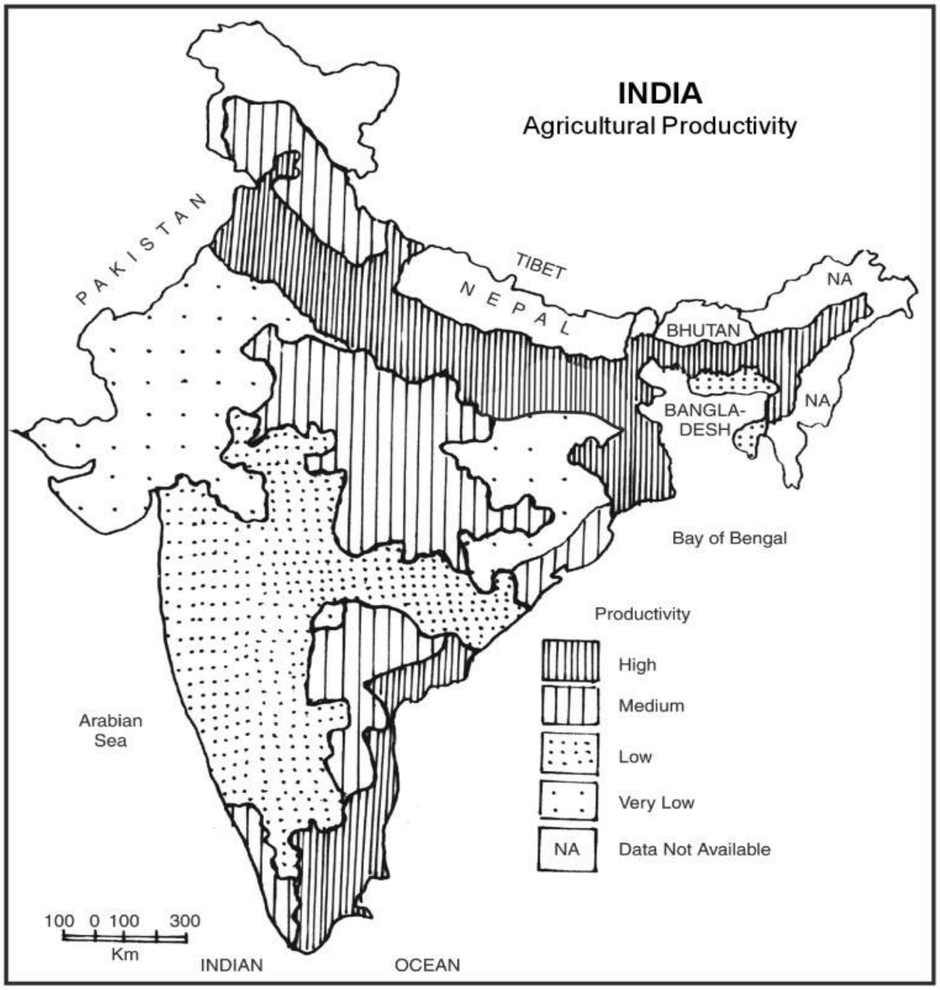

Fig. 10.2 Agricultural Productivity (2003–06)

Very Low Agricultural Productivity

The areas of very low agricultural productivity sprawl over greater parts of Rajasthan, Jharkhand, and Chhattisgarh. The main cause of very low agricultural productivity are either high rainfall variability or poverty and illiteracy of the farmers.

AGRICULTURAL INTENSITY

Cropping intensity has been defined as the ratio between the net sown area and the gross or total cropped area. The double and multiple cropped area added into the net cultivated area gives the

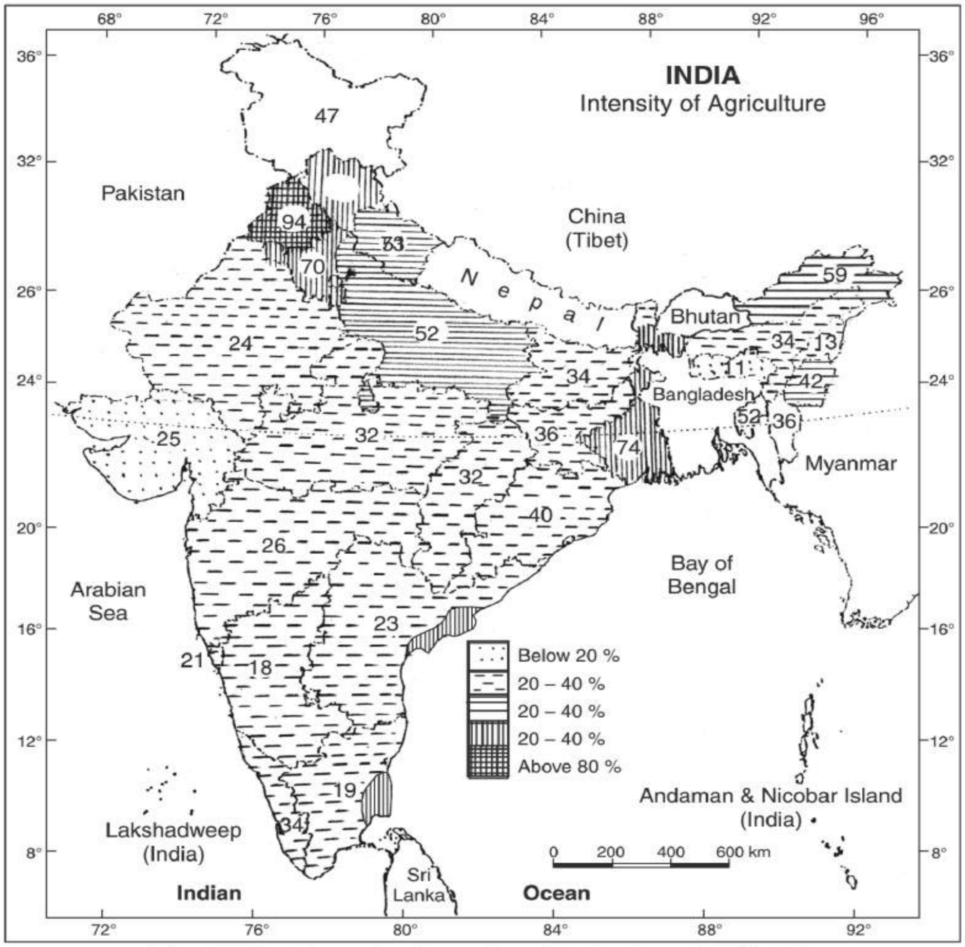

Fig. 10.3 Statewise Intensity of Agriculture (2005–06)

In the arbitrary choice method, the first two or the first three crops in the area are included and the rest of the crops are excluded from the combination. This is an unscientific method as the crops are excluded from the combination without any consideration of their percentage area and their monetary value.

The second method is known as the *statistical method.* This method being based on statistical formula is more scientific and reliable for the objective grouping of crops. In the field of agricultural geography, Weaver (1954) was the first to use statistical technique for the demarcation of crop combination regions of the Middle West (USA).

