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MATERIAL PRODUCTION

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BLOCK 3 HORTICULTURE AND ALLIED SECTORS

In this block, the production of major fruits and vegetables of India is discussed for their area and production, composition, and nutritive value. The orchard layout of different types and planting systems are described. After going through this block, learners would be able to choose a suitable fruit and vegetable for a given geographical location and would be able to understand the role of crops as agro-industry in the Indian economy.

Due discussion is also done on the livestock wealth of India. The principles of animal husbandry like breeds, nutrition, housing, and health care are elaborated in this block. Major animals like cattle and buffalo, sheep, goat, poultry, and pigs are taken care of for development here.

A concise description of allied sectors like apiculture, sericulture, agro-forestry, and mushroom is done in this block. After going through this block, learners would be aware of the scope, benefit, market linkages, and market prospects of these sectors. It is important to note that these sectors can be managed by small and marginal farmers very conveniently and efficiently.

The material provided in this block is supplemented with various examples and activities to make the learning process simple and interesting. We have also provided Check Your Progress questions for self-test at a few places of these units which invariably lead to possible answers to the questions set in those exercises. What perhaps you ought to do, is to go through units and jot down important points as you read, in the space provided in the margin. This will help you in assimilating the content. A list of reference books has been provided at the end of each unit for further detailed reading.

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UNIT 10 FRUIT PRODUCTION

Structure

- 10.0 Objectives
- 10.1 Introduction
- 10.2 Area and Production of Major Fruits in India
 - 10.2.1 Major fruits of India and their share in total fruit production
 - 10.2.2 Major fruit producing states and production belts
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- 10.4 Importance, Composition, and Nutritive Value of Fruits
 - 10.4.1 Importance of fruits
 - 10.4.2 Composition and nutritive value of fruits
 - 10.4.3 Health benefits of fruits and vegetables
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10.0 OBJECTIVES

After studying this unit, you will be able to:

- classify fruits as per their climatic requirements;
- identify the important fruits and their major production areas;
- discuss the nutritive composition of fruits;
- explain the importance of fruits in human health; and
- compare and list the principles and planting systems of orchard establishment.

10.1 INTRODUCTION

Whenever you go to villages, you might have seen several orchards or plantations of fruits. Similarly, whenever you visit any market, you see several types of fruits in the shops. In addition, several times, you might have purchased fruits from vendors for consumption or you might have consumed juice of Mosambi or pomegranate. Have you ever thought about where these are fruits are produced? How there are produced? What are different methods of planting an orchard? Why does the doctor recommend consuming *Chiku* or juice of *Mosambi* when you fall ill? Have you ever guessed as to why do we consume them and for what we consume a specific fruit? There can be several similar queries in your mind regarding fruits. We produce several types of fruits in our country. There are certain specific production belts of these fruits where they are produced in enormous quantity

with fewer inputs. Similarly, their orchards can be established by using systems like square, rectangular, triangular, or contour, but the square system of planting is usually followed. Fruits have been classified as '*protective foods*' as they contain several vital vitamins and minerals, which protect us from several ailments and diseases.

10.2 AREA AND PRODUCTION OF MAJOR FRUITS IN INDIA

India is bestowed with different types of climatic conditions ranging from tropical to temperate conditions. As a result, several types of fruits are cultivated in India. Broadly, the country can be divided into tropical, subtropical, and temperate regions. Within each broad category, there are differences in temperature, rainfall, humidity, altitude, etc. Considering these aspects in mind, Horticulturists have divided the whole country into six different horticultural zones so that appropriate choices of the fruit crop (s) can be made in a planned way. These horticultural zones are as under:

- **Temperate Zone:** Kashmir, Himachal Pradesh, North Uttarakhand, Sikkim, and part of Arunachal Pradesh.
- **North-West Subtropical Zone:** Punjab, Haryana, Rajasthan, Central Uttar Pradesh, and North Madhya Pradesh.
- **North-East Subtropical Zone:** Bihar, Jharkhand, Assam, Meghalaya, Nagaland, Manipur.
- **Central Tropical Zone:** South Madhya Pradesh, Chhattisgarh, Gujarat, Maharashtra, Odisha, West Bengal.
- **Southern Tropical Zone:** Karnataka, Andhra Pradesh, Tamil Nadu.
- **Coastal Tropical Humid Zone:** Konkan region, Goa, Kerala, Western Ghats, the Eastern Ghats in Tamil Nadu, Andhra Pradesh, and Odisha.

The temperate zone is further classified into the following zones:

1. **North West Hill Region/Zone:** In this region, the areas like Srinagar, Budgam, Pulwama, Anantnag, Baramullah, Kupwara (J & K), Shimla, Kullu, Sirmour, Mandi, Chamba, Kinnaur (H.P.), Almora, Nainital, Pithoragarh, Tehri, Pauri, Chamoli, Uttarkashi, and Dehradun (U.K) have been included.
2. **North East Hill Region/Zone:** In this zone/region, the areas like Twang, West Kanneng, Lower Subansiri (Arunachal Pradesh), and part of Sikkim and Meghalaya have been included.

Based on climatic requirements, fruits have been classified as temperate, tropical, and subtropical fruits. Temperate fruits are those which are grown in cooler regions where the temperature falls to near zero degrees during winters. The important fruits of this region are apple, pear, peach, plum, cherry, apricot, almond, walnut, etc. Tropical fruits are those which grow in a climate, which does not show much variation in summer and winter temperatures. Important fruits of this region are mango, guava, banana, papaya, pineapple, coconut, sapota, etc. Subtropical fruits are those, which grow in areas experiencing both extremes of temperature i.e. areas where winters

are very cool and summers are very hot. Important fruits of this region are citrus, litchi, pomegranate, grapes, *aonla* (*amla*), etc. However, we can not classify fruits distinctly based on climatic requirements because there are certain fruits, which perform equally well in all types of climate. For example, grape and several citrus fruits perform well in almost all types of climates. Mango classified as tropical fruit grows equally well even in the subtropical climate. Guava is a tropical fruit but grows well in subtropical climates as well. *Aonla* is now being grown commercially in tropical parts of India. Peaches and plums grow profitably well in the subtropical plains of India, although these are classified as temperate fruits. At present, India is the 2nd largest producer of fruits (102.08 MT in 2019-20) in the world after China (Table 10.1), and we have achieved Golden Revolution in India.

Table 10.1: Area and production under major horticultural crops in India

Hort. crop	Year			
	2008-09		2019-20	
	Area (000 ha)	Production (000 MT)	Area (000 ha)	Production (000 MT)
Fruits	5,857	65,587	6774	102080
Vegetables	7,848	1,28,449	10310	188284
Plantation crops	3,190	11,300	4143	16116
Spices	2,617	4,357	4291	10137
Flowers	166	868		
Total	20,207	2,11,234	26482	320471

Source: agricoop.nic.in

10.2.1 Major Fruits of India and their Share in Total Fruit Production

About 72 different kinds of fruits are grown in India, of which mango, banana, citrus, papaya, apples, sapota, pomegranate, pineapple, and litchi are only considered as major fruit crops, as these crops occupy the major area under fruit crops grown in India (Table 10.2). Among these fruit crops, the highest acreage is under mango, followed by citrus and banana, whereas the highest production share is that of banana (Table 10.2). In the area, the maximum share is that of mango (34%), followed by citrus (16%) and banana (14%) (Fig.10.1), whereas in production, the maximum share is that of banana (32%), followed by mango (20%) and citrus (14%) (Fig.10.2). Unfortunately, the overall productivity of fruit crops is dismally low (15.07 MT/ha) than other countries of the world. However, due to the adoption of modern production techniques, there has been a sizeable increase in the productivity of some fruit crops like banana, papaya, and grapes in recent years, although there is still good scope to increase it further.

