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# UNIT 19 FOOD AND AGRICULTURE

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## 19.1 INTRODUCTION

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As you have already studied in Block 1, availability of food has considerably influenced human societies in the past. It was with the advent of agriculture, that supply of food was assured to man, and he could give up nomadic life. In this unit, we shall take up various basic aspects of agriculture and its products.

In Unit 2, Section 2.3, there is a brief mention of the origin of agriculture and civilisation. You may perhaps like to look at that section again. Having done that, now let us discuss food and agriculture. You would find a lot of numbers mentioned in this unit. You are not expected to memorise all of them. These figures are meant to give you a more realistic picture of the whole situation.

### Objectives

After studying this unit, you should be able to :

- describe the basic resources for agriculture,
- list the various scientific and technological advancements in crop production,
- discuss the various agrotechniques,
- describe the alternate food resources, and advancements made in their production,
- understand that growth in agriculture has resulted because of inputs from science and technology.

## 19.2 AGRICULTURE IN INDIA—A WAY OF LIFE

Agriculture is the bedrock of Indian economy. Of the approximately 245 million working people in India, (1981 figures) about 93 million were cultivators and 56 million were agricultural labourers. Together they constituted more than 60% of the total work-force. To these 149 million people, agriculture is not only the chief occupation, but a way of life.

We have a total geographic area of about 329 million hectares. The net area under cultivation is 142 million hectares, of which about 31 million hectares are cultivated more than once a year, hence the total cropped area amounts to 173 million hectares. The land under forests is about 67 million hectares.

Of our total net national product of Rs. 1,732,000 million at current prices, agriculture contributes Rs. 570,660 million, forestry Rs. 15,970 million, and fishing Rs. 14,430 million. Thus our farmers and agricultural labourers, who constitute 60.5% of work-force, contribute 34.7% of our total net national product. While reading these figures, we should keep in mind the following points:

- i) The majority of our farmers are poor, hence they are unable to make the inputs required to get the maximum production from their land.
- ii) Our agricultural technologies and policies should, for some time to come, be labour-intensive to provide employment to the large number of people already engaged in agriculture. The introduction of any drastic labour-reducing technology will throw most of the agricultural workers out of employment, and will create more rural poverty and hence social unrest.

So you have seen that agriculture employs a large chunk of our manpower and provides them means to earn their livelihood. Now let us study the basic resources for agriculture.

## 19.3 BASIC RESOURCES FOR AGRICULTURE

Besides human endeavour, the basic resources for agriculture are sunlight, soil and water. We shall now discuss them one by one.

### 19.3.1 Sunlight

You already know that only when sunlight is available, can plants manufacture food. On an average, in a 12 hour day, we on the earth, receive 500 kilocalories of solar radiation per square centimetre. Of these, only 222 kilocalories are used by plants for photosynthesis. Theoretically it is possible to get 140 tonnes of crop yield per hectare in a year, if water, carbon dioxide and nutrients are not the limiting factors. In practice, however, the maximum yield, has been only 25 tonnes of grains, per hectare in a year. During monsoon, the wettest season, the sky is overcast most of the time, reducing the availability of sunlight. In summers, maximum sunlight is available. But unfortunately, it is the period when water availability is at its minimum. Under such circumstances, we could perhaps collect the runoff during the monsoon in storage tanks in the low lying areas (see Fig. 19.1), and use



Fig. 19.1: A storage tank to collect surface runoff during rains.

this water in summers when crops need it. This, however, requires cooperative community action of the whole village, or block, as construction of storage tanks is beyond the means of individual farmers. Winter, however, is the best period of the year, as there is enough of sunlight and moisture.

### 19.3.2 Soil

Nature takes more than 50 years to build a centimetre of top soil. But every year, wind, water and human neglect, cause worldwide erosion of over 6,000 million tonnes of soil, along with 2.6 million tonnes each of nutrients like nitrogen and potassium, and 3.3 million tonnes of phosphorus. The best way to check soil erosion is by providing adequate tree and grass cover. If this cannot be easily done in regions where there is an acute demand on land for crop cultivation, we should resort to contour-bunding and gully-plugging on scientific lines, followed by planting green-manure shrubs and trees on field bunds. The commonly used green-manure crops in our country are sunnhemp, dhaincha, cluster-bean, senji, cowpea, horse gram, pillipesara, berseem and lentil.

Though history has taught us that civilisations have vanished because of improper use of soil, still we are diverting millions of tonnes of excellent soil for brick-making and road-laying. This wasteful practice should be drastically curtailed by making use of alternative and more durable materials for making bricks and roads.

Do you know that every person born today needs 0.4 hectare of land for food production and another 0.08 hectare for housing, roads, waste disposal, power supply and other needs. Today, our agricultural land is less than 0.33 hectare to a person, which is below the prescribed limit. It is time we created a country-wide awareness of the value of soil and the importance of scientific land use. We must understand that, if we neglect our soils, our future will be in peril.

Let us now see the different types of soils found in our country. Indian soils are grouped into 25 different classes. For simplification, they can be sorted out into 10 major groups that are given in italics in the following lines. Their maximum production potential, in terms of grain equivalent, is estimated at 4,572 million tonnes: *alluvial soils* can produce 1,536 million tonnes; *black soils* 1,236 million tonnes; *red-and-yellow soils* 669 million tonnes; *red soils* 530 million tonnes; and *coastal and deltaic alluvial soils* 413 million tonnes of foodgrain equivalent. *Brown, laterite, desert, hill and mountain soils* can produce another 176 million tonnes.

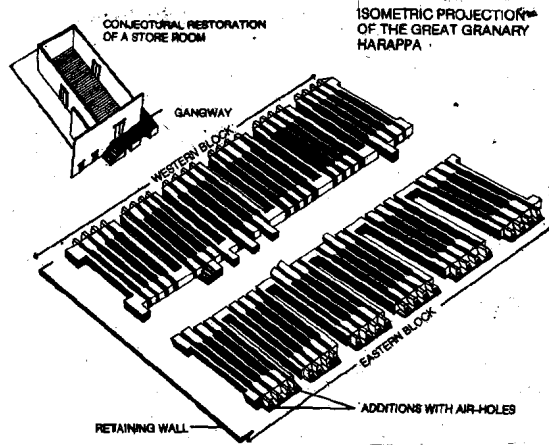
We see that we are endowed with a wide variety of soils. Before growing crops or other plants in any soil, it is essential that we first ascertain whether this soil is suitable for the plants that we intend to grow. The soils should, therefore, be tested to check their nutrients and physical characteristics. This is important because if the soil is not of the right kind, not only will the yield be poor but the soil would also be damaged.