In his attempt to demarcate the agricultural regions of the Middle West (USA), Weaver based his analysis on acreage statistics. Weaver computed the percentage of total harvested cropland occupied by each crop that held as much as one per cent of the total cultivated land in each of the 1081 counties covered in his research work. He devised a rigorous approach that would provide total cropped area. The Department of Agriculture, Government of India, developed the following formula for the measurement of agricultural intensity:

$$\text{Agricultural Intensity} = \frac{\text{Gross (total) cropped area}}{\text{Net cultivated area}} \times 100$$

The formula may be illustrated with the help of the following example:

Suppose the net cultivated area in a village is 1000 hectares and the total cropped area is 1500 hectares (800 hectares in the *kharif* and 700 hectares in the *rabi* season)

The agricultural intensity in this village would be:

$$\frac{800 + 700}{1000} \times 100 = 150\%$$

The agricultural intensity depends on the geo-climatic, pedological, socio-cultural, and infrastructural factors. Thus, the agricultural intensity is generally high in the well irrigated alluvial plains like Punjab, Haryana, and western Uttar Pradesh. Contrary to this, the agricultural intensity is low in the less rainfall recording areas, e.g. western Rajasthan, in which only one crop (*kharif*) is obtained during the season of general rains.

The agricultural intensity of India for 2005–06 has been plotted in **Fig. 10.3.** It may be observed from **Fig. 10.3** that the agricultural intensity for the country as a whole is 132 per cent (2005–06). The highest agricultural density is in Punjab being 165 per cent, followed by Haryana 160 per cent and Uttar Pradesh 150 per cent. The main cause of high agricultural intensity in these states is the diffusion of short duration High Yielding Varieties of rice and wheat, availability of controlled irrigation, better accessibility to the market, storage facilities, and the progressive nature of the farmers who adopt the new innovations quickly and want to achieve a high standard of living. Contrary to this, the agricultural intensity is low in Rajasthan, north-western Gujarat, Hill states of North East India, Chhattisgarh, Jammu & Kashmir, Himachal Pradesh, and Uttarakhand (excluding its plain districts). In all these regions agriculture is rain-fed, the average annual rainfall is less than 60 cm. and irrigation facilities are not adequately available.

CROP COMBINATIONS

The study of crop combinations constitutes an important aspect of agricultural geography. In fact, it provides a good basis for agricultural regionalisation and helps in the formulation of strategy for agricultural development.

Crops are generally grown in combinations and it is rarely that a particular crop occupies a position of total isolation. The distribution maps of and their concentration are interesting and help in knowing the density and concentration of individual crops, but it is even more important to view the integrated assemblage of the various crops in a region. For example, the demarcation of India into rice or wheat region does not explain the agriculturally significant fact that very often the wheat/rice region also has mustard, gram, pulses, and maize. For a comprehensive and clear understanding of the agricultural mosaic of a region, a systematic study of the crop combinations has great planning significance. The methods applied for the demarcation of crop combination regions may be summed up under two categories:

1. The arbitrary choice method, and
2. The statistical method

an objective, constant and precisely repeatable procedure and would yield comparable results for different years and localities. In his work, Weaver calculated deviation of the real percentages of crops (occupying one per cent of the cropped area) for all the possible combinations in the component areal units against a theoretical standard. The theoretical curve for the standard measurement was employed as follows:

Monoculture = 100 per cent of the total harvested crop land in one crop
2-crop combination = 50 per cent in each of the two crops
3-crop combination = 33.3 per cent in each of the three crops
4-crop combination = 25 per cent in each of the four crops
5-crop combination = 20 per cent in each of five crops
10-crop combination = 10 per cent in each of 10 crops

For the determination of the minimum deviation the standard deviation method was used:

$$\text{SD} = \sqrt{\frac{\Sigma d^2}{N}}$$

Where '*d*' is the difference between the actual crop percentage in a given county (areal unit) and the appropriate percentage in the theoretical curve and '*n*' is the number of crops in a given combination.

As Weaver pointed out, the relative, not absolute, value being significant, square roots were not extracted; so the actual formula used was as follows:

$$d = \frac{\Sigma d^2}{n}$$

To illustrate Weaver's technique an illustration can be given from the Gorakhpur district where the percentage share of crops in the total harvested area in a year was as follows: rice—48 per cent, wheat—23 per cent, barley—15 per cent, sugarcane—6 per cent, and pulses—5 per cent.

$$\text{Monoculture} = \frac{(100 - 48)^2}{1\text{ crop}} = 2704$$

$$\text{2-crop combination} = \frac{(50 - 48)^2 + (50 - 23)^2}{2\text{ crops}} = 366.5$$

$$\text{3-crop combination} = \frac{(33.3 - 48)^2 + (33.3 - 23)^2 + (33.3 - 15)^2}{3\text{ crops}} = 216$$

$$\text{4-crop combination} = \frac{(25 - 48)^2 + (25\ 23)^2 + (25 - 15)^2 + (25 - 6)^2}{4\text{ crops}} = 248$$

$$\text{5-crop combination} = \frac{(20 - 48)^2 + (20 - 23)^2 + (20 - 15)^2 + (20 - 6)^2 + (20 - 5)^2}{5\text{ crops}} = 248$$

The deviation of the actual percentage from the theoretical curve is seen to be the lowest for a 3-crop combination. This result established the identity and the number of crops in the basic combination for the district of Gorakhpur as rice-wheat and barley.

Weaver's technique when applied at the district level for the data of 2003–06 gives the following eight-crop combinations to India which have been plotted in **Fig. 10.4.**

An examination of **Fig. 10.4** show that the lower Brahmaputra Valley, West Bengal, Odisha and coastal Andhra Pradesh has the monoculture of rice while in Western Rajasthan, *Bajra* is the dominant single most important crop. In Punjab and Haryana rice and wheat enter into combination and in western Uttar Pradesh wheat, rice, and sugarcane constitute the combination. In the remaining parts of the country crop combinations vary between four to eight. In these combinations, wheat, rice, maize, gram, barley, ragi, pulses, oilseeds, cotton, sugarcane, *bajra*, and millets form different crop associations.

Weaver's method has admirably been accepted and applied for the demarcation of crop combination regions as its application results into suitable and accurate grouping of crops. The technique, however, gives most unwieldy combinations for the units of high crop diversification. This method, however, suffers from the setback of laborious calculations.

LAND CAPABILITY

Land capability survey was devised by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for the demarcation of land capability regions of Australia. Subsequently, the land capability survey was widely applied in the European and Anglo-American countries and in some of the Third World countries.

Land capability survey helps in ascertaining the usefulness of land, its utility for agriculture, forest, industry, tourism, and other land use purposes.

For the delineation of land capability regions, only *physical parameters* are taken into consideration. The demarcation of these regions in fact is on the basis of texture, structure of soil, terrain, slope, run-off, temperature, and precipitation. Thus, in the land capability survey, there is a heavy reliance on the results of soil survey and pedological conditions.

In general each soil group has its own physical and chemical properties. These properties determine the land capability and land suitability. For example, the *regur* soil is good for the cultivation of cotton, sugarcane, and citrus fruits, while the alluvial soil is utilised for wheat, rice, maize, sugarcane, pulses, and oilseeds.

In India, the basic objective of the Soil Survey was to achieve the land capability classification. The All India Soil and Land Use Survey Organisation attempted the land capability survey in 1960 which identified eight land use capability classes given below.

Land Suitable for Cultivation

Class I: Very good arable land with no specific difficulty in farming. It is nearly levelled, well–drained, easily worked soil. These soils are very productive.

Class II: Good cultivable land which needs protection from erosion or floods, drainage improvement and conservation of irrigation water. It has gentle, slope, less than ideal slope.

Class III: Moderately good cultivable land where special attention has to be paid to erosion control, conservation of irrigation water, intensive drainage, and protection from floods.