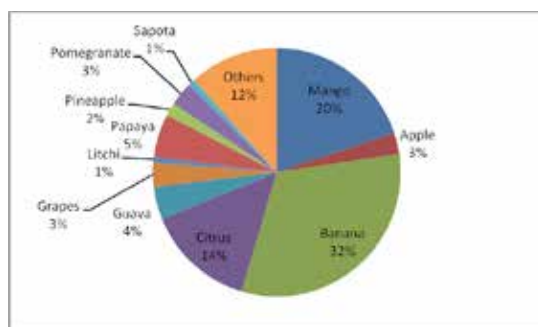


Fig.10.1: Production share of major fruits in India (2019-20)

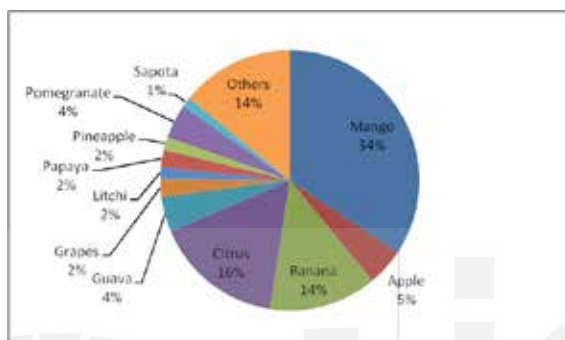


Fig 10.2: Area share of major fruits in India (2019-20)

Table 10.2: Crop wise area, production, and productivity of major fruits in India

Fruit crop	Year			
	2008-09		2019-20	
	Area (000 ha)	Production (000 MT)	Area (000 ha)	Production (000 MT)
Mango	2,201	13,997	2294	20317
Apple	264	2,001	310	2814
Banana	658	23,823	897	32597
Citrus	867	8,015	1075	14568
Guava	179	1,981	292	4361
Grapes	68	1,735	150	3181
Litchi	69	418	97	726
Papaya	83	2,909	142	5780
Pineapple	80	1,245	106	1732
Pomegranate	124	884	283	3186
Sapota	152	1,258	84	906
Total	5,857	65,587	6674	102080

Source: agricoop.nic.in

10.2.2 Major Fruit Producing States and Production Belts

Andhra Pradesh, Uttar Pradesh, Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Tamil Nadu, Bihar, Odisha, West Bengal, Jammu & Kashmir, Himachal Pradesh are the major fruit producing states of India. The maximum fruit production share is that of Andhra Pradesh (17%) followed by Uttar Pradesh (11%) Maharashtra (12%), Gujarat (8%), and Madhya

Horticulture And Allied Sectors Pradesh (8%) as presented in Fig.10.3. Every state produces some amount of specific fruits and there are specific fruit producing belts as well (Table 10.3).

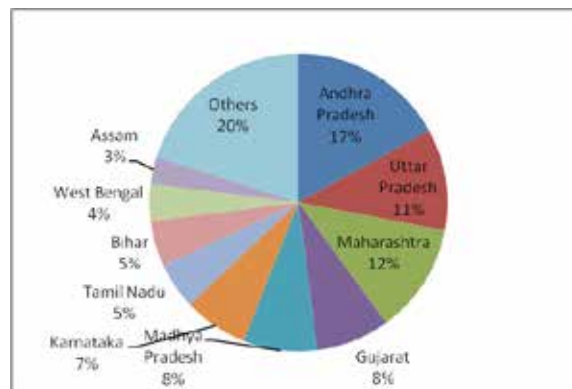


Fig. 10.3: Leading Fruits Producing States of India (2019-20)

Table 10.3: Major fruit producing states, and production belts in India

Fruit	Main production belts
Apple	Srinagar, Budgam, Pulwama, Anantnag, Baramullah, Kupwara (J & K), Shimla, Kullu, Sirmour, Mandi, Chamba, Kinnaur (H.P.), Almora, Nainital, Pithoragarh, Tehri, Pauri, Chamoli, Uttarkashi, Dehradun (U.K) and Twang, West Kanneng, Lower Subansiri (Arunachal Pradesh)
Banana	Jalgaon, Ahmadnagar, Dhule, Nanded, Parbhani (Maharashtra), East Godawari, West Godawari, Kurnool (A.P.) whole Arunachal Pradesh, Assam, Sikkim, Bihar, W. Bengal, Kerala, Karnataka, and Tamil Nadu.
Citrus	Jammu & Kashmir (Jammu, Kathua, Udhampur, Rajauri), Himachal Pradesh (Kangra & Sirmaur), and Uttrakhand. Punjab, Haryana, and Rajasthan (Shriganganagar), West Bengal (Darjeeling, Jalpaiguri), Sikkim, Arunachal Pradesh, and Assam, Rajashtan (Bharatpur, Dholpur & Sawai Madhopur) and Madhya Pradesh (Mandsaur, Shajapur). Maharashtra (Amravati, Nagpur, Akola, Aurangabad) and Madhya Pradesh (Chhindwara, Khandwa, Hosangabad). West Bengal (Midnapur, 24 Pargana (N) and Odisha (Ganjam). Andhra Pradesh, Tamil Nadu (Dindigul Anna, Trichy, Tirunelveli Kattabomman), and Karnataka.
Grapes	Andhra Pradesh (Rangareddy, Medak, Ananthapur) Tamil Nadu and Karnataka Bangalore), Kolar, Bijapur), Maharashtra (Sangli, Satara, Nasik, Sholapur, Pune, Ahmed Nagar), Haryana, Punjab, and Rajasthan (Jhalawad).
Banana	Arunachal Pradesh, Assam, Sikkim, Bihar, West Bengal. Maharashtra (Jalgaon, Ahmednagar, Dhule, Nanded, Parbhani), Gujarat, Madhya Pradesh, Odisha Andhra Pradesh (East Godavari, West Godavari, Kumool, Cuddapah), Kamataka, Tamil Nadu, and Kerala.