### 19.3.3 Water

A major factor in our country's agriculture is its dependence on rain to fulfil the requirements of water. Out of our net sown area of 142 million hectares, the net irrigated area is only 40 million hectares. The rest is dependent on rains.

Indian agriculture is sometimes described as a gamble on the monsoon. There is some truth in the statement. In our country, which is situated in the monsoon belt of south-east Asia, the rainfall is neither uniform, nor is it distributed throughout the year, therefore, we do not have good growth of the rain dependent crops. You might be knowing that most parts of our country receive their annual rainfall in less than three months, leaving the rest of the year dry. But in places like Rajasthan, 3 days of rain may be followed by 3 years of dry period! Every year, droughts or floods are common in one or another part of our country, often upsetting our economy. Droughts are known to Indians from times immemorial. The Mahabharata makes a mention of a famine that caused untold suffering to people. The great granaries of the Harappan period (see Fig. 19.2) are indicative not only of good agriculture but also of the need to store grains in large quantities to cover the lean years. In 1987, we faced the worst drought of this century, but our comfortable grain reserves helped us pass through the difficult period. In recently recorded history, the years 1877, 1899 and 1918

Contour bunding refers to the ridges made out of soil in the field. In gully-plugging, materials like hedges, soil, sand bags etc. are placed in water channels in the field to reduce the speed of runoff water. This results in the settling of fine soil particles carried along with running water, and an increased seepage of water in the soil.



**Fig.19.2: The granaries of the Harappan Period.**

stand out prominently as years of country-wide drought and 1878, 1892 and 1912 as years of widespread floods. On an average, we face drought, in various parts of the country, once in every 4 years, and country-wide droughts occur once in every 20 years. There is, however, no regular periodicity in the occurrence of droughts and floods. Since we cannot change the geographic situation of our country we have to learn to live with our inconsistent monsoons.

On an average, we receive an annual rainfall of 370 million hectare-metres (one hectare-metre of rain is equivalent to 10,000 cubic metres). The south-west monsoon is responsible for over 80% of the total rainfall in most parts of the country. An estimated 80 million hectare-metres of water seeps into the soil, of which about half remains in the top soil layer and supports plant growth. The rest seeps further down into the ground, and constitutes ground water. Of this, three quarters may be re-utilised for crop growth. Currently, however, we are using only one fourth of it. Here, we would like to point out that the ground water should be used only after careful study. There are salt deposits in the ground, in some places, which make the water unusable for crops. These salts dissolve in ground water, come up when water is pumped up, and form salt crusts on the soil surface, making the land unproductive.

You have just seen that a large number of variations in these basic resources are found in our country. In the next section, that follows SAQ 1, we shall describe some of the economically important plants and useful animals found in India. We shall also see whether they are natives of this country or they have been introduced from elsewhere.

**SAQ 1**

a) Why is India referred to as an agriculture-based country? Justify your answer giving two or three reasons.

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b) Fill in the blanks picking up the suitable word or words from the list given below :

- i) Nearly eighty per cent of the total rainfall in our country is due to ..... monsoon.
- ii) Of the total amount of solar radiations received on earth, less than ..... are used by plants for photosynthesis.
- iii) As a result of soil erosion, we not only lose soil but also many.....
- iv) ..... soils have the maximum production potential as compared to the remaining nine groups of soils.
- v) Most of our agricultural land is dependent on rains and only a very small proportion, that is, about ..... per cent is under irrigation.  
(alluvial, south-west, twenty eight, nutrients, half)

## 19.4 THE PLANT AND ANIMAL WEALTH OF INDIA

You might be surprised to know that over 20,000 plant species are found in our country—a number that is more than that found in countries with larger land masses. This is because of the great diversity in our soils and climate. Of the 20,000 species, 500 are used in one form or another, and about 250 species are under cultivation, excluding ornamentals, shrubs and herbs. About 35 of these cultivated species were first domesticated in India and the adjoining countries. These include rice, minor millets, yam, taro, pulses, beans, mustard, Asiatic cotton, jute, sunnhemp, mesta, roselle, brinjal, spinach, cucumber, a diversity of gourds, black-pepper, long-pepper, cinnamon, ginger, turmeric, cardamom, hemp, mango, banana, citrus, jackfruit, date palm, tamarind, amla, ber, wood-apple, phalsa, jamun, and several medicinal plants.

Amongst animals, the humped zebu cattle and the riverine buffalo have originated in India. Motifs of domesticated humpless cattle occur on the seals of the Harappan period (2400 B.C.) (see Fig. 19.3) that were found in Gujarat and Rajasthan.

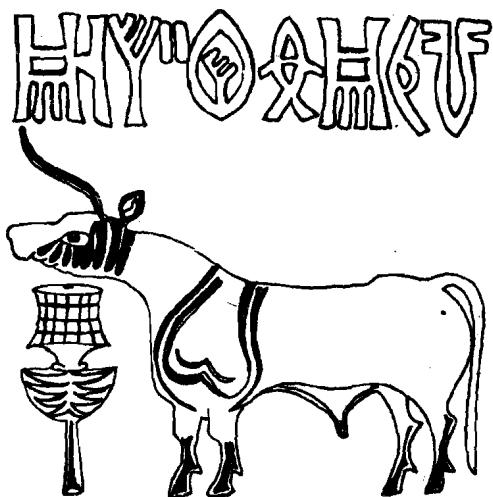


Fig. 19.3: Humpless cattle of the Harappan period.  
The presence of a feeding trough indicates that the cattle was domesticated.

The earliest ploughed field, dating back to 2450 B.C. was discovered in Kalibangan, Rajasthan. You might be surprised to know that all the world's poultry trace their origin to the red jungle fowl (see Fig. 19.4) of Madhya Pradesh.

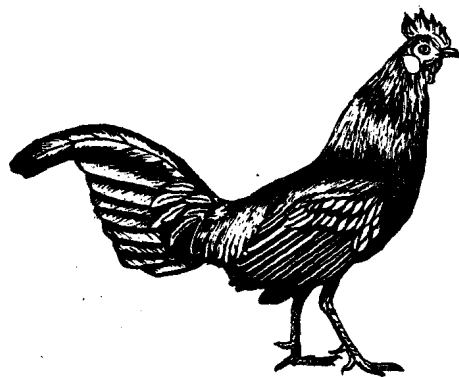


Fig. 19.4: Red Jungle Fowl (*Gallus gallus*).  
Hindi name—Jangli murgh.