Class IV: Fairly good land suited for occasional or limited cultivation. It needs intensive erosion control, intensive drainage and very intensive treatment to overcome the soil limitations.

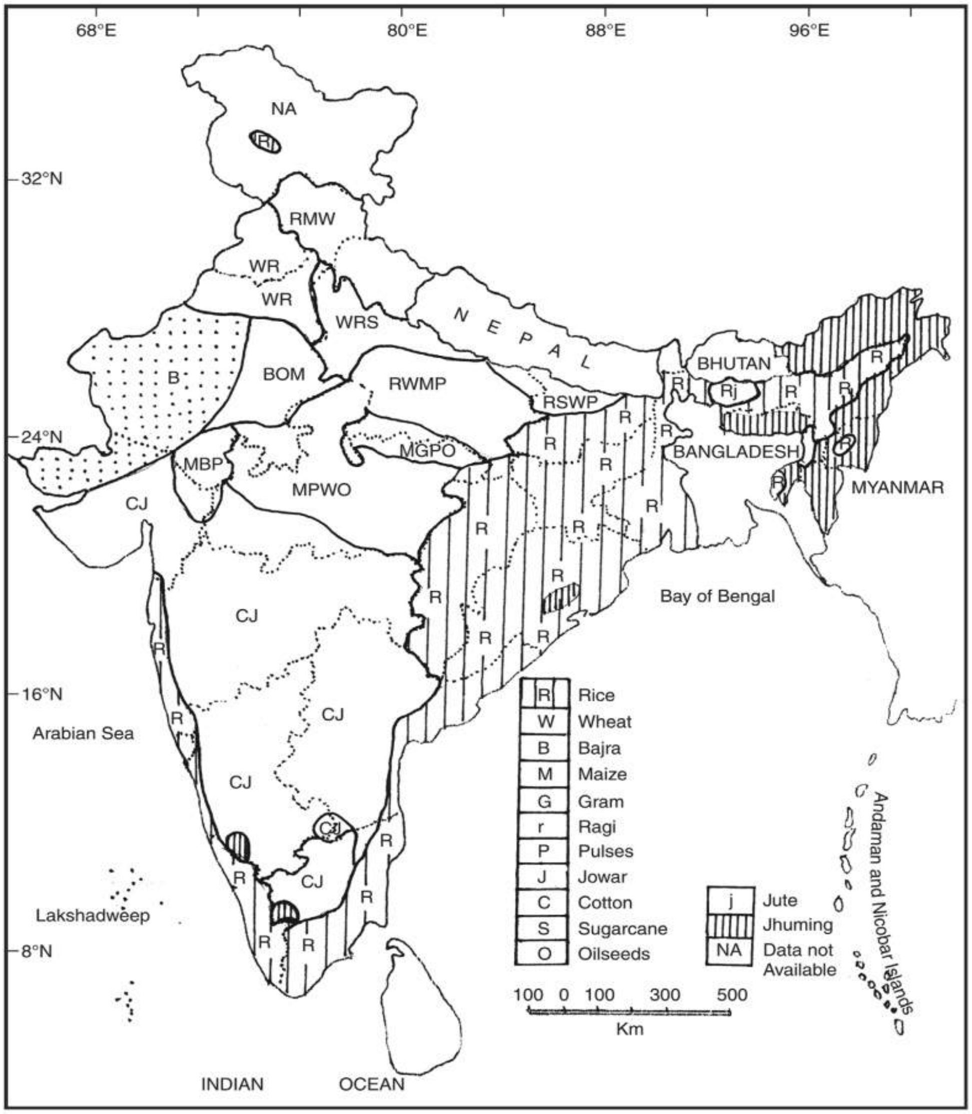

Fig. 10.4 Crop Combination Regions (2005–2006)

Land not Suitable for Cultivation

Class V: Very well suited for grazing and forestry but not for cultivation of crops. It has a very good carrying capacity of livestock but needs protection from gullying.

Class VI: Well suited for grazing and forestry but not for cultivation of crops. It has a moderate carrying capacity of livestock. This land has steep slope, severe erosion, stoniness,, poor moisture retaining capacity, sainity and severe climate.

(iii) Multi-element (Statistical) Technique
(iv) Quantitative-cum-Qualitative Technique

(i) Empirical Technique: It is largely based on the experience of the farmers and the observed facts. Von Thunen was the 1st scholar who adopted the empirical technique and prepared the first agricultural land use and crop intensity models.

The empirical technique gives a generalised picture of the cropping pattern and agricultural regions. By adopting the empirical technique Symons, Munton and Morgan demarcated the agricultural regions of the different parts of the world. This technique, has, however, been criticised as it is not objective and scientific.

(ii) Single-Element Technique: This is an arbitrary technique in which only the first ranking crops in respect of area are plotted for the purpose of demarcation of agricultural regions. Baker was the first geographer who adopted the single-element technique for the demarcation of agricultural belts of U.S.A. This technique has however been criticized as it is not scientific and objective (Fig. 10.5). On the basis of this technique, the first ranking crops of India in the different districts in 2005–06 have been plotted in **Fig. 10.1** which show the rice, wheat, maize, bajara, ragi, millets, cotton, and groundnut regions.

The main weakness of this technique is that it conceals the position and importance of other crops grown in the region. In fact, in most of the districts of India, crops are grown in combination and not in isolation. A combinational analysis is more important from the agricultural planning point of view than that of the single dominant crop.

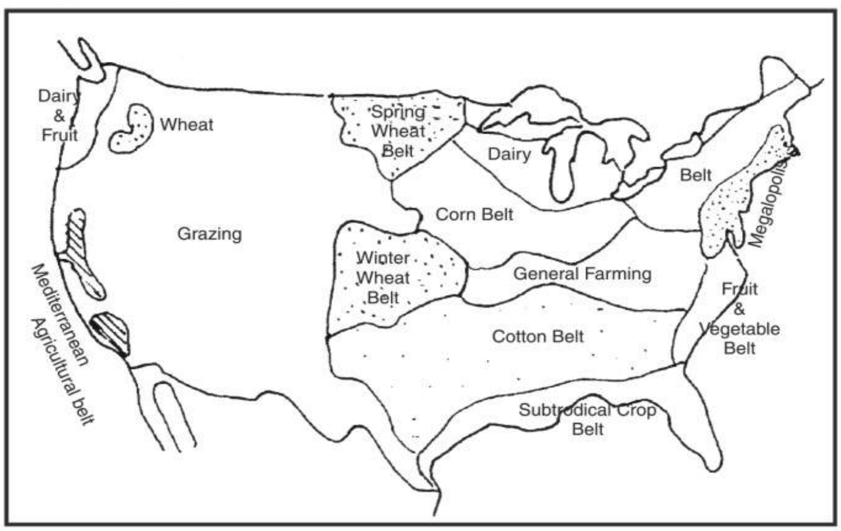

Fig. 10.5 Agricultural Belts of USA (After Baker)

(iii) Multi-Element or Statistical Technique: The multi-element technique is more objective and scientific. In the statistical techniques more than one elements (crops, etc.) are taken into consideration. The crop combination regions demarcated by Weaver, Doi, Coppock, Shafi, Jasbir Singh, Aiyer, Husain, Sapre, and Deshpande, Tiwari etc., were based on the Standard Deviation Technique. This technique is free from bias and subjectivity.