Guava	Andhra Pradesh (Eash Godavari, West Godavari, Guntur, Krishna, Ananthapur, Medak, Khemmam) and Madhya Pradesh & Chhattisgarh (Raipur, Durg Jabalpur) Gujarat (Bhavnagar, Ahmedabad) and Bihar Maharashtra (Satara, Beed, Pune, Ahmednagar, Aurangabad, Amravati) Uttar Pradesh (Allahabad, Farrukhabad, Aligarh, Badaun) Kamataka (Bangalore (R&U), Kolar, Shimoga, Dharwar) Tamil Nadu (Mudurai, Dindigul, Salem) and Odisha
Litchi	Uttarakhand (Dehradun, Pithoragarh, Nainital, Haridwar) West Bengal (Murshidabad, 24 -Paraganas) Bihar (Muzzafarpur, East Champaran, Samastipur, Vaisali, Bhagalpur) Assam (Kamrup, Sonitpur, Bongaigaon) Punjab (Gurdaspur, Ropar, Hoshiarpur) Uttar Pradesh (Saharanpur) Jharkhand & Tripura
Mango	Jammu & Kashmir (Jammu, Katliwa, Udhampur), Punjab (Gurdaspur, Hoshiarpur, Ropar), Uttarakhand (Almora, Nainital, Dehradun) Haryana (Karnal, Kurukshetra) Uttar Pradesh (Saharanpur, Bulandshahar, Lucknow, Faizabad, Varanasi), and Chhattisgarh (Jabalpur, Raipur, Bastar). Maharashtra (Ratnagiri, Sindhudurg, Raigarh), Gujarat (Bhavnagar, Surat, Valsad, Junagarh, Mehsana, Khera), and West Bengal Andhra Pradesh (Krishna, East & West Godavari, Khamman, Vijayanagar.), Madhya Pradesh (Rewa, Satna, Durg, Bilaspur, Bastar, Ramnandgaon, Rajgari) and Odisha (Dhankamal, Ganjam, Korapu, Puri). Kerala (Calicut, Cannanoore), Kamataka (Kolar, Bangalore (R&U), Tankur, Kagu, and Tamil Nadu.
Papaya	Andhra Pradesh (Cuddapah, Medak, Kurnool, Rangareddy) Gujarat (Kheda, Ahmedabad, Jamnagar) and Odisha Maharashtra (Sangli, Satara, Pune, Nasik, Sholapur, Nagpur, Amravati), Karnataka (Shimoga, Chitradurga, Mysore, Belgaum, Hassan), Madhya Pradesh (Dhar, Khandwa, Bilaspur, Ratlam, Guna) West Bengal (North 24 -Paraganas, Hoogly) Assam (Nagaon, Darrang, Karbi Anglong)
Pineapple	Karnataka (Shimoga, North & South Kannada, Chickmagalore) Kerala (Enrakulam) and Nagaland (Kohima, Zunheboto) West Bengal (North Dinajpur, Darzeeling, Jalpaiguri) Assam (Nagaon, Kamrup, Karbi Anglong) and Bihar Manipur (Thoubal, Churchandpur, Imphal- East) Meghalya (Ri-Bhoi, East Khasi, Garo Hills)
Pomegranate	Maharashtra (Solapur, Sangli, Nashik, Ahmednagar, Pune, Dhule, Aurangabad, Gujrat (Satara, Osmanabad, and Latur districts). Karnataka (Bijapur and Bagalkot), Gujarat Rajasthan, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, Punjab & Haryana
Sapota	Andhra Pradesh (East & West Godavari, Krishna, Guntur, Kumool, Medak), Gujarat (Valsad, Surat, Kheda, Bhavnagar) Karnataka (Belgaum, Dharwar, Chickmangalore, Shimoga, Hassan), West Bengal (South 24 -Paraganas, Midnapur) Maharashtra and Odisha

10.3 SEASON OF AVAILABILITY OF MAJOR FRUITS IN INDIA

In India, several temperate, subtropical, and tropical fruits are grown in different states. There are certain fruits, which are produced almost throughout the year but few have a limited season of availability. Some of them have very limited shelf-life and others have very high shelf-life. So to make such fruits available for a longer period, these are stored in cold stores. Similarly, when there is a glut of a particular fruit in a season, it is either stored or processed into value-added products. The season of availability of major fruits grown in India is given in Table 10.4.

Table 10.4: Major fruits of India and their season of production/availability

Fruit crop	Major season of availability
Apple	June –October
Banana	Round the year in some states like A.P., Arunachal Pradesh, Maharashtra, Nagaland, Tamil Nadu, Tripura, and Lakshadweep. May-November in other states.
Grapes	February-May (M.P., Karnataka, Maharashtra, A.P.), May June (North India)
Guava	Throughout the year.
Lemons and limes	Round the year in Andhra Pradesh and Punjab. In other states, the major production season may be June-September (Assam, Tripura, Uttrakhand, and Karnataka) or October-December (A.P., U.P., J & K, and Jharkhand).
Litchi	May-June
Mandarin	October-December (Arunachal Pradesh, Assam, H.P., J & K., Manipur, Meghalaya, Maharashtra), and January-March (Karnataka, M.P., Odisha, Punjab, Rajasthan, Uttrakhand, West Bengal).
Mango	April-August in most of the states and January-April in Kerala, parts of Tamil Nadu and Andaman and Nicobar Islands.
Mosambi	November-January (A.P., H.P., J & K, Odisha, Sikkim, Rajasthan) and July-October (Karnataka) and October-November (Maharashtra)
Papaya	Throughout the year in A.P., Assam, Maharashtra, Tamil Nadu, and West Bengal, and April-October in Karnataka.
Pear	June-October.
Pineapple	Throughout the year in Tamil Nadu, and April to August in Goa, Arunachal Pradesh, Chhatisgarh, Manipur, West Bengal, and Kerala.
Pomegranates	Throughout the year in Maharashtra and Tamil Nadu, and July-December in Karnataka, March-May in Gujrat and Rajasthan.

Sapota	Throughout the year in Maharashtra, February-April in A.P., Assam, Gujarat, and during May-June in Haryana, Karnataka, Odisha, Sikkim, and Uttrakhand.
Stone fruits (peach, plum, cherry, etc.)	May-July.

Activity 10.1
 Visit your local fruit *mandi*. Make a list of fruits, which are sold/auctioned there, and enquire about the area from where a particular fruit has been received. Also make frequent visits to some supermarket, which deals with fresh fruits, make a list and enquire about the area of production of the fruits grown in a particular locality from patwari, village panchayat pradhan, etc.

.....

Check Your Progress 10.1

- Note:** a) Use the space given below for your answers.
 b) Check your answers with those given at end of the unit.
- Which are the major fruits of India? What is their production share?

 - Which are the major states producing mangoes, bananas, and apples?

 - What is the major season of production of mango and papaya in India?

10.4 IMPORTANCE, COMPOSITION, AND NUTRITIVE VALUE OF FRUITS

10.4.1 Importance of Fruits

The importance of fruits in the human diet is well known. They play im-

portant role in the balanced diet of human beings by providing not only energy-rich food but also promise the supply of vital protective nutrients like minerals and vitamins. They not only adorn the table but also enrich health from the most nutritive menu and tone up the energy and vigour of a man. They are a rich and comparatively cheaper source of vitamins and minerals. Their consumption in sufficient quantities provides taste, palatability and increases appetite, and provides a fair amount of fibers. These are reckoned as an important adjunct for the maintenance of good health and beneficial in protecting us against some degenerative diseases like heart attack, cancer, etc. They also play a key role in utilizing the acids produced during the digestion of proteinaceous and fatty foods and also provide valuable roughage, which promotes digestion and helps in preventing constipation.

Extensive studies conducted by the Indian Council of Medical Research, New Delhi, and the National Institute of Nutrition, Hyderabad, have revealed that the meager intakes and low purchasing power of even low-cost protective foods like fruits have been largely responsible for malnutrition and under-nutrition in a large segment of the Indian population. Intake of proteins in fairly inadequate quantity and quality and intake of vitamin A is low since our diets are mostly based on cereals and very little greens. Those who consume little fruits or in an improper form may suffer from diseases arising due to mineral and vitamin deficiency.

10.4.2 Composition and Nutritive Value of Fruits

Fruits were thought to be an ill man's food about 4 decades back and were being given to a person when he was not feeling well. At that time, more emphasis was put on foods providing energy such as carbohydrates and fats. However, the importance of fruits for human nutrition was known which is obvious from the famous proverb 'An apple a day keeps the doctor away'.

To meet the requirements of fruits for our increasing population, the production potential needs to be increased besides reducing post-harvest losses to a greater extent.