After Salim Ali, the Book of Indian Birds, Bombay Natural History Society, Bombay, 1972.

Not all the plants or animals that we use here, in our country, are the natives of this place. Some of them were brought here from different parts of the globe. Since India had trade ties with other countries from ancient times, a large number of economic plants and domestic animals have been introduced into our country both from the east and the west. From western Asia, the following plants were brought and grown here: barley, wheat, lentil, pea, broad-bean, onion, garlic, beet, carrot, radish, fenugreek, coriander, cumin, fennel, alfalfa, flax, belladonna, poppy, black-psyllium, licorice and foxglove. From Africa came sorghum, pearl-millet, finger-millet, cowpea, castor, sesamum, okra, guinea-grass, elephant-grass and coffee. Similarly, from China, proso-millet, soybean, tung, tallow, loquat, litchi, peach, apricot, walnut and tea were brought. The introductions from southeast Asia and Pacific Islands include breadfruit, bilimbi, carambola, lime, lemon, sweet-orange, sour-orange, citron, tangerine, mangosteen, coconut, sago, sugarpalm, arecanut, betel and henna. From the New World, i.e., America came maize, potato, tobacco, sweet-potato, arrow-root, tomato, chilli, pumpkin, papaya, guava, custard-apple, groundnut, cashewnut, American cotton, rubber, sunflower, grape, squash and sarsaparilla. These plants once they reached our land, quickly established themselves in our diverse climates and soils. Indeed, some of them thrive much better in our country than in their native lands.

Some of these plants, such as wheat and many pulses etc. have since been grown on a large scale to meet the food requirements of our people. As these plants are grown in varied conditions in our country, certain improvements in them were essential, to get maximum yields from them. Our agricultural scientists have developed high-yielding varieties, and evolved disease-resistant crops. In the following section, we shall discuss some of these advancements brought about in our cereals, millets, oilseeds, pulses and many other crops.

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## **19.5 SCIENTIFIC AND TECHNOLOGICAL ADVANCEMENTS IN OUR AGRICULTURAL PRODUCE**

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In the recent years, there has been a marked increase in our agricultural productivity. A major factor responsible for this is the change brought about by scientists in the genetic architecture of plants (such as dwarf and bushy) and their developmental rhythms (for example, when the plant puts forth flowers). Let us see what this means. Supposing there is a plant that grows and gives optimum yield in a particular part of the year. By genetic manipulations, the scientists have now made it possible that it can be grown profitably in any part of the year. Examples are many. Perhaps you may not remember, but surely your parents can tell you, that a few years back, plants like potato, dolichos-beans etc. were available in local market only during certain months of the year. Now, one can find them almost throughout the year. This is due to the change brought about in their developmental rhythms.

### **19.5.1 Cereals and Millets**

The crops sown during the south-westerly monsoon are called kharif crops. In north India where there are distinct seasons, it is the period from July to October. The post-monsoon crops, i.e., the ones sown between October and March are known as rabi crops. The kharif crops include rice, maize, jowar, bajra, ragi and other small millets. On the other hand, wheat, barley, oat, rye and triticale are the examples of our rabi crops.

Rice is the main cereal of the country, accounting for some 80% of the cultivated area. In Section 19.4, you have studied that, in our country rice was one of the first domesticated plants. The rice varieties under cultivation up to the mid 1950s were tall and weak stemmed. They were not efficient in making use of sunlight or nutrients, and produced only a few grains on loose panicles (see Fig. 19.5a). In contrast, the present high-yielding varieties are dwarf, stiff-strawed, and produce tillers profusely. They respond positively, to the fertilisers and produce compact panicles bearing an abundance of grains. The flag leaf (the leaf immediately below the panicle) remains erect (see Fig. 19.5 b) and green right up to the harvest stage, manufacturing food and sending it for grain filling. Most of the new varieties are not season-bound, and can, hence, be grown any time of the year. They can be fitted in rotation with other crops in summer, winter or the rainy season.



Fig. 19.5: A primitive rice variety (a) and an improved variety (b).

As a result of this breakthrough, rice production increased from 25 million tonnes in 1954-55, to about 59 million tonnes in 1984-85. In terms of yield per hectare, it increased from 820 kg to 1,425 kg. Though the population in this period shot up from about 390 million to 751 million, the per head net availability of rice increased from 159 grams to 207 grams per day.

The story of wheat, our most important rabi crop, is even more spectacular, the yields per hectare increased from 827 kg to 1,873 kg during the same period as above. This remarkable increase has revolutionised the whole agricultural set up in the country. This is also popularly known as the green revolution. Despite our population growth, the per head availability of wheat has gone up from 80 grams to 130 grams per day.

With the release of high-yielding varieties, some of the area traditionally sown to coarse grains were diverted to rice and wheat. Hence, the area under coarse grains declined from 44.7 million hectare in 1958-59, to 39.2 million hectare in 1984-85. Still, the production of coarse grains during the same period increased from 23.2 million tonnes to 31.2 million tonnes. This is mainly due to the use of the new, improved varieties of the coarse grains.

Coarse grains also known as millets, e.g., bajra, Italian-millet, sorghum, finger-millet and other small millets.

The concept of the new, improved plant type has been extended to most other crops also. Based on the evolutionary history of the plants and using statistical analysis, scientists now create ideotypes, i.e. plants with ideal frame and desirable physiological and biochemical characteristics. Scientists select suitable type of characters, by scanning the wide variation in the available *germplasm*. They, then, try to incorporate as many of the desirable characters as possible into one variety.

### 19.5.2 Pulses and Soybean

Pulses occupy an important place in the diet of our population. These are an excellent source of protein. They meet the needs of a large majority of consumers who are mainly vegetarians. Many of them belong to weaker sections of our population, who cannot afford better protein sources, such as eggs or other animal products. Pulses are also important for feeding livestock. Pulses are legumes, and you know that they play an important part in maintaining soil fertility (see Unit 14).

Let us now talk about pulses that we commonly use in this country. The most commonly used pulse is pigeonpea or arhar. Some of its traditional varieties have too many leaves and branches and too few pods and grains. These are being replaced by more compact, manageable plants with more pods and seeds. Many present day varieties come to harvest in less than 150 days, compared with more than 300 days required by earlier varieties. In chickpea or chana the straggling plant type was changed to an erect type with many branches, that produce pods from the base to the tip. A change in the developmental rhythm

has now made it possible to grow mungbean and urdbean in winter and summer. Such a change has also made it possible, now to grow rajmash in the plains, which was not possible hitherto.