Class VII: Fairly well suited for grazing or forestry with little carrying capacity of livestock.
Class VIII: Suited only for wildlife. This land has severe climate, wet soil, stones, bad lands, sandy beaches, marshes, deserts, and nearly barren lands.

CONTRACT FARMING

Contract farming is a method to maximise profit in dealing with agricultural products. In this system, a company enters into a written contract with farmer/farmers with the following objectives:
A. To produce a given volume of produce, of specified quality, and that the company will purchase the produce on an agreed price. So briefly, it can be said that marketing enters into contract with production. The company after making the purchase, freezes, dehydrates, and starts canning operation. Sometimes the companies enter into contracts with co-operatives. In contract farming, the major items are fruits, vegetables, flowers and poultry.
B. The farmers gain certain advantages which are briefly given below:
- (i) The sale of their produce is assured.
- (ii) They earn higher price than the price in the open market.
- (iii) The capital requirements of the farmers are reduced as the contract often agreed for advance payment.
- (iv) Very often, the companies also provide specialised knowledge and expertise.

Contract farming also leads to certain disadvantages:
- (i) If a farmer has produced quality products, he could get a higher price than offered by the contracts in the open market.
- (ii) The farmer acts mechanically and loses his independent status.
- (iii) The bargaining power is tilted in favour of companies as they are financially more powerful.

AGRICULTURAL REGIONALISATION

Region is one of the basic concepts in geography. It has been defined differently by different geographers. A widely accepted definition of region is 'an area that is differentiated from other areas according to a specific criteria.' In other words, 'region is a differentiated segment of the earth surface. (Whittlesey, 1936)

Agricultural region is an uninterrupted area having some kind of homogeneity with specifically defined outer limit. It is an area which depicts homogeneity in respect of agricultural land use, agricultural practices, and cropping patterns. Agricultural region, in fact, is a device for selecting and investigating regional groupings of the complex agricultural phenomena found on the earth's surface. In other words, any segment or portion of the earth surface possessing a distinctive form of agriculture is an agricultural region. Agricultural region is a dynamic concept which changes in space and time.

The main characteristics of agricultural regions are: (i) they have location; (ii) they have transitional boundaries; (iii) they may be either formal or functional; and (iv) they may be hierarchically arranged.

Since the boundaries of agricultural regions are transitional and not sharply dividing lines, their precise delineation is a difficult task. Some of the important techniques used for the delineation of agricultural regions by the geographers are:
- (i) Empirical Techniques
- (ii) Single-element Technique

In the multi-element or statistical techniques, the agricultural regions may be demarcated with the help of the following:

(i) Cropping patterns, crop concentration, and crop diversification
(ii) Crop combination
(iii) Regional patterns of agricultural productivity

Some of the studies made with the help of the multi-element techniques gave very reliable agricultural regions. In the developing countries the non-availability of reliable data is a limiting factor in the application of this technique.

(iv) Quantitative-cum-Qualitative: The technique in which the physical (geo-climatic factors), socio-economic, cultural, and political factors are taken into consideration for the demarcation of cultural regions is known as the quantitative-cum-qualitative method. The factors which are taken into consideration for the delineation of agricultural regions on the basis of quantitative-cum-qualitative techniques are six physical traits: (i) relief, (ii) climate, (iii) surface and subsoil water, (iv) soil, (v) sub-soil, and (vi) natural vegetation; and six functional traits: (i) rural population, (ii) cultural and religious values, (iii) technological, (iv) farming operations, (v) dependent rural population, and (vi) degree of commercialisation.

The non-availability of reliable data and the quantification of cultural-cum-religious values are the limiting factors in the delineation of agricultural regions with the help of this technique.

Many of the scholars have attempted to delineate the agricultural regions of India. The divisions of India into climatic divisions made by L.D. Stamp (1958), M.S.A. Randhawa (1958), O.H.K. Spate and A.T.A. Learmonth (1960), P. Sengupta and G. Sdasyuk (1967), R.L. Singh (1971) and Jasbir Singh (1975) are important. A brief account of some of the important agricultural regionalisations of India have been given in the following section.

1. M. S. Randhawa's Classification of Agriculture (1958)

On the basis of geo-climatic variations, crop characteristics and animals, Randhawa has identified five main agricultural regions of India (**Fig. 10.6**).

1. The Temperate Himalayan Region

The Temperate Himalayan region includes the states of Jammu and Kashmir, Himachal Pradesh, and Uttarakhand in the west, and Arunachal Pradesh and Upper Assam in the east. It has two sub-divisions:

(i) The eastern part comprising Arunachal Pradesh, Sikkim, Nagaland, Tripura, and Upper Assam records heavy rainfall and are covered with thick forests. Here rice and tea are the dominant crops.
(ii) The western temperate Himalayan region consists of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. This region is characterised by horticulture (apples, cherries, pears, peach, almond, apricot, and walnut). Other crops grown are maize, rice, wheat, and potatoes.

2. The Northern Dry (Wheat) Region

This region stretches over Punjab, Haryana, western Uttar Pradesh, north-western Madhya Pradesh, and irrigated parts of Rajasthan. The average annual rainfall in this region is less than 75 cm. Parts of it are adequately irrigated by canals and tube wells. The main crops of this region are wheat, maize, cotton, mustard, gram, rice, sugarcane, and millets.

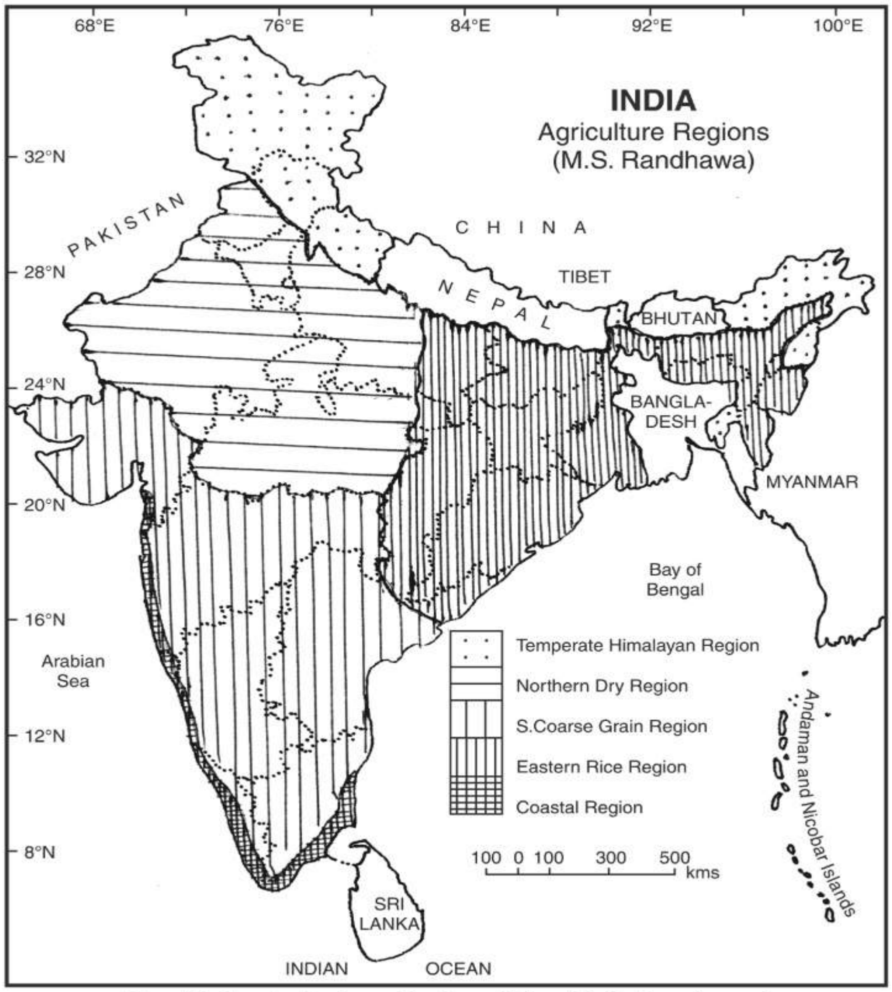

Fig. 10.6 Agriculture Regions (after M. S. Randhawa)