In general, fruits are a good source of vitamins and minerals and are hence termed *protective foods*. Vitamins and minerals are required in minute amounts and are hence known as micronutrients. They help in better utilization of other nutrients such as carbohydrates, fats, and proteins by affecting their metabolism and hence in better assimilation in the body.

Reduced intake of fruits in the diets by a large segment of our population due to socio-economic reasons are largely a contributing factor for the prevalence of different types of nutritional deficiency diseases. Many of the common fruits found or grown locally could make a major difference in not only supplying vitamins and minerals but also inefficient utilization of other food constituents. In the absence of an adequate supply of vitamins and minerals, utilization of other nutrients particularly proteins is poor.

The most common vitamin deficiency symptoms among our population include night blindness, which is due to carotene/vitamin A deficiency, scurvy due to vitamin C deficiency, beriberi due to thiamin deficiency, and pellagra due to niacin deficiency. In addition, many common symptoms appear like soreness of the tongue, cracking at the angles of the mouth, redness of the

eye, burning of feet, anemia, etc., due to deficiency of one or the other vitamin or mineral in the diet. Goitre is quite prevalent in hilly regions, which is due to the deficiency of iodine in the diet.

Vitamin A is needed for the synthesis of a pigment present in the retina called *rhodopsin*, which helps in night vision. Therefore, vitamin A deficiency leads to night blindness. This is the earliest sign of vitamin A deficiency. If the deficiency is not managed in time, it can lead to total blindness. The appearance of a white plaque on the white of the eye called Bitot's spot is also an indication of vitamin A deficiency. Vitamin A deficiency is an important problem particularly in preschool children and yet it can be prevented by the inclusion of cheap Vitamin A rich fruits such as mango, papaya, apricot, and pineapple.

Vitamins are very sensitive to heat and light and get easily destroyed when food is cooked in open vessels for a long time. Vitamins also get destroyed on storage and hence it is recommended to consume fresh fruits. Similarly, after cutting, fruits should not be washed as water-soluble vitamins are lost.

Fruits contain several minerals such as calcium, iron, zinc, etc. Calcium is the major component of bones and teeth. Iron is a part of the red pigment of blood called hemoglobin. Iron deficiency leads to anemia. Unlike vitamins, minerals are not easily destroyed by heat and light but they can be washed away if fruits are cut and washed.

Fruits are also a rich source of pigments. The chief pigments of fruits are carotenoids, chlorophylls, anthoxanthins, and anthocyanins. The carotenoids are a group of yellow, orange, and orange-red fat-soluble pigments widely distributed in nature. These pigments are present in mango, papaya, peach, apricot, etc. The chlorophylls are fat-soluble pigments like carotenoids. They are important in photosynthesis and occur in the plants in the ratio of 3:1 as chlorophyll a and chlorophyll b. Anthoxanthins are flavonoids, which are yellow in colour, and anthocyanins are also flavonoids, which consist of red, blue, and purple pigments and are water-soluble. These pigments are widely distributed in the fruits such as grapes, plum, cherries, berries, *Jamun*, *phalsa*, etc.

Different types of fruits vary in their contents of vitamins. Some of them are rich in vitamin C (Barbados cherry, *aonla*, guava) while others are rich in vitamin A (mango, pineapple, and papaya). In India, due to different types of climatic zones, a large number of fruits are grown and available, and accordingly, their composition and nutritive value also differ widely (Table 10.5).

Table 10.5: Composition and nutritive value of major fruits (per 100 g edible portion)

Fruit	Water (%)	Calories	Protein (g)	Fat (g)	Total carbohydrates (g)	Fibre (g)	Calcium (g)	Phosphorus (mg)	Iron (mg)	Vit. A (mg)	Thiamine (mg)	Riboflavin	Niacin (mg)	Vit. C (mg)
Apples	84.8	56	0.2	0.6	14.1	1.0	7	10	0.3	90	0.03	0.02	0.1	7
Apricots	85.3	51	1.0	0.2	12.8	0.6	17	23	0.5	2700	0.03	0.04	0.6	15
Aonla	81.5	58	0.5	0.1	13.7	3.4	50	20	1.2	9	0.03	0.01	0.2	600
Avocados	74.0	167	2.1	16.4	6.3	1.6	10	42	0.6	290	0.11	0.20	1.6	14

Bananas	75.7	85	1.1	0.2	22.2	0.5	8	26	0.7	190	0.05	0.06	0.7	10
Black berry	87.2	37	1.3	0.5	3.8	0.5	30	20	4.3	7	-	-	2.0	9
Grape pale green	79.2	71	0.5	0.3	16.5	2.9	20	30	0.5	0	-	-	0.0	1
Grapes fruit	88.4	41	0.5	0.1	10.6	0.2	16	16	0.4	80	0.04	0.02	0.2	38
Guava	85.3	38	0.1	0.2	9.0	4.8	50	20	1.2	0	0.02	0.02	0.3	15
Lemon	83.7	62	0.7	0.3	14.0	0.9	15	15	1.2	48	0.03	0.01	0.2	18
Lemons	90.1	27	1.1	0.3	8.2	0.4	26	16	0.6	20	0.04	0.02	0.1	53
Litchi	84.1	61	1.1	0.2	13.6	0.5	10	35	0.7	0	0.02	0.06	0.4	31
Mosambi	88.4	43	0.5	0.3	9.3	0.5	40	30	0.7	0	-	-	0.0	50
Musk-melon	91.2	30	0.7	0.1	7.5	0.3	14	16	0.4	3400	0.04	0.03	0.6	33
Mango	81.0	74	0.6	0.4	16.9	0.7	14	16	1.3	2743	0.05	0.09	0.9	15
Orange	86.0	49	1.0	0.2	12.2	0.5	41	20	0.4	200	0.10	0.04	0.4	50
Papaya	90.8	32	0.6	0.1	7.2	0.8	17	13	0.5	566	0.04	0.25	0.2	57
Peaches	89.1	38	0.6	0.1	9.7	0.6	9	19	0.5	1330	0.02	0.05	0.0	-
Pears	83.2	61	0.7	0.4	15.3	1.4	8	11	0.3	30	0.02	0.04	0.1	4
Straw-berries	89.9	37	0.7	0.5	8.4	1.3	21	20	1.0	60	0.03	0.07	0.6	59

Further, the grouping of fruits based on their nutrients is as follows:

- *Carbohydrates*- Raw or ripe banana or mangoes and other sweet fruits.
- *Fats*- Avocado, olives, figs, apricots, almonds, etc.
- *Protein*- Apricots, almonds, avocados, etc.
- *Vitamins*
- *Carotene (Vitamin A)*: Mango, pineapple, papaya, apricots.
- *Vitamin C*: Aonla, citrus fruits like lemons, limes, orange, guava, papaya, strawberries.
- *Thiamine*: Avocado, mango, orange.
- *Riboflavin*: Bael, avocado, mango, papaya, strawberries.
- *Niacin*: Avocado, blackberry, mango.
- *Minerals*
- *Calcium*: Amla, guava, Mosambi orange.
- *Iron*: Amla, blackberry, guava, Jamun, mango, strawberries.
- *Phosphorus*: Avocado, banana, grapes, litchi, Mosambi.

Fruits contain simple sugars such as glucose and fructose etc., and also organic acids such as citric acid, malic acid, tartaric acid, etc., which give instant energy to our body. Hence, intake of fruit provides a feeling of freshness. Organic acids also increase the availability of some mineral elements by solubilizing them.