One thing that we would like to point out here is that, in the cultivation of pulses, crop management is more important than the variety grown. A fortnight's delay in sowing may mean all the difference between a bumper harvest and total crop failure. Just one irrigation, at a critical stage of crop life can boost yields considerably. Pulse crops have nodules on their roots which harbour bacteria that fix nitrogen from the atmosphere. Hence, their nitrogen needs are less. But they need adequate doses of phosphate, which must be applied only after getting the soil tested. Proper spacing of plants, their watering and need-based application of chemicals to control pests like the pod-borers, are the other very important factors. Unfortunately, the management technology has not spread among farmers as fast as the high yielding seeds. Consequently, pulse production has not made any significant advance. Our total production of pulses in 1986-87 was 12 million tonnes, compared with 11 million tonnes in 1954-55. Meanwhile, our population has shot up so much that our per head availability of pulses today is reduced. Presently, it is less than 40 grams (compared with 64 grams in 1954-55), as against the minimum requirement of 80 grams a day, as recommended by the World Health Organisation. This is an alarming trend because we have a very large number of growing children, who need pulses in their diet for adequate muscle-building. Protein malnutrition not only hampers physical growth but also has an adverse effect on the mental development of growing children.

In this context, there is an urgent need to popularise soybean cultivation in our country. Soybean has 43.2 grams of protein per 100 grams of seed, compared with only 22.3 grams of protein in pigeonpea or arhar. Trials conducted throughout India have shown that soybean yields 29.6 quintals to grain per hectare whereas pigeonpea yields only 16.60 quintals under similar conditions. The protein-rich soybean has also 19.5% oil in its grain and occupies the top rank in world vegetable oil production. Soybean can be cultivated on uplands, on rice bunds, and as a companion crop with cotton, maize, fingermillet and pigeonpea. It can be cultivated throughout the country. It has been found that, the quality of soybean is better in the cooler hilly regions. Soybean can thus be a boon to India. Though, presently, the crop is grown mostly in parts of Madhya Pradesh and Uttar Pradesh, its cultivation can spread dramatically if we acquaint people with its advantages and increase the marketing facilities.

### 19.5.3 Oilseeds

The traditional oilseed yielding crops of our country are groundnut, sesamum, niger, castor, brassicas, linseed, and safflower. To this list are to be added new crops, soybean, sunflower and oilpalm which are highly promising. The vegetable oils that we all use, are derived not only from traditional oilseed crops, but also from cotton seeds, rice bran, maize (corn), coconut, and several other oil containing herbs, shrubs and trees.

Though oilseeds contributed to 7% of our foreign exchange earnings in 1963-64, our oilseed production has never really been high. Our per head availability of oilseeds increased from 2.5 kg in 1955-56 to 5.5 kg in 1984-85. The per head availability of vanaspati oil increased from 0.7 kg to 1.2 kg during this period. But the availability of oils and fats is only about 15 grams to a person in a day, which is, half the recommended level of 30 grams. Though an essential item of balanced diet, fats have traditionally formed an item of low importance in our food intake. This disturbing trend needs immediate correction, since malnutrition is rampant in India.

For centuries, the cultivation of oilseed crops has been relegated to marginal and submarginal lands that are poor in both soil nutrients and water supply. As a result, most of our oilseed types are those that can survive in most adverse conditions but their production is very low. Efforts are being made to remedy the situation by evolving plant types capable of giving high yields under better conditions of cultivation.

Groundnut is our most important oilseed crop. Our immediate target should be to produce about 4 tonnes of pods per hectare and this would yield nearly a tonne of oil. In groundnut as well as in mustard, rapeseed, castor and safflower, we have varieties that can more than meet his target. The use of well-filled pods with healthy seeds, optimum plant population per hectare, timely sowing, at least one irrigation at the critical stage of crop growth, and fertiliser application



based on crop needs can give more than 80% of the highest attainable yield. The other factors are timely weed control, need-based use of plant protection measures and prevention of post-harvest losses. There is also considerable scope for updating the present inefficient village level methods of expelling oil from seeds. Not only that, our strategy should also be to fit them in rotation with other crops, in areas where good soil, and assured rainfall are available, and stabilise their yields with good management in regions receiving medium amount of rainfall.

#### 19.5.4 Sugar Crops

India has a history of producing superior varieties of sugarcane. Over 25 countries grow sugarcane varieties bred in India, including the internationally popular 'NCO 310' variety. The yields and duration of sugarcane show much variation in our country because of the variations in our climates. Our effort should be to grow more sugarcane in regions where the per-day productivity is high. We have several, good spring and autumn-planted varieties. If the planting of these varieties is properly planned, we can produce enough sugarcane to keep our sugar mills busy throughout the year. What is needed is some sort of guarantee for remunerative price and assured sale for these crop. This assurance must come from the sugarcane mills and the cooperative societies. They should also supply the farmers with timely inputs in terms of fertilisers and crop protection measures, etc.

Sugarbeet, another sugar yielding crop, was introduced in India in the 1960s. It has an excellent scope for cultivation on soils having very high amount of sodium, where no other crop can profitably be cultivated. Sugarbeet removes the excessive sodium and improve the texture of such soils.

In spite of increase of population, our per head availability of sugar increased from 4.7 kg in 1960-61 to 10.7 kg in 1984-85.

#### 19.5.5 Fibre Crops

Of our fibre crops, cotton is the foremost. In fact, India is the first country that developed hybrid cotton. Today we have a wide spectrum of varieties not only in the long-staple (see Fig. 19.6) group but also in the medium and short staple categories, for which there is a



Fig. 19.6: Hybrid cotton, LRA 5166

great demand in rural India. In spite of our research achievements, the availability of cotton cloth decreased from 13.8 metres per person in 1960-61 to 10.6 metres in 1984-85. The increase in synthetic fabrics from 1.2 metres to 3.9 metres per person during the same period did not offset this decrease. It is highly disturbing to note that an average Indian today, has less cloth than his counterpart two and a half decades ago, even though, today, our area under cotton cultivation and our textile industry are the largest in the world. Since we cannot bring any more additional land under cultivation, cotton in rotation with other crops should receive a high priority together with adequate pest control and crop management.

Jute is cultivated in regions where rainfall is high. In 1980-81, India exported 558 thousand tonnes of jute goods valued at Rs. 3,991 million. But because of the world-wide changes in materials used for packaging, storage and transporting which replace jute, our exports fell in 1984-85 to 160 thousand tonnes. There is, however, a good demand for jute products within the country. Hence, our scientists have developed jute varieties that can be rotated with rice, wheat, potato and mungbean.