3. The Eastern Wet (Rice) Region

It includes the greater parts of the states of Assam, Meghalaya, Manipur, Mizoram, West Bengal, Jharkhand, Bihar, Chhattisgarh, eastern Uttar Pradesh, Odisha, and coastal Andhra Pradesh. This region records more than 150 cm of rainfall. Rice, jute, pulses, oil seeds, tea, and sugarcane are the main crops of this region.

4. The Western Wet (Malabar) Region

This region stretches over from Maharashtra to Kerala. The average annual rainfall in this region is over 200 cm. Rice is the main food crop although coconut and plantation crops (rubber, coffee, spices, cashew nut, etc.) are the main cash crops.

5. The Southern Coarse (Cereals) Region

This agricultural region sprawls over Gujarat, Madhya Pradesh, southern Uttar Pradesh (Bundelkhand), eastern Maharashtra, western Andhra Pradesh, Karnataka, and western Tamil Nadu. These areas record rainfall between 50 to 100 cm. Millets, *Bajra*, cotton, groundnut, oilseeds, and pulses are the main crops.

2. P. Sengupta and G. Sdasyuk's Classification of Agriculture

Miss P. Sengupta and Galina Sdasyuk (1968) presented a three-tier classification of India's agricultural regions.

(i) Climatic characteristics : 4 macro regions.
(ii) Physiographic characteristics: 11 meso regions.
(iii) Crop combinations : 60 micro regions.

These agricultural regions have been plotted in **Fig. 10.7** to **Fig. 10.8.**

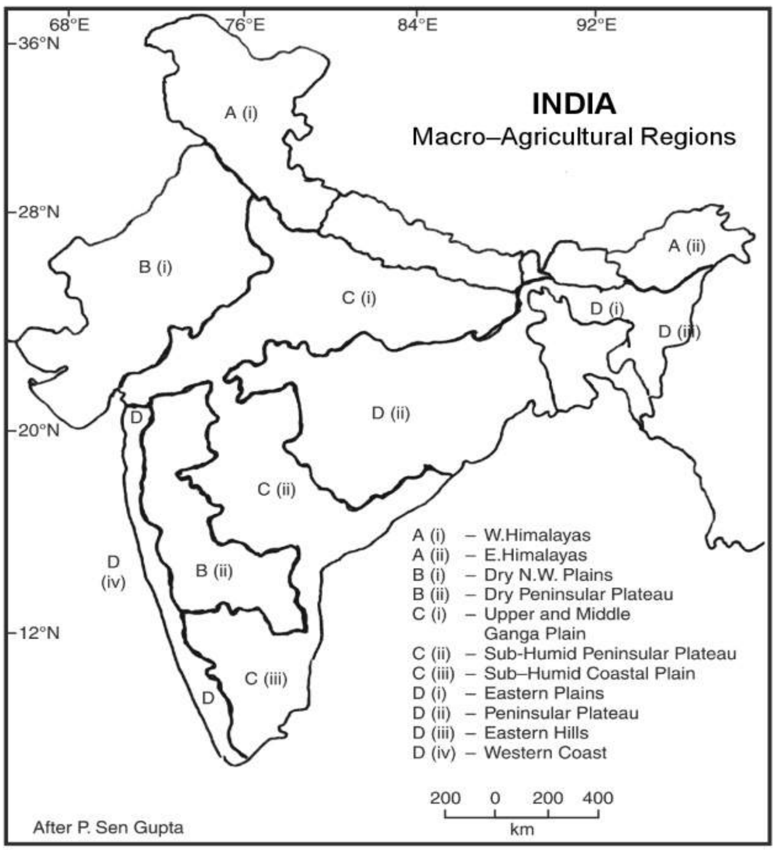

Fig. 10.7 Major Agricultural Regions

A. Himalayan Agricultural Belt

This belt sprawls over Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Darjeeling District of West Bengal, Sikkim, Arunachal Pradesh, and Assam Himalayas. The mean annual rainfall in this belt varies between 125 to 250 cm. Being mountainous, the percentage of arable land is low. Rice, wheat, maize and orchards are the main crops in the Western Himalayas, while rice, tea, and maize are the main crops in the Eastern Himalayas. It has 2 meso and 4 micro regions. Rice, maize, and wheat the significant crops of this region.

B. The Dry Agricultural Belt

The dry agricultural belt stretches over Rajasthan, western Uttar Pradesh, Haryana, and the leeward side of the Western Ghats (Sahaydris). This region records less than 75 cm of average annual rainfall.

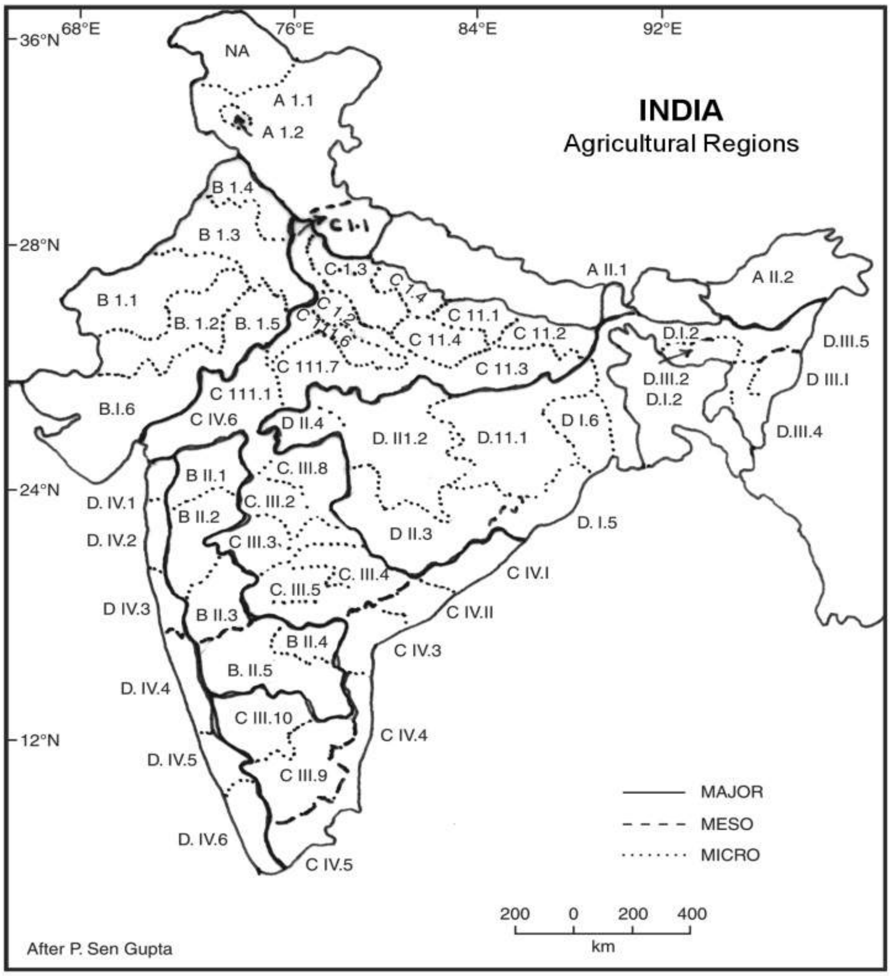

Fig. 10.8 Agricultural Regions

In Punjab, Haryana, and western Uttar Pradesh, irrigation by canals and tube wells is adequately available. The main crops of this region are wheat, rice, sugarcane, maize, pulses, oilseeds, millets, and *bajra*. It has 2 meso and 11 micro agricultural regions.