As most of the fruits are eaten in the fresh form, some of the digestive enzymes such as proteolytic enzymes (Papain from papaya; bromelin from pineapple; ficin from figs) or starch digestive enzymes (amylase) may help

in better digestion of the nutrients in foods and therefore, help in reducing the stomach problems.

Although in some fruits, for example, apple, the composition is poor still they have beneficial effects on the human body due to the presence of dietary fibers or flavonoids, which act as antioxidants. Dietary fibers not only help in bowel movement but also help in reducing the absorption of anti-nutritional factors and in reducing the incidence of ulcers. Many fruits such as apple, guava, and citrus are rich in pectin, which is a component of dietary fiber.

In recent years, emphasis is being put on the use of antioxidants for the control of cancer and heart diseases. In this regard, fruits play a vital role in providing antioxidants in the form of vitamin C, carotenoid pigments, and flavanoids. Several fruits like apple, blackberry, blueberry, strawberry, pomegranate, plums are considered as the rich source of antioxidants, and their consumption in fresh form is highly beneficial to human beings.

Thus, fruits occupy a unique position in the human diet. To meet their requirement, the production potential needs to be increased besides reducing post-harvest losses to a greater extent.

10.4.3 Health Benefits of Fruits and Vegetables

Supplementation of our daily diet with fruits may be helpful to us in several ways as under:

- Fruits neutralize the acids produced during digestion.
- Fruits are rich in carbohydrates and hence are an important source of energy for our body.
- Fruits help in the maintenance of the general vigour of our body.
- Consumption of fruits promotes appetite and proper functioning of the digestive tract.
- The presence of fibers in several fruits helps in proper digestion and avoidance of constipation.
- Antioxidants present in fruits help in reducing the risk of heart attack, blood cancer, and several other chronic diseases.
- Some fruits contain valuable compounds, which protect us from diseases like diabetes, etc.
- Fruits contain several vitamins and hence protect us from diseases like scurvy and beriberi.
- Fruits contain several minerals like Ca, Fe, % K and are thus helpful in bone building and prevention of rickets, osteomalacia, and teeth diseases.
- Some fruits are rich in vitamin A and thus help prevent eye disorders.
- Fruits play a vital role in maintaining generative function and promote fertility in human beings.
- Several fruits help in reducing blood clogging and help maintain proper blood flow.

Activity 10.2

Visit any one center related to Yoga Peeth in your area. Make a list of medicines containing supplements from fruits. Also, discuss the role of fruits in human health with Ayurvedic doctors of the center.

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Check Your Progress 10.2

Note:a) Use the space given below for your answers.

b) Check your answers with those given at end of the unit.

1. Write the importance of fruits in the human diet.

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2. What is the role of Vitamin A and C in human health?

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3. Write the names of fruits rich in Vit. A and C.

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10.5 ORCHARD ESTABLISHMENT

Successful fruit growing requires unusual knowledge, skill, accuracy, and thoroughness. Several factors influence the choice of fruit orchard and each factor should be weighed individually and in combination with others before making a final decision for establishing a fruit orchard for commercial purposes. The successful establishment of an orchard and subsequent satisfactory production is dependent on favorable combination of certain natural factors, among which climate and soil are the most important. The climate includes basic environmental elements like temperature, rainfall, atmospheric humidity, wind, hail, and light, while soil covers factors such as soil moisture supply, texture, structure, chemical composition, and temperature. Each of these factors has a determining influence on the growth and

performance of fruit trees. The basic requirements for a satisfactory orchard site are climate relatively free from temperature and wind hazards, a reasonably deep and fertile uniform soil having good drainage, and an adequate supply of water for irrigation. Apart from this, other factors like altitude, location, the topography of the land, air drainage, adaptability of variety chosen, availability of labour and facilities for transportation, and easy disposal of the production which is equally important, should be considered in planning an orchard. Besides, the availability of resources with the growers also determines the profitability of a fruit orchard. The essential resources required for successful fruit growing are broadly categorized as biophysical resources and socio-economic resources. The biophysical resources include land, soil, planting materials, irrigation facility, and flow of agrochemicals and manpower. On the other hand, the socio-economic resources consist of the flow of finance, technical know-how, market, transport, storage, and social amenities of the workers engaged in the orchard. Each of the resources is essential for successful fruit growing and each of them has a specific role to play in the establishment of an orchard.

10.5.1 Layout Plan of an Orchard

Orchard establishment can be considered as an art to be developed and displayed by the use of modern technologies and a sense of aestheticism. The following points in respect of orchard layout are very important for the growers.

Provision of roads/ paths: There should be an appropriate provision for roads and paths in an orchard for easy movement. It should be cleaned and demarcated properly. Network of internal crossroads and paths should be meticulously provided in such a way that the movement of man, vehicle, and farm machinery is freely done. Over enthusiasm in the process of road making should be avoided to safeguard the utter economy of planning.

Farmstead buildings: Allocation of land for the construction of farmstead buildings should be carefully done. The building should include an office, implement shed, godown, and pump houses at appropriate locations. All the buildings should be provided with a permanent power supply. In no case, the area under road and buildings should exceed 10 percent of the orchard space.

Irrigation facility: The installation of an irrigation system is a prerequisite for establishing an orchard of fruit trees. The main source of irrigation should be either dug wells or deep tube wells and those should be installed at a higher elevation and distributaries channels be spread out covering the entire area of cultivation along with the inspection chambers at specific locations. Provision of water harvest structures at an appropriate elevation for effective conservation of soil and moisture would be of immense help as an alternate source of irrigation.

Demarcation of blocks: Once the layout is complete and channels are established, the area to be covered under the plantation of fruit trees should be segmentally divided to form distinct blocks.

Fencing: It is considered to be the most important defensive mechanism of the orchard and it should be erected before planting. It protects both

Horticulture And Allied Sectors domestic and wild animals and human pilferage. Fencing may be done in different ways. Temporary fences could be erected with bushes and thorns. Construction of a boundary wall around the orchard would be the most ideal fence, however, it is a costly affair. Barbed wire fencing of required height is as good as the wall but it needs annual maintenance. So the best compromise is to grow hedges (bio-fencing), which would offer a more promising solution, being both cheap and effective. But the worst feature of hedges is that being living plants; they may overgrow beyond the admissible limit. Therefore proper pruning of hedges is very necessary after substantial time. Important plant species, which can be used as bio-fence, are *Carissa carandas*, *Purkinsonia aculeata*, *Prosopis juliflora*, *Lawsonia alba*, *Duranta plumieri*, *Clerodendron inerme*, *Justicia gendarusa* etc.

Provision of windbreaks: Wind of high velocity often creates disaster to the orchards and uproots the trees, breaks branches, causes premature flower and fruit drop, and erosion of surface soil. Hence, an effective windbreak with tall and compact trees should be established within the orchard along with the fence. The planting of windbreaks should be done at least 2-3 years before the establishment of the orchard so that they are ready to give protection to the fruit trees from heavy winds. Important windbreaks are *Casurina equisetifolia*, *Polyathia longifolia*, *Erythrina indica*, *Syzizium* species.

Choices of planting system: The main objective of the planting plan is to accommodate the maximum possible number of fruit trees per unit area without affecting the efficiency of production.