### 19.5.6 Plantation Crops

Tea, coffee, cocoa, rubber, coconut, arecanut, cashew, cardamom, blackpepper and related spices are grown on a plantation scale, and their produce has a good demand both within and outside our country. Our scientists have developed technologies for multi-tier cropping (Fig. 19.7) to make a more profitable use of the available space in plantations and orchards. For example, pepper can be twined along the trunks of coconut and arecanut trees, and in the space between arecanut trees, pineapple, fodder legumes and grasses can be planted. Such multi-tier cropping increases the productivity per unit area per unit time.



Fig. 19.7: Multi-tier cropping. The tall, coconut trees are in the background, cocoa plants in the middle row and the pineapple plants form the third tier.

### 19.5.7 Potato and other Tuber Crops

Potato is propagated by seed-tubers, which should be disease-free to raise a healthy crop. Till recently, healthy seed-tubers could be raised only in the hilly regions that are free from aphid pests which spread virus diseases. Through detailed monitoring studies, our scientists have identified different periods of the year when different regions of our country are free from the disease-spreading aphids. With the development of suitable varieties, all the potato growing regions of the country can now raise healthy seed-tubers during the aphid-free time.

The potato crop is traditionally raised from cut pieces of seed tubers, which are expensive and account for the major cost of potato cultivation. Recently, scientists have developed the technology to raise the crop from potato seed much the same way as we grow tomato or brinjal. When perfected, this technology will considerably cut the cost of cultivation of this energy-rich crop.

Cassava (tapioca), sweet-potato, Dioscorea and a variety of other yams constitute an important source of food, especially among weaker sections of the people. Though, some of the consumers may switch over to cereals when our development programmes make headway, tuber crops will continue to be important to our agricultural economy as they are a cheap source of food calories and can be raised on lands that cannot support other crops.

### 19.5.8 Fruits and Vegetables

Annually, we produce about 15 million tonnes of fruits from about 2 million hectare land and 9 million tonnes of vegetables from about 1 million hectare land. Our per head daily

consumption is only 60 grams of fruits and 75 grams of vegetables, much below the minimum recommendation of 85 grams and 200 grams respectively.

However, after the initial emphasis on self-sufficiency in foodgrains, research was intensified in horticulture, and the past two decades have witnessed considerable development of high-yielding horticultural crops with better quality produce.

Recently a Technology Mission has been constituted and a Ministry for Food Processing established to harness the best available technology for long-distance transport, packaging, processing and canning of fruits, vegetables, and low-fat, high-protein mushrooms, so that these important food items are readily available to buyers.

Fruits and vegetables are seasonal produce. When produced in abundance, they create a glut in the market, and the prices go down. The product is also, sometimes, wasted. Drying, canning, extracting juices etc. are methods by which the product can bring good returns to the farmers, and fulfil the needs of the buyer.

### 19.5.9 Agroforestry

As a result of clearing forests so as to put the land to other uses, or of cutting trees to sell wood for construction or other purposes like making packing cases, our forest cover has diminished at an alarming rate. Presently, forests occupy a precarious 22% of our geographical area against the recommended minimum of 33%. Shrub jungles and fuelwood trees are vanishing so rapidly that one wonders whether a day would come soon when common people may have enough food but not enough fuel. Between 1960 and 1984, the prices of fuelwood shot up by 65%! This concern has prompted planners to think of large scale planting of fast growing trees with some suitable crops in between. But, not all trees and crops are compatible with each other, and even the best of the combinations have an adverse effect on each other's maximum potential. However, a certain sacrifice in productivity is considered inevitable to partly meet the shortage of tree cover.

In the Gangetic plains, wheat or rapeseed in rabi and sesamum or pearl millet in kharif can be grown in the interspaces of subabul (*Leucaena latisiliqua*) trees. In the tropical region, *Casuarina* is compatible with food crops in the first two years, after which the shallow-rooted fodder sorghum and cowpea fare better. In the humid and sub-humid regions, maize is suitable for intercropping with *Acacia* and *Stylosanthes* (stylos) for fodder for growing with *Eucalyptus*.

We have a great scope for tree plantation on our 60.09 million hectares of land that is not being used for one reason or the other. Much of the roadsides along villages can also be planted with trees, whose wood forms fuel.

You have just studied that improvements in our crops have resulted in better, healthy plants with high yields. Here, we would like to point out that it is not only the use of improved seeds which is important, but also other factors like cropping system, application of fertilisers and pesticides. Let us now look into some of these factors, in the following section. But how about trying a SAQ first?

#### SAQ 2

Fill in the blank spaces choosing appropriate word or words from the list given below.

- i) The diversity in ..... and ..... in our country is responsible for the great many types of plant species found here.
- ii) All the world's poultry trace their origin to the Red Jungle Fowl belonging to .....
- iii) ..... is our main kharif cereal, whereas ..... is the chief rabi cereal.
- iv) After studying the evolutionary history of plants, and using statistical analysis, agricultural scientists create ....., that is plants with ideal framework and other desirable biochemical and physiological characteristics.
- v) In the cultivation of pulses, crop management is more important than .....
- vi) For past several years, oil seeds have been grown in our country where lands are poor in ..... and ..... This has resulted in hardy, plants with very ..... production.

- vii) ..... is an important sugar-yielding crop, that can be profitably cultivated in soils having high amounts of sodium.
- viii) The credit for developing the first hybrid cotton goes to the ..... agriculturists.
- ix) A judicious mix of plantation crops can be profitably grown in a farm under the ..... cropping pattern.
- x) The major expenditure incurred in potato cultivation is on the procurement of healthy. ....
- xi) ..... etc. are some of the methods that can bring good returns to farmers, who grow fruits on large scale.
- xii) ..... and ..... are some of the fuel-wood yielding trees that have a great promise for our country.

(drying, Subabul, seed tubers, canning, Indian, sugarbeet, multi-tier, low, Casuarina, extracting juices, Stylos, wheat, India, seed variety, ideotypes, soil, nutrients, Eucalyptus, water supply, rice, climate)

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## 19.6 AGROTECHNIQUES

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### 19.6.1 Cropping Systems

Since cultivable land is limited, the only way to meet our growing food needs is by growing two or more crops in a year from the same piece of land. Such multiple-cropping practices would generate more employment in rural areas and also fulfil our food needs. In a relay cropping system, a crop is sown before its preceding crop is harvested. The last irrigation given to a crop also serves as a pre-sowing irrigation to the next crop. This results in saving of water. In mixed cropping, compatible crops like chickpea and mustard are sown in parallel rows with wheat. Pigeonpea, mungbean, groundnut, soybean and cowpea can be grown in between rows of either sorghum, or maize, or sugarcane or cotton. Such intercropping systems have a high production potential and generate additional employment opportunities.