C. The Sub-Humid Belt

The sub-humid belt stretches over the Upper and Middle Ganga Plains and a narrow central belt running from Bundelkhand Andhra Pradesh to Tamil Nadu Plateau and the Eastern Coastal plain. The average annual rainfall in this region varies between 75 cm to 100 cm. The main crops are wheat, rice, sugarcane, gram, maize, millets, cotton, groundnut, oilseeds, and tobacco. It has three mesodivisions and 24 micro-agricultural regions.

D. The Wet Belt

The wet belt sprawls over West Bengal, Jharkhand, Meghalaya, Assam, Manipur, Nagaland, Mizoram, and Tripura. It receives 100 to 200 cm average annual rainfall. The main crops are rice, jute, tea, oilseeds, wheat, rubber, spices, and oilseeds. It consists of 4 meso and 21 micro-level agricultural regions. Rice, jute, oil seeds, maize, coconut, sugarcane are the dominant crops in this region.

AGRO-CLIMATIC REGIONS OF INDIA

India has great variations in the geo-climatic, socioeconomic, and agricultural practices. The variations in the geo-ecological and socioeconomic conditions have closely influenced the agricultural activities. For the planning of agriculture, the Planning Commission and the National Remote Sensing Agency (NRSA) have divided the country into 15 agro-climatic regions (**Fig. 10.9**). The main objectives of agro-climatic regions are

(i) to optimise agricultural production
(ii) to increase farm income
(iii) to generate more rural employment
(iv) to make a judicious use of the available irrigation water
(v) to reduce the regional inequalities in the development of agriculture.

These agro-climatic regions are as under:

1. The Western Himalayan Region
2. The Eastern Himalayan Region
3. The Satluj-Yamuna Plain
4. The Upper Ganga Plain
5. The Middle Ganga Plain
6. The Lower Ganga Plain
7. The Eastern Plateau and Hills
8. The Aravalli Malwa Upland
9. The Plateau Maharashtra
10. The Deccan Interior
11. The Eastern Coastal Plain
12. The Western Coastal Plain
13. The Gujarat Region
14. The Western Rajasthan
15. The Islands (Andaman and Nicobar and Maldives)

Fig. 10.9 Agro-Climatic Regions

1. The Western Himalayan Region

The western Himalayan region stretches over the states of Jammu and Kashmir, Himachal Pradesh, and Uttarakhand. There is great variation in its topography. The average temperature of July varies between 5°C and 30°C, while the January temperature reads between 15°C to –5°C. The mean annual rainfall varies between 75 cm to 150 cm except Ladakh where it is below 20 cm. The valley of Kashmir, Kullu, and Dun have thick alluvial soils while the hills and mountains have thin cover of brown soils. This region has perennial rivers, some of which are utilised for irrigation and hydel-power generation.

Rice, maize, wheat, barley, oilseeds, pulses, potato, and vegetables are the main crops of this region. Temperate fruits like apples, peach, pears, almond, apricot, walnut, etc. are the source of cash for the cultivators. Though the geographical conditions of this region are well suited for orchards and plantation crops, there is a need of improvement in the old less productive varieties of fruits.

A more judicious land use planning is required for the region. Land should be rationally allotted for cultivation of crops, horticulture, pastures, and forestry. Better quality of seeds and planting materials should be made available for growing fruits, vegetables, flowers, saffron, ginger, and potato.

2. The Eastern Himalayan Region

This region sprawls over Arunachal Pradesh, Hills of Assam, Nagaland, Meghalaya, Manipur, Mizoram, Tripura, Sikkim, and Darjeeling District of West Bengal. It has rugged topography. The temperature of July varies between 25°C to 30°C and of January between 10°C and 20°C. The soil is red-brown and less productive. About 33 per cent of the total cultivated area is under *Jhuming* (shifting cultivation).

Rice, maize, potato, tea, and orchards (pineapple, lime, litchi, oranges, etc.) are the main crops. Shifting cultivation should be controlled by developing terrace farming. Soil erosion is another important problem which needs immediate attention of the planners.The region needs marked improvement in infrastructural facilities to accelerate the pace of agricultural development. Moreover, a long term quality seed production suitable for the region needs to be implemented.

3. The Satluj Yamuna Plain

It stretches over Punjab, Haryana, Chandigarh, Delhi, and the Ganganagar District of Rajasthan. The climate has the semi-arid characteristics with July's mean monthly temperature between 25°C and 35°C and that of January between 10°C and 20° C. The average annual rainfall varies between 65 cm and 125 cm. The soil is alluvial which is highly productive. Apart from the canals, there are lakhs of tube wells and pumping sets installed by the cultivators and the governments. The intensity of agriculture (165 per cent) is the highest in the country.

Wheat, rice, sugarcane, cotton, maize, gram, millets, pulses, oilseeds, and orchards are the main crops. The farmers of this region are most innovative and progressive. The High Yielding Varieties of rice and wheat were adopted first by the farmers of this region which led to Green Revolution. At present contract farming has been started by the corporate sector in some of the districts of this region.

Development of saline and alkaline patches, water-logging, and soil erosion are the main problems of the region.

Agriculturally, this is the most developed part of the country. Agriculture may be made more productive and sustainable if the following steps are taken:

(i) Less area be devoted to rice as it is depleting the underground water table and the fertility of soil. Nearly 5 per cent of the rice and wheat area may be diverted to pulses, oilseeds, maize, fodder, vegetables, flowers, and orchards.
(ii) Pests and disease resistant seeds of rice and wheat need to be developed.
(iii) Horticulture should be promoted.
(iv) Emphasis should be made on the cultivation of vegetables.
(v) High quality fodder crops should be developed.
(vi) Steps should be taken for the diversification of agriculture.

4. The Upper Ganga Plain

The Upper Ganga Plain stretches over the western Uttar Pradesh and the Hardwar and Udham-Singh Nagar districts of Uttarakhand. The July temperature varies between 25°C and 35°C and that of January between 10°C and 25°C. The soil varies from sandy loam to clayey loam. Adequate facilities of irrigation by canals and tube well are available. Agriculture is well developed and Green Revolution is a big success in this region also.

Wheat, rice, sugarcane, maize, millets, pulses, oilseeds, and vegetables are the main crops. Mango and guava orchards are also quite significant in the agricultural landscape.

In order to make agriculture more productive and sustainable there should be emphasis on mixed cropping, horticulture, floriculture, judicious use of irrigation water, lining of canals, reclamation of saline/alkaline soils.