10.5.2 Planting Systems

There are few planting systems, which may be employed for establishing a fruit orchard. These systems are described briefly hereunder:

Square system: Planting of trees in the square was formerly the most common practice but, it is desired to have trees closer in one direction than the others. In this system, the trees are planted on the four corners of the square in straight lines running across in right angles. It is an easy method of layout and permits cross cultivation and irrigation in two directions.

Rectangular system: This is a modification of the square system where row-to-row distance is kept greater than plant-to-plant distance. This system has almost all the advantages of the square system except that cultivation between the trees is difficult when trees are fully grown.

Quincunx system: This system of planting is the same as the square system except that an addition of a tree in the center of each square is done in this system. The central tree is usually the filler tree, which is kept for a short period. In this way, the number of trees is almost doubled but the distance between the central and corner trees is greatly reduced, resulting in eventual crowding with no space for cultivation. This system is, therefore, used mainly where it is desired to have temporary trees along with permanent ones. The temporary trees known as *fillers* are planted in the centers and permanent trees in the corners of the square.

Triangular system: This system is not popular and seldom adopted for planting. In this system, the trees are planted as in the square system except that those in the even-numbered rows are midway between instead of oppo-

site to the trees in odd-numbered rows. Though this system provides more space to the plants, it becomes difficult to carry out intercultural operations.

Hexagonal system: This system should not be confused with the triangular system. Here, the trees are equidistantly spaced from each other and the sixth tree encloses the seventh one. It is difficult to adopt and seldom used. The main advantage of this system is that about 15 percent more trees can be accommodated per unit area as compared to the square system.

Contour system: Used in hills side planting. Trees are adjusted as per available contour. When the slope exceeds 10 %, terraces are made to plant the tree.

Hedge row system: In this system, the distance between trees in a row is half to one-third the distance between rows. That means the distance between rows is 1.3 to 2.0 times more than that between plants. It was generally followed in high-density planting of apple and pineapple. Now, this system of planting is becoming popular in other fruit crops also. It is followed by mechanized fruit cultivation.

Activity 10.3
 Visit some well established orchards (3-4) nearby your village or town. Note down the fruits grown there and their planting density, planting distance, and planting system. Also classify different fruit plants grown in the orchards as temperate, tropical, or subtropical fruits.

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Check Your Progress 10.3

- Note:** a) Use the space given below for your answers.
 b) Check your answers with those given at end of the unit.
1. Mention important points to be considered while making a layout of an orchard.

 2. Mention different planting systems used in laying out orchards.

 3. Which is the most commonly used planting system in India and which system is preferred in hills?

10.6 LET US SUM UP

As we have gone through this unit, we could understand that different types of fruits are grown in India in different climatic conditions. Among fruits, mango, banana, grapes, citrus, papaya, apples, sapota, pomegranate, pineapple, and litchi are only considered as major fruit crops, as these crops occupy the major area under fruit crops grown in India. Among these fruit crops, the highest acreage is under mango, followed by citrus and banana, whereas the highest production share is that of banana. In the area, the maximum share is that of mango, followed by citrus and banana, whereas in production, the maximum share is that of banana, followed by mango and citrus. Maharashtra, A.P., Uttar Pradesh, Tamil Nadu, Gujarat, Karnataka, Bihar, Odisha, W. Bengal. J & K, and H.P. are the major fruit producing states of India. Every state produces some amount of specific fruits and there are specific fruit-producing belts as well. Fruits are considered *protective foods* as they are a rich source of antioxidants, fiber, proteins, vitamins, and minerals, which protect us from several diseases. Several principles are involved in orchard establishment. Although, several layout plans are there for the establishment of orchards but usually square and rectangular systems are used in plains. In hills, the contour system of planting is used commercially for establishing the orchards of temperate fruits like apple, pear, peach, plum, almond, walnut, cherry, etc.

Let us conclude by saying that we must consume an ample quantity of fruits daily so as keep us healthy and fit.

10.7 KEYWORDS

Antioxidant : Compound which prevents oxidation of food substances by binding with free radicals.

Carbohydrates : Molecules containing carbon, hydrogen, and oxygen, primarily used as a source of energy.

Carotenoids : These are usually 40 carbon compounds, stored in the chloroplast of a plant cell, mainly responsible for imparting orange or red color to fruits.

Functional food : Food that provides specific health benefits along with nutrition.

Layout : Demarcation of plants and other assets in an area.

Productivity : Production per unit area.

Protective food : Food that protects us from diseases, disorders, or ailments.

Vitamins: Organic compounds which cannot be [synthesized](#) in sufficient quantities by an organism, and must be obtained from the diet.

10.8 SUGGESTED FURTHER READINGS / REFERENCES

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10.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 10.1

1. Mango, banana, citrus, papaya, apples, sapota, pomegranate, pineapple, and litchi are major fruit crops. The highest production share is that of banana, followed by mango and citrus
2. Mango, banana, and apple producing states are:
Mango: Uttar Pradesh, Maharashtra, Gujarat, West Bengal, Andhra Pradesh, Madhya Pradesh, Odisha, Kerala, Karnataka, Goa, and Tamil Nadu.
Apple: Jammu and Kashmir, Himachal Pradesh, Uttrakhand, Arunachal Pradesh.
Banana: Maharashtra, Tamil Nadu, Kerala, Karnataka, Odisha, Madhya Pradesh, Bihar, Chhattisgarh.
3. The production season of mango is April-August in most of the states and January-April in Kerala, parts of Tamil Nadu, and Andaman and Nicobar Islands. Papaya is available throughout the year in A.P., Assam, Maharashtra, Tamil Nadu, and West Bengal, and April-October in Karnataka.

Check Your Progress 10.2

1. Fruits play a vital role in the balanced human diet as they are a rich and comparatively cheaper source of vitamins and minerals. Their consumption in sufficient quantities provides taste, palatability and increases appetite, and provides a fair amount of fibers. These are

reckoned as an important adjunct for the maintenance of good health and beneficial in protecting against some degenerative diseases. Mango, pineapple, papayas are a good sources of Vitamin A and *aonla* and guava of vitamin C. Dates, bananas, grapes are good sources of carbohydrates. Most fruits contain acids like malic acid, citric acid, which play a key role in the digestion of proteinaceous and fatty foods. Some fruits are a good source of valuable roughage, which promotes digestion and helps in preventing constipation.

2. Vitamin A is essential for normal growth, reproduction, maintenance of health, vigour, and proper functioning of the eyes. It helps to keep off influenza. Vitamin C is essential for keeping the blood vessels in good condition. Its deficiency causes scurvy.
3. Fruits rich in Vitamin A are mango, pineapple, papaya, apricots, and fruits rich in Vitamin C are Barbados cherry, *aonla*, guava, citrus fruits, kiwifruit, etc.

Check Your Progress 10.3

1. Before making a final decision for establishing a fruit orchard, climate and soil are the most important factors. Apart from this, other factors like altitude, location, the topography of the land, air drainage, adaptability of variety chosen, availability of labor and facilities for transportation and easy disposal of the produce, etc., are equally important and should be considered well before planning an orchard establishment. During layout, we should make provision for roads/paths, farm buildings, stores, irrigation source, different fruit blocks, and provision for windbreaks, etc.
2. Several planting systems used for the layout of orchards in India are square, rectangular, triangular, hexagonal, quincunx, contour, and hedgerow.
3. A Square system is commonly used because it is easy to use and follow. In hills, however, a contour system of planting is practiced to avoid soil erosion.