### 19.6.2 Input of Fertilisers

Nitrogen, phosphorus and potassium are the major nutrients that plants require. In addition, zinc, iron, manganese, boron, molybdenum and cobalt are also needed by plants in small quantities for healthy growth. Deficiency of any of these elements reduces yields, even when all other nutrients are available in adequate amounts. But, the excessive presence of some of these nutrients may prove toxic to plants.

Cereals require more nitrogen than phosphorus and potash. But pulses, whose root nodules harbour bacteria, that fix nitrogen directly from the atmosphere, need adequate doses of phosphorus. As said earlier, the nutrient needs vary not only from crop to crop but also from soil to soil. It is essential, therefore, that the soil is tested and the required amounts of nutrients supplied according to the needs of the crops. Generalised application of commercially available fertiliser mixtures such as the one having nitrogen, phosphorus and potassium in the ratio of 120:60:40, is often quite wasteful and may even reduce yields. The time and depth of application of fertilisers is also very important. Research has shown that most farmers over-irrigate their crops when water is available. Consequently, not only is water, a precious input is wasted but the yields get depressed. Thus, crop management is as important as the crop variety in realising optimum yields.

### 19.6.3 Crop Protection

Several kinds of insects, diseases, weeds, rodents and birds cause immense damage to crops both in the field and in storage. Pests have been there long before man came into existence. It is not possible to eliminate them entirely, either by developing varieties which resist attacks of pests or by using potent pesticides, for pests are adept in their struggle for existence and have always countered man's attempts to exterminate them. The best course for us is to resort to what is called "integrated pest management" that keeps the damage due

to pests at the barest minimum. Integrated pest management will be effective if we grow resistant varieties in regions where incidence of pests is severe, ensure that crops grown one after another do not have common pests, instead of chemicals for pest control use biological organisms that attack the pest, apply pesticides only when the pest population has reached its threshold value, and take co-ordinated community action on pest control in adjoining fields over the whole village or block.

The war against pests is so long-drawn-out and difficult that farmers often use very high doses of pesticides at frequent intervals. This is a dangerous tendency. Excessive doses of pesticides leave harmful residues (also see Unit 16, Section 16.2) which find their way into the human body either directly from the consumed agricultural produce or through the milk of animals that feed on plants. It is essential, therefore, that pesticides are applied only in recommended doses that are harmless.

### SAQ 3

Match the items of the first column with that of the second. Write the number of the appropriate match in the bracket given in the first column.

Column I		Column II
a) Relay cropping system	[ ]	i) require more nitrogen than potassium and phosphorus
b) Crop protection	[ ]	ii) compatible crops sown together in a field
c) Cereals	[ ]	iii) consists of fixed amount of nitrogen, phosphorus and potassium
d) Mixed cropping	[ ]	iv) integrated pest management
e) Commercially available fertiliser mixture	[ ]	v) crop sown before the preceding crop is harvested

So far, you have studied various aspects of agriculture dealing mainly with our crops. Now, let us know something about our alternate food resources.

## 19.7 LIVESTOCK

Livestock provide us milk, meat, eggs, wool and skins, and other by-products. All these contribute about Rs. 20,000 million a year to our national economy. Practically every family in the village is involved with domestic animals, which are an important source of livelihood and employment to the villagers. The number of cows, oxen, buffaloes, bulls, sheep, goats, pigs or poultry is often an indication of the economic status of the rural family.

Livestock are our mainstay for providing power needed for agricultural operations and transport. Machines provide marginal power because of the small and scattered farms in our villages. Still, inadequacy of power is a basic cause of our inability to improve the efficiency of agriculture through timely operations.

India today has about 185 million cattle, 61 million buffaloes, 45 million sheep, 97 million goats, one million horses and ponies, one million camels, about one million other livestock, and 156 million poultry, fowls, ducks, quails, turkey-birds, etc. In 1984-85, they produced 40 million tonnes of milk, 13 million eggs, 39 million kilograms of wool and 958,000 metric tonnes of meat.

### 19.7.1 Cattle

The humped, zebu cattle originated in India. The Brahman bull, a hardy, disease resistant animal that quickly gains weight, is much in demand in the west for siring beef breeds. The humpless taurus breeds of cattle are generally considered to have originated in Europe. But there is evidence to show that humpless cattle were under domestication in India as early as the Harappan period (also see Fig. 19.3).

Today we have several good milch, draught, and dual-purpose breeds. Milch breeds refers to the milk producing animals; draught breeds are the animals that are used as work animals; and the dual purpose breeds include those animals that are used both for milk purposes as

well as for doing laborious work. Gir, Sahiwal, Red Sindhi and Deoni are our milch breeds. The draught breeds include Nagari, Kenkatha, Malvi, Hallikar, Amrit Mahal, Khillari, Kangayam, Ponwar and Siri. Among the important dual purpose breeds are Haryana, Danji, Rewati, Ongol and Tharparkar (or Kankrej).

Besides that, India has the best riverine (water) buffaloes in the world. Some of them like Murrah, Mehsana, Jaffarabadi, Surti, Nili-Ravi are imported by many countries for developing animals, suiting to their requirements. Swamp buffaloes, that are common in south-east Asian countries, are frequently found in the coastal and swampy regions of our country. Since their milk yield is less, they are used as work animals in swampy regions to which cattle are not suited.

**Milk Production :** Indian economy is village-based. In the absence of long-distance transport and marketing facilities for milk, the selection of dairy animals over the centuries was based on their ability to produce just enough milk for the family needs. Consequently, the best of our milk yielding animals produce only a quarter of their counterparts in Europe, although Indian cattle are hardier.

The country, today, has less than half a million good dairy cows and about 25 million buffaloes that give a medium yield of 1,000 to 1,500 litres per lactation (the milk secreting period after the birth of a calf). High-yielding breeds of cows such as the Holstein-Friesian, Brown Swiss and Red Dane averaging 5,000 to 6,000 litres per lactation and Jersey cows averaging 4,000 litres per lactation, were imported and used in crossbreeding programmes. Their progenies yield, on an average, about 3,000 litres of milk. However, some of these crossbreeds, are not likely to be popular with village farmers who cannot provide intensive feeding, management and health care.

### 19.7.2 Sheep and Goats

Income from sheep and goats sustain 12-15 million people in India living in regions where agricultural activities are restricted. The small muzzle and split-up upper lip help sheep to nibble at tiny blades of vegetation which cannot be eaten by larger animals. India has the sixth largest sheep population in the world. But large flocks of sheep like those seen in Australia and New Zealand are not common in our country since we do not have extensive grasslands and meadows. Though highly nutritious, lamb meat is not as popular in our country as goat meat.