5. The Middle Ganga Plain

It sprawls over the greater parts of Uttar Pradesh and Bihar. The July temperature varies between 25° C and 35° C and that of January between 10° C and 25° C. The average annual rainfall varies between 100 cm and 150 cm. The soil is alluvial and there is great potential of underground water.

Rice, wheat, barley, maize, millets, pulses, mustard, sugarcane and oilseeds, are the main crops. Agriculturally, these plains are less developed than the Upper Ganga Plains.

Agriculture can be made more productive and sustainable to improve the input delivery system and diversification of crops by giving more area to vegetables, fruits, and floriculture. Dairying, silviculture, agro-forestry, and pisciculture can also go a long way in improving the income of the farmers.

6. The Lower Ganga Plains

This region stretches over the Brahmaputra Valley, West Bengal (excluding the Darjeeling District) and eastern Bihar. The July temperature varies between 25°C and 35°C and that of January between 10°C and 25°C. The mean annual rainfall varies between 100 cm and 200 cm. The soil is alluvial and highly productive.

Rice is the main crop. From the same field the farmers obtain three successive rice crops (*Aman, Aus, and Boro*) in a year. Jute, maize, pulses, and potato are the other important crops of the region.

Development of horticulture (banana, mango, and citrus fruits), pisciculture, poultry, and livestock can enhance the income of the cultivators substantially.

7. The Eastern Plateau and Hills

The Chotanagpur Plateau, stretching over Jharkhand, Odisha, Chhattisgarh, and Dandakarnaya are included in this agro-climatic region. The mean monthly temperature of July ranges between 25°C and 35°C and that of January between 15°C and 25°C. The mean annual rainfall ranges between 75 cm and 150 cm. Soils are red and yellow.

The agriculture in this region is mainly rain-fed The main crops are rice, maize, millets, *ragi*, oilseeds, gram, and tobacco.

The cultivation of high value crops like oilseeds, pulses, vegetables can increase the income of the farmers. Water-harvesting and watershed development as well as soil conservation practices can make the agriculture more remunerative.

8. The Aravalli–Malwa Upland

This region includes Bundelkhand, Baghelkhand, Mahabharat Plateau, Malwa Plateau, and Vindhyachal Hills. This region is characterised by semi-arid climatic conditions. The mean July temperature reads between 25°C and 35°C, while the mean January temperature ranges between 15°C and 25° C. The soil is mixed yellow, red, and black. It has scarcity of water, both surface and underground.

Millets, wheat, gram, pulses, oilseeds, cotton, and sunflower are the main crops. Agriculture returns can be improved by farming, sprinkle irrigation, water-harvesting, dairy development, and poultry farming.

9. The Plateau of Maharashtra

It stretches largely on Deccan Plateau. This is a region of *regur* soil (black earth soil). The July temperature ranges between 25°C and 35°C, while the mean monthly temperature in January ranges between 15°C and 25° C. The average annual rainfall varies between 50 cm and 75 cm.

Wheat, gram, millets, cotton, pulses, groundnut, and oilseeds are the main crops in the rain-fed areas, while in the irrigated areas, sugarcane, rice, and wheat, are cultivated.

In place of coarse grains, value crops like pulses and oilseeds need to be cultivated. About 5 per cent of the cotton area may be transferred to oilseeds. Dairy development, poultry farming, and social forestry are the other aspects of agricultural landscape which deserve immediate attention.

10. The Deccan Interior

The Deccan interior sprawls over the greater parts of Karnataka, Andhra Pradesh, and Tamil Nadu uplands from Adilabad District in the north to Madurai District in the south. The mean monthly temperature of July varies between 25°C and 35°C, and the mean January temperature reads between 15°C and 20°C. This region records rainfall between 50 cm and 100 cm.

This is essentially a dry-farming area where millets, pulses, oilseeds, groundnut, coffee, tea, cardamom, and spices are the main crops. The area under millets and *bajra* can be devoted to pulses. Development of horticulture, poultry, and dairy-farming can help the farmers in the augmentation of their income.

11. The Eastern Coastal Plain

This region sprawls over the Coromandal and northern Circar coasts of Andhra Pradesh and Odisha. The mean July temperature ranges between 25°C and 35°C and the mean January temperature varies between 20°C and 30°C. The mean annual rainfall varies between 75 cm and 150 cm. The main crops of this region are rice, jute, tobacco, sugarcane, maize, millets, pulses, groundnut, and oilseeds. Area from coarse grains need to be shifted to high value crops like pulses and tobacco. Development of dairying, poultry, fisheries, and social forestry deserve more attention and investment.

12. The Western Coastal Plains

This region stretches over the western fringes of the states of Maharashtra, Karnataka, and Kerala. In the north, it is known as the *Konkan coastal plains* and in the southern parts as the *Malabar coastal plains.* The mean July temperature varies between 25° C and 30° C and mean January temperatures between 18° C and 30° C. The mean annual rainfall is more than 200 cm.

Rice, oilseeds, sugarcane, millets, pulses, cotton, and coconut are the main crops. Moreover spices are raised along the hill slopes of the Western Ghats.

Raising of high value crops (pulses, spices, and coconut) should get more agricultural area. Development of infrastructural facilities and promotion to prawn culture in brackish water should get preference.

13. The Gujarat Plains and Hills

This region consists of the hills and plains of Kathiawar, and the fertile valleys of Mahi, and Sabarmati rivers. It is an arid and semi-arid region where the July temperature reads about 30ºC and that of January about 25ºC. The mean annual rainfall varies between 50 cm and 100 cm.

Groundnut, cotton, rice, maize, millets, oilseeds, wheat, pulses, and tobacco are the main crops. It is an important oilseeds producing area. The major thrust of development in the region should be on canal and ground water management, rain-water harvesting, agro-forestry in the region, and brackish/backwater aquaculture in coastal areas.

14. The Western Region

This region stretches over Rajasthan west of the Aravalli mountains, and northern Gujarat. The mean July and January temperatures vary between 40ºC and 15ºC respectively. The mean annual rainfall is less than 25 cm.

Bajra, pulses, and fodder are the main crops. Livestock contributes greatly to the desert ecology. Rain water harvesting horticulture of date-palm, water-melon, and plums deserve more attention.

15. The Islands Region

This region includes Andaman-Nicobar, and Lakshadweep which have marine equatorial climates. At Port Blair, the mean July and January temperatures read 30ºC and 25ºC, respectively. Rice, maize, millets, *bajra*, pulses, arecanut, turmeric, and cassava are the main crops. The main thrust in the development of agriculture should be on crop improvement, water management, and fisheries. Brackish water prawn culture should be promoted in the coastal areas.

AGRO-ECOLOGICAL REGIONS OF INDIA

The concept of 'agro-ecological region' is a modification and improvement on agroclimatic regions. The concept of agro-ecological region is perhaps hazy to our scientific communities. People generally confuse these two terms (agroclimatic and agro-ecological) and use them in more or less the same way. But there is a distinct difference between these two terms. According to FAO (1983), agro-climatic region is a land unit in terms of major bioclimate and length of growing period and which is climatically suitable for certain range of crop cultivation. But agro-ecological region is the land unit carved out of agro-climatic region when superimposed on land form and soil condition that acts as modifier of the length of growing period. Therefore, within an agro-climatic region there may be a few agro-ecological regions depending on soil condition. This approach has been used in delineating agro-ecological regions of India.