UNIT 11 VEGETABLE PRODUCTION

Structure

- 11.0 Objectives
- 11.1 Introduction
- 11.2 Relevance of Vegetables to Agro-Industry
- 11.3 Fruit and Leafy Vegetables
 - 11.3.1 Tomato
 - 11.3.2 Brinjal
 - 11.3.3 Chilli
 - 11.3.4 Okra
 - 11.3.5 Amaranth
 - 11.3.6 Beet Leaf or Palak
- 11.4 Cole and Bulb Crops
 - 11.4.1 Cole Crops
 - 11.4.2 Bulb Crops
- 11.5 Tuber and Root Crops
 - 11.5.1 Potato
 - 11.5.2 Sweet Potato
 - 11.5.3 Cassava
 - 11.5.4 Carrot
 - 11.5.5 Radish
- 11.6 Let Us Sum Up
- 11.7 Keywords
- 11.8 Suggested Further Readings
- 11.9 Answer to Check Your Progress
- 11.10 Unit End Questions

11.0 OBJECTIVES

After studying this unit, you will be able to:

- to discuss the importance of vegetable crops for food and nutritional security;
- create awareness about the area, production, and productivity of major vegetable crops; and
- to explain the role of vegetable crops as an agro-industry in the Indian economy.

11.1 INTRODUCTION

Vegetable crops are the most sought crops the world over as they are essential items of food and nutrition both for rich as well as poor. Their role in our diet needs no emphasis as they are a rich source of carbohydrates, proteins, fats, minerals, and vitamins and are regarded as protective foods

well equipped to combat malnutrition. Although there has been a tremendous increase in production and consumption of vegetable crops since independence in the country, there exists a gap between the optimum needs and their present proportion in the average Indian diet due to ever increasing population which has already touched 1.3 billion. Increasing vegetable production, therefore, continues to be the main goal vis-à-vis quality of the produce. A systematic approach towards increased vegetable production and consumption is essential.

Progress made in the development of improved varieties of major vegetable crops concerning maturity periods, growth habits, resistance to diseases and insect pests, and the extreme temperature has been remarkable. Besides, agro-techniques for getting maximum production have been standardized and enough progress has also been made in the management of diseases, insect pests, nematodes, and weeds. However, there has been a gap in the full dissemination of this knowledge to the vegetable growers, therefore, there is a need to compile recent advances in major vegetable crops concerning varieties, agro- techniques, integrated pest management for the benefit of vegetable growers, researchers, teachers, and students.

Presently, vegetable production in India is more than 188 million tonnes from an area of around 10 million hectares with a productivity of 18.26 metric tonnes per hectare (the year 2019-20). With the rising population pressure, this productivity further needs to be increased to meet the dietary recommendations of 300 g vegetables per capita per day. This is possible by following an improved package of practices for scientific vegetable cultivation. Besides, to reduce post-harvest losses, it is essential that on-farm primary processing, grading, and packaging are encouraged which will go a long way in value addition and improving the quality of the produce.

11.2 RELEVANCE OF VEGETABLES TO AGRO-INDUSTRY

Major Solanaceous vegetable crops like potato, tomato, brinjal, chili, sweet pepper have potential not only for fresh market but potato, tomato and chili have special utility for processing industry so these are good for developing agro-industry. Likewise, cole crops (cauliflower, cabbage, broccoli, knol khol, Brussels sprouts, and kale), bulb and root crops (onion, garlic, carrot, radish, beetroot, turnip, etc.), leafy vegetables (beet leaf, spinach, amaranth, chenopod, vegetable mustard, etc.), legume vegetables (garden pea, French bean, winter bean, cowpea, cluster bean, and dolichos, etc.) and cucurbits (cucumber, muskmelon, watermelon, bitter gourd, pumpkin, bottle gourd, etc.) have great potential in the domestic fresh market, export market, processing industry and emerging functional and fusion food industry for balanced food for tackling malnutrition. This is because these vegetable crops are rich sources of various bioactive compounds that can be extracted and used in balanced food development. Besides, these are potent sources of edible colour and various anti-oxidants. Thus, their suitability is not limited to the domestic cottage industry for chips, ketchup, puree, and pickle making but for the multi-national nutraceutical industry.

11.3 FRUIT AND LEAFY VEGETABLES

The importance of fruits and leafy vegetables in human nutrition is well known. These vegetables are rich and comparatively cheaper sources of vitamins and minerals. Their consumption in sufficient quantities provides sufficient immunity to the human body for fighting against certain degenerative diseases. Solanaceous fruit vegetables, okra, and leafy vegetables are therefore important human diet for good human health. In general, they provide different minerals like iron, calcium, phosphorus, potassium, iodine, etc, and different nutraceuticals like beta carotene, lycopene, lutein, capsaicin, and capsanthin which have antioxidant activity. Thus, the consumption of these vegetables protects our body from exposure to free radicals which cause degenerative diseases like cancer, etc. It is therefore essential to produce a large quantity of these types of vegetables to supply our constantly growing population in ample amounts to protect our population from degenerative diseases. So growers should have sufficient knowledge of production practices and plant protection of these vegetables without hampering their quality and consumer acceptability, especially during this organic era. Fruit vegetables are transplanted crops i.e. their seeds should be sown in the nursery so that they can be nurtured well in a smaller area and then transplanted depending upon the crop at three or four weeks age.

11.3.1 Tomato

Tomato (*Solanum lycopersicum L.*) is an important widely cultivated the world over. Tomato is diploid species with $2n = 2x = 24$ chromosomes. It belongs to the family Solanaceae. It can be consumed raw, boiled, stewed, as a sauce, or in combination with other foods. These can be used as an ingredient in the kitchen or can be commercially processed whole or as a paste, juice, and powder. The red colour of the tomato is due to lycopene, which has anticancer activity. Its culture extends from the tropics to a few degrees in the Arctic Circle.

11.3.2 Brinjal

Brinjal, eggplant, or aubergine (*Solanum melongena L*) is one of the most commonly grown vegetable crops in India. It belongs to the family Solanaceae. The somatic chromosome number of the brinjal is $2n=24$. It is adapted to a wide range of climatic conditions. It has a long bearing period when grown under a mild climate of southern states but its bearing is shortened under hot climate. Its fruits are a fairly good source of calcium, phosphorus, iron, and vitamin, particularly B groups. Brinjal is reported to stimulate the intrapeptic metabolism of blood cholesterol. White brinjal is said to be anti-diabetic.

11.3.3 Chilli

Chilli is known as hot pepper, was introduced to India from Brazil in the 16th century by the Portuguese. The botanical name of chilli is *Capsicum annum* and belongs to the family Solanaceae. The basic chromosome number of chilli is $x=12$. Within a span of over four centuries, it has spread to an area of around 0.39 million hectares and production of 4.12 million tonnes covering almost all the states of the country (in the year 2019-20). Chilli is mainly used in culinary adding flavour, colour, vitamins, and pungen-

cy. Therefore they are indispensable to Indian and many African and Asian countries. In the food and beverage industry, chilli is being used in the form of an oleoresin. In India, no dish is complete without chillies.

11.3.4 Okra

The cultivated okra (*Abelmoschus esculentus* L. (Moench)) is an important vegetable crop throughout tropical and subtropical regions of Asia and Africa. The most frequently observed somatic chromosome number is $2n=130$. It belongs to the family Malvaceae. It is valued for its mature, tender, and green fruits. Okra fruits are rich in calcium (90 mg/100 g fresh weight) and provide a valuable supplementary item in the tropical diet. The young fruits are consumed as a cooked vegetables, mostly fresh but sometimes sun-dried or frozen. The fruit is fairly rich in protein and minerals. Its seed contains 13–22% edible oil and 20–24% edible protein and is viewed as an alternative source for edible oil. In Far East countries like Papua, New Guinea, Fiji, and Solomon Island a wild relative of okra known as *Abelmoschus manihot* is used as a leafy vegetable.