Our common breeds of sheep are: Kashmir, Gaddi, Chokla, Bhakarwal, Magra, Kali, Marwari, Bellary, Deccani and Nilgiri. They produce short wool suitable for making carpets. For the production of wool suitable for making clothes, there was need to improve our breeds of sheep. For this purpose, the Merino and Suffolk breeds were imported.

Goat is considered the poor man's cow in India. It is a versatile animal, easy to maintain on marginal lands. In Europe, it is called the 'wet nurse', as it produces cheap and wholesome milk. Its milk contains 4.5% fat, well-distributed in small globules, and is easily absorbed in our digestive system. The milk-breeds of goat such as Toggenberg, Saanan, Alpore and Nubian were introduced to develop better breeds that suit our conditions. Goat meat and skin are in great demand in our country. Pashmina and Chegu breeds produce soft and warm fibres used for making shawls and similar apparel. The Angora breed produces the valuable textile hair called mohair. Jamunapari, Beetal, Barbari, Black Bengal, Deccan and Malabari are other quality breeds of goat. One thing particular about goats is that they are fastidious about cleanliness. They require clean and fresh food, put in clean containers when fed indoors.

Goats and sheep do not compete with each other, since their feeding habits and requirements are different. There is a misconception that goats denude the vegetation and contribute to the deterioration of the environment. But the real culprit is man, who leaves goats in the open to fend for themselves, not providing them even the minimum feed needed to keep them going.

### 19.7.3 Pigs

The pig is nature's protein factory on land. It has the capacity to turn most of its feed into high-quality protein. Unlike cattle, sheep and goats, the pig has a one-chamber stomach. It cannot eat and digest roughages like straw etc., but it can feed on most cellulosic material, including algae. Like the buffalo, the pig has very few sweat glands on its skin, and hence needs water to keep the body cool, particularly in summer.

In India, pigs are kept by people who are so economically backward that they can scarcely give any attention to the animal. Hence pigs wallow in mud, eat all sorts of rubbish and harbour many parasites. Consequently, the pig is considered dirty and despicable while it could be an elegant, healthy, productive, and rapidly multiplying animal. In a country like ours where protein malnutrition is rampant, pig rearing will be a boon to the poorer sections of the society. Hence, to improve the productivity of indigenous pigs, breeds like White Yorkshire, Landrace, Tamworth and Berkshire have been introduced.

**Animal Health Care:** The type of climate, i.e. tropical and subtropical, that we have in our country is conducive to a variety of animal diseases like rinderpest, foot-and-mouth disease, rabies, and tuberculosis. Health care and proper medication are both important to maintain our animals in a fit and productive condition. But awareness about health care of our animals is needed. Today, we in our country produce most of the required medicines and vaccines of high quality that are required for health care of our livestock.

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## 19.8 POULTRY

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During the last two decades, our poultry industry has shown a phenomenal growth. The value of our poultry products today is about Rs 9,000 million. The production in the year 1984-85 was about 13,475 million eggs and about 51 million broilers. The growth of production during the last decade is 400%, that is unmatched either by any branch of agriculture or industry. Some of our best broiler strains are: B 77, JBL 80, IBB 83, ILI 80, and ILI 82. Because of intensive research on poultry nutrition, we have been able to reduce the feed requirement from 6 kg to about 2.2 kg for the production of one kilogram of live-weight broiler or one dozen eggs. Today, we are self-sufficient in the production of all medicines required for poultry health. Most of these medicines conform to the highest standards of efficiency and potency.

Almost all the world's fowls trace their origin to the Red Jungle Fowl of India (Fig. 19.4). In addition to our famous Assel breed, we have Kadaknath, short-legged Nicobari and large number of diverse hardy breeds that have adapted themselves to our various ecological regions. There is, however, a need to conserve and improve their type for future growth of the poultry industry.

Ducks need more water than fowls, but it is wrong to presume that they require water for swimming. Unlike fowls they can feed on water-borne organisms, and hence are popular in swampy regions. They constitute about 10% of the total poultry population and deserve more attention than given at present.

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## 19.9 FISHERIES

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Marine and freshwater fish are an excellent source of animal protein. They grow rapidly, feeding on plankton, weeds and other water-borne organisms, and convert them into food of high biological value.

In 1984, we produced about 3 million tonnes of fish, ranking eighth in the fish-producing countries of the world. Our production can still be increased up to 12 million tonnes, because we have a long coastline and a large adjoining area of water that can be utilised for fishing. Our inland freshwater spread is 1.6 million hectares, and brackish waters and estuaries occupy about 2 million hectares.

### 19.9.1 Marine Fisheries

Our present catch from the seas is about 1.2 million tonnes. But there is a good prospect for increasing the catch all along the Indian coast, particularly in the north-east and south-west regions. Sophisticated techniques such as Remote-sensing and Satellite imageries are now being used to locate concentrations of fish. Improved techniques have been devised for the culture of mussels, pearl, oysters, shrimps, lobsters and seaweed. Mechanised fishing boats and vessels (see Fig. 19.8) have also been introduced, together with facilities for cold storage and canning.

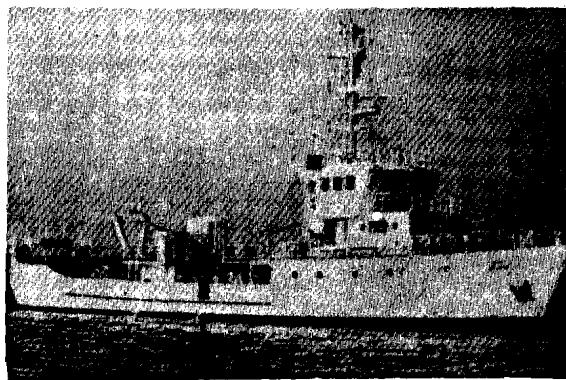


Fig. 19.8: M.V. Saraswati, a modern vessel used by our fisheries.

### 19.9.2 Inland Fisheries

Inland fisheries are categorised as of 'capture' or 'culture' type. Capture fisheries refer to the catch from rivers and reservoirs. On the other hand, in culture fisheries, the fish are first grown in ponds, pools and swamps, and are caught when they are of the right size.