Methodology

The methodology used in the delineation of agro-ecological region is given below:

(i) Mean monthly temperature and mean monthly precipitation.
(ii) Type of soil.
(iii) Length of growing period.

In order to prepare an agro-ecological region map, the soil-scap (soil-map) was superimposed on bio-climatic map. On the resultant map, the growing period was incorporated, using GIS technology.

In the demarcation of agro-ecological regions of India, the agro-climatic regions of India have been sub-divided on the basis of soil type. In the meso-regions thus obtained, the length of growing period (LGP) has been superimposed. This method has resulted into 20 agro-ecological regions and 60 agro-ecological sub-regions. The 20 agro-ecological regions of India have been plotted in **Fig. 10.10.**

The agro-ecological regions of India are:

1. Western Himalayas, cold arid eco-region with shallow soil and length of growing period less than 90 days.
2. Western Plain, Kachchh, and part of Kathiwara Peninsula, hot and arid ecoregion with desert and saline soils and growing period less than 90 days.
3. Deccan Plateau, hot arid region with red and black soils and growing period of less than 90 days.
4. Northern Plain and Central Highlands including Aravallis, hot semi-arid ecoregion, with alluvium-derived soils and growing period between varying between 90–150 days.
5. Central Malwa Highlands, Gujarat Plains, and Kathiawar Peninsula, hot semi-arid ecoregion with medium and deep black soils and growing period varying between 90 to 150 days.
6. Deccan Plateau, hot semi-arid ecoregion, with shallow and medium black soils and growing period varying between 90 to 150 days.
7. Deccan (Telengana)Plateau and Eastern Ghats, hot semi-arid ecoregion with red and black soil and growing period from 90 to 150 days.
8. Eastern Ghats, Tamil Nadu Plateau and Deccan (Karnataka), hot semi-arid ecoregion with red-loamy soils, and growing period of 90–150 days.
9. Northern Plain, hot sub-humid (dry) ecoregion, with alluvium soils, and growing period of 150–180 days.
10. Central Highlands (Malwas, Budelkhand, and Eastern Satpura), hot subhumid ecoregion, with black and red soils, and growing period 150–189 days.
11. Eastern Plateau (Chattisgarh), hot sub-humid ecoregion, with red and yellow soils, and growing period of 150–180 days.
12. Eastern (Chotanagpur) Plateau and Eastern Ghats, hot subhumid ecoregion, with red and lateritic soils, and growing period of 150–180 days.
13. Eastern Plain, hot sub-humid (moist) ecoregion, with alluvium soils, and growing period of 180–210 days.
14. Western Himalayas, warm sub-humid to humid with inclusion of perhumid ecoregion, with brown forest and podzolic soils, and growing period of 180–210 days.
15. Bengal and Assam Plain, hot sub-humid (moist) to humid (inclusion of perhumid) ecoregion with alluvial soils, and growing period 180 to 210 days.

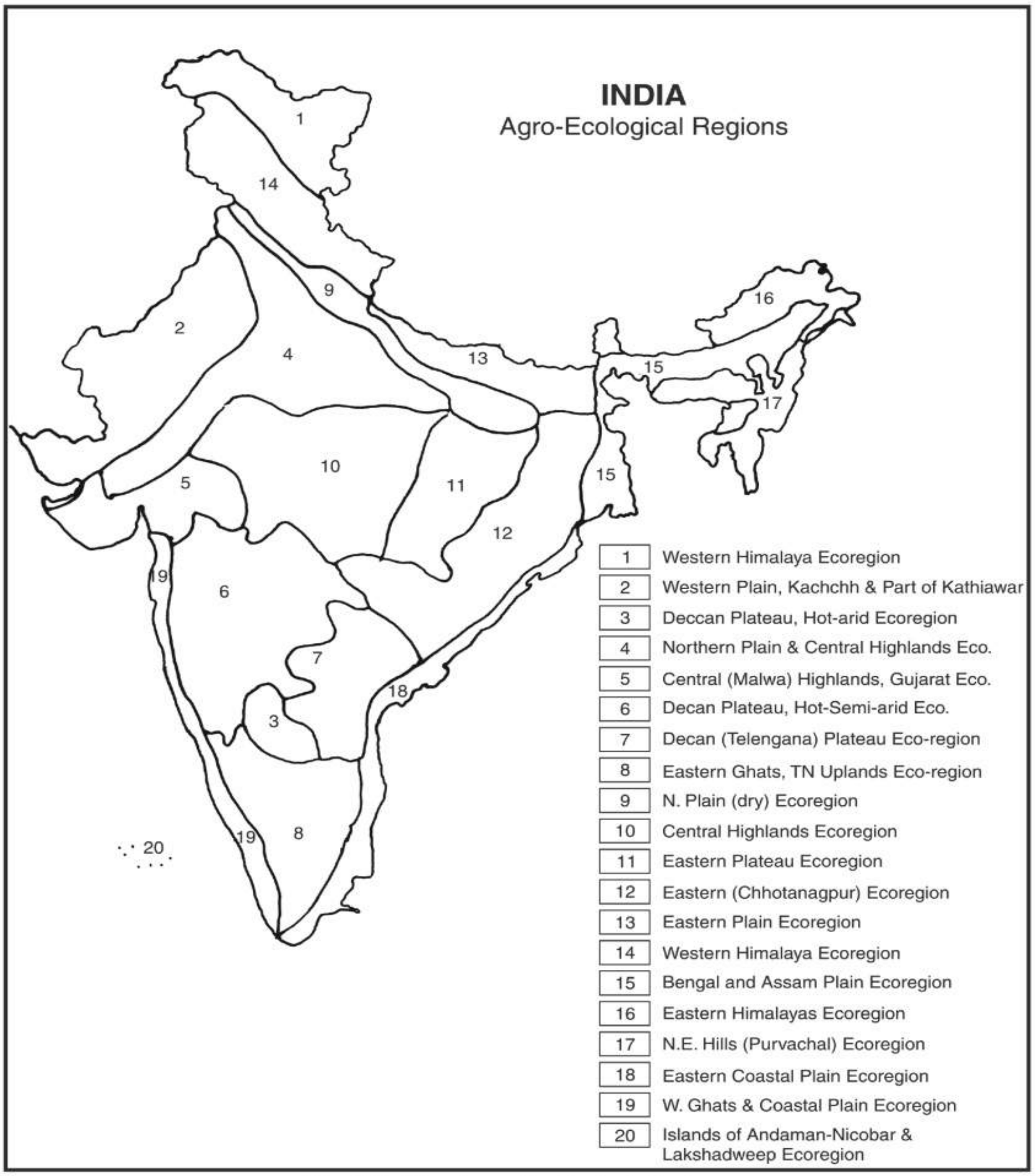

Fig. 10.10 Agro-Ecological Regions

16. Eastern Himalayas, warm perhumid ecoregion with brown and red soils, and growing period over 210 days.
17. North-Eastern Hills (Purvanchal), warm perhumid ecoregion with red and lateritic soils, and growing period over 210 days.

18. Eastern Coastal Plain, hot sub-humid to semi-arid ecoregion with coastal alluvium soils, and growing period varying from 90 to 210 days.
19. Western Ghats and Coastal Plain, hot humid per humid ecoregion, with red lateritic and alluvium soils, and growing period varying from 90 to 210 days.
20. The Islands of Andaman and Nicobar and Lakshadweep, hot humid to perhumid island ecoregion, with red loamy and sandy soils, and growing period over 210 days.

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