Pond culture of fish is conventional in our country, and the average production is about 600 kg per hectare in a year. However, if ponds are stocked with different types of fish that feed at the bottom, middle level and surface of the pond, the fish do not compete with each other, but utilise the food resources throughout the pond. Such a practice is also known as composite fish culture. A yield up to 11 tonnes per hectare in a year can be obtained, although an average farmer obtains about 5 tonnes from such composite fish culture. Integrated culture of compatible species of fish, prawn, frogs, ducks and useful plants is even more profitable, as they will make a full use of the entire pond environment. Swamps and derelict waters are suited to air-breathing fish which yield up to 15 tonnes per hectare in a year. Their use could supplement our fish production.

#### SAQ 4

Fill in the blanks choosing appropriate word or words from the list provided.

- i) Majority of our farmers depend on their ..... for the power needed for the various agricultural operations.
- ii) In our country, owing to not so well-developed ..... and ..... facilities, the dairy animals have been bred to produce just enough milk for the family needs.
- iii) Animals like ..... and ..... can be profitably reared in areas where agricultural activities are restricted.
- iv) The ..... is also commonly called as the nature's protein factory.
- v) In the last decade, the increase in production in our ..... industry has been tremendous, and is unmatched by any other branch of agriculture or industry.
- vi) India presently ranks ..... in the fish-producing countries of the world, and there is considerable scope in increasing production in both the ..... and ..... fisheries.

(marine, pig, transport, livestock, goats, inland, marketing, poultry, sheep, eighth)

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### 19.10 SUMMARY

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In this unit you have learnt :

- Ours is an agriculture-based country, and our agricultural products contribute significantly to our economy.
- Sunlight, soil and water are the basic resources for agriculture, besides the numerous varieties of crops and animal breeds, and the labour input by the farmers. Our agricultural production is affected if any of these factors is limited, or disturbed.





- b) Pick up *any two* of the examples that you have written above and write about the unimproved and their correspondingly improved features in the table given below :

Name of the plant	Features of unimproved plant	Features of improved plant
i	i) ..... ii) ..... iii) .....	i) ..... ii) ..... iii) .....
ii	i) ..... ii) ..... iii) .....	i) ..... ii) ..... iii) .....

- 3) Write short answers for the following questions.

- a) What are the salient features of mixed, and relay-cropping system?

.....  
 .....  
 .....

- b) What points should one keep in mind while using fertilisers?

.....  
 .....  
 .....

- c) What is the ideal way of pest management?

.....  
 .....  
 .....

- 4) a) List the alternate food resources.

.....  
 .....  
 .....

- b) Mention briefly, as to what advancements have been made in the production of the following alternate foods.

- i) milk

.....  
 .....  
 .....

- ii) fish

.....  
 .....  
 .....

iii) broiler

.....  
 .....  
 .....

iv) eggs

.....  
 .....  
 .....

## 19.12 ANSWERS

### Self Assessment Questions

- 1) a) i) About 60.5% of the working people of India depend on agriculture in one form or the other.  
 ii) Nearly 53% of our land is utilised for agricultural purposes.  
 iii) Various agricultural activities contribute to about 34.7% of the total net national product.
- b) i) south-west ii) half iii) nutrients iv) alluvial v) twenty eight
- 2) i) soil, climate ii) India iii) rice, wheat iv) ideotypes v) seed variety  
 vi) nutrients, water supply, low vii) sugarbeet viii) Indian ix) multi-tier  
 x) seed tubers xi) drying, canning, extracting juices xii) Subabul, Casuarina, Stylos, Eucalyptus
- 3) a [v] b [iv] c [i] d [ii] e [iii]
- 4) i) livestock ii) transport, marketing iii) sheep, goats iv) pig v) poultry  
 vi) eighth, marine, inland

### Terminal Questions

- 1) a) **Sunlight:** It is available in plenty throughout the year. During monsoons, the clouds cut down the incoming sunlight considerably. Plants can, however, make maximum use of the sunlight if other factors like water, carbon dioxide and nutrients are not limiting.
- b) **Soil :** A variety of soils are found in our country, and each supports different types of crops. Before growing crops in any of the soils, they should be checked for their nutrients and other physical characteristics.
- c) **Water:** Our agriculture depends mainly on monsoon for this resource. Rainfall, however, is not uniform in our country. During rainfall, a considerable amount of water seeps into the soil. The water in the top layer is utilised by plants. The ground-water can also be used for irrigation, after testing its quality.
- 2) a) i) rice, bajra  
 ii) pigeonpea, chickpea  
 iii) groundnut, brassica  
 iv) sugarcane, sugarbeet  
 v) cotton, jute  
 vi) potato, cassava  
 vii) tea, arecanut  
 viii) mango, brinjal

b)

	<b>Name of the plant</b>	<b>Features of unimproved plant</b>	<b>Features of improved plant</b>
i	Rice	i) tall, weak-stemmed ii) not efficient users of sunlight as flag leaf dries up early iii) few grains on loose panicles	i) dwarf, stiff-stemmed ii) efficient users of sunlight, as flag leaf remains green, and erect for a long time iii) many panicles full of grains
ii	Pigeonpea	i) plants unmanageable with too many leaves and branches ii) ready for harvest in 300 days iii) low production	i) plants manageable and compact ii) ready for harvest in 150 days iii) high production

- 3) a) In mixed cropping system, a number of compatible crops are sown together in a field. In relay cropping system, a crop is sown in a field before the preceding crop is harvested.
- b) i) The kind of fertiliser to be applied should be based on the need of the crop, e.g., cereals require more nitrogen.
- ii) Apply fertiliser only after getting the soil tested, this gives information as to which nutrients are limiting.
- iii) Apply fertiliser at right time of crop development, in right amount and at right place.
- c) Integrated pest management is the best way, as the resultant effect on environment is kept in mind. A minimal use of chemicals prevents these harmful substances from accumulating, and passing on in the food chain to man.
- 4) a) cattle, sheep, goat, pig, poultry, fish.
- b) i) Presently we have half a million good dairy cows and 25 million buffaloes that yield 1000-1500 litres of milk per lactation. Cross-breeds yielding about 3000 litres of milk per lactation have been developed in our country.
- ii) Today, India ranks eighth in the world as far as fish production is concerned, still there is considerable scope in this field. The use of advanced techniques, and mechanised boats etc., have been of great help. In Inland fisheries, composite fish culture has great potential for high yield and better resource utilisation.
- iii) Intensive research work has enabled to evolve many good, high-yielding strains of broilers. Also now, methods are available for the efficient use of feed. More live-weight broiler can be produced in less of feed.
- iv) The production of eggs has also gone up in recent years. Also now more eggs can be obtained by less of feed inputs to the poultry.