11.3.5 Amaranth

Amaranths are primarily used as potherbs. It is the most common leafy vegetable grown during the summer and rainy seasons in India. It fits well in crop rotation as it is a short-duration crop and produces more biomass per unit area. Leafy amaranth is said to be native to India. Among leafy types, *Amaranthus tricolor* is the main cultivated species in India.

11.3.6 Beet Leaf or Palak

Beet leaf is one of the most common leafy vegetables of the tropical and sub-tropical region. The states popularly growing this crop include Uttar Pradesh, West Bengal, Maharashtra, and Gujarat. However, it is not very popular in southern states. Botanically, Palak is known as *Beta vulgaris* var. *bengalensis*. Palak has a chromosome number $2n=2x=18$. It is a native of the Indo-Chinese region.

Check Your Progress 11.1

- Note:** a) Use the space given below for your answers.
 b) Check your answers with those given at end of the unit.
- i. Vegetables are called as..... food.
 - ii. Dietary recommendation of.....g vegetables per capita per day.
 - iii. Lycopene antioxidant compound is found in..... crop.
 - iv. Botanically palak is known as.....
 - v. *Amaranthus*.....is the main cultivated species of India.
 - vi. White brinjal is said to be anti.....
 - vii. Botanically okra is known as.....
 - viii. Chromosomes number of tomato and chilli.....
 - ix. Family of brinjal.....

11.4 COLE AND BULB CROPS

11.4.1 Cole Crops

The word 'Cole' is originated from the Latin word 'caulis' meaning stem. Cole crops are a group of highly differentiated plants are originated from a single wild species *Brassica oleracea* var. *sylvestris*. *Brassica oleracea* is a versatile species that under human selection has generated several crops each targeted to a different organ of the plant (leaves along the stem: kales; leaves surrounding the terminal bud: cabbage; enlarged axillary buds: Brussels sprouts; inflorescences: cauliflower and broccoli; swollen stem: kohlrabi and marrow stem kale). Cauliflower (*Brassica oleracea* L. var. *botrytis* L. $2n = 2x = 18$) is one of the most popular vegetables after cabbage. It is grown for its highly suppressed 'prefloral fleshy apical meristem' branches called "curd." This is cultivated worldwide in different climatic conditions, ranging from temperate to tropics during most cropping seasons, and is available round the year in the market. Cabbage (*Brassica oleracea* var. *capitata*) is another important vegetable of the Cole crops group. It is a rich source of vitamin A, B, C, and minerals. It covers about 4% of the total area under vegetables. India comes next to china in cabbage production. It is now grown almost throughout the year. Odisha, West Bengal, Bihar, Karnataka, Maharashtra, Gujarat, and Punjab are major cabbage-growing states. Commonly grown cabbage in India is white. Red and Savoy cabbage is not so popular. The heads of cabbage vary from flat-topped to long-oval. The tender leaves are primarily used as a cooked vegetable, more in raw than in processed form. Knol-khol (*Brassica oleracea* var. *gongylodes*) is known by many names in India. It is popular in Kashmir, West Bengal, Maharashtra, Assam, Uttar Pradesh, Punjab, and some parts of South India, but it is not cultivated commercially. It is characterized by the formation of knob which arises from a thickening of the stem tissue above the cotyledons. The fleshy turnip-like enlargements of the stem develop entirely above the ground. This knob is harvested for human consumption as a raw or cooked vegetable, though in some parts, young leaves are also used. All the cole crops are transplanted and require extra care during nursery raising and transplanting and for a month after.

11.4.2 Bulb Crops

Onion (*Allium cepa* L.) is an important vegetable crop the world over. Onion is consumed in the form of fresh, frozen, dehydrated powder and green bunching onions. As a culinary ingredient, it adds to the taste and flavor in a wide range of food preparations and it is also used as a salad. India produces all three varieties of onion – red, yellow, and white. In some parts of the country, onion is grown in all three seasons. In the northern part of the country, onion is usually grown in the winter (Rabi) season. However, in the southern and western states of Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat, and Maharashtra, it is grown in winter (Rabi) as well as in the rainy (Kharif) seasons. Currently, Kharif onion is gaining ground in the northern part of the country. The top five onion producing states include Maharashtra, Karnataka, Gujarat, Bihar, and Madhya Pradesh accounting for about 70 percent of the total production. Garlic (*Allium sativum*) is the second important bulb crop grown after onion in India. Garlic is used as a spice or

Horticulture And Allied Sectors condiment throughout India. It is also an important foreign exchange earner for India. It has a higher nutritive value than other bulb crops. It is rich in proteins, phosphorous, potassium, calcium, magnesium, and carbohydrates. India has become one of the biggest exporters of garlic worldwide. Madhya Pradesh, Gujarat, Uttar Pradesh, and Rajasthan contribute 73 % area and 78 % of the production of garlic in India.

11.5 TUBER AND ROOT CROPS

11.5.1 Potato

Potato (*Solanum tuberosum*) is grown in about 17.34 million ha with an annual production of nearly 377.44 million tonnes the world over in the year 2019 (FAO State 2021). It is one of the major food crops grown in a wide variety of soils and climatic conditions in nearly 150 countries and is the world's single most important tuber crop with a vital role in the global food system. It is the most important dicotyledonous source of human food. It ranks as the fourth major food crop of the world, exceeded only by wheat, rice, and maize. The dry matter production of potatoes per unit area of land, total potato production has increased in both developed and developing countries in the past 40 years. Potato is a versatile, carbohydrate-rich food highly popular worldwide and prepared and served in a variety of ways. Potato is a wholesome food in terms of protein and energy. Apart from starch, it provides the body-building substances such as vitamins, minerals, and proteins. Carbohydrates constitute about 80% (range 63-86%) of the total solids found in potatoes. Freshly harvested, it contains about 80 percent water and 20 percent dry matter. About 60 to 80 percent of the dry matter is starch. On a dry weight basis, the protein content of potato is similar to that of cereals and is very high in comparison with other roots and tubers. In addition, the potato is low in fat. Potatoes are rich in several micronutrients, especially vitamin C - eaten with its skin; a single medium sized potato of 150 g provides nearly half the daily adult requirement (100 mg). The potato is a moderate source of iron, and its high vitamin C content promotes iron absorption. It is a good source of vitamins B1, B3, and B6 and minerals such as potassium, phosphorus, and magnesium, and contains folate, pantothenic acid, and riboflavin. Potatoes also contain dietary antioxidants, which may play a part in preventing diseases related to aging, and dietary fiber, which benefits health.

The year 2008 was declared the International Year of Potato (IYP) by the United Nations. The declaration of IYP reflects the importance of potato in food security, nutrition, poverty alleviation, environmental conservation, and sustainable development.

Area and Production

India ranks second largest country in the world in the production of potato after China. Potato is produced in an area of 2.05 million ha with a production of 48.56 million tonnes and productivity of 23.68 t/ha. in the year 2019-20 (agricoop.nic.in). Indian processing industry consumes less than 2% of the total production in the country. Out of the total area of vegetables, potato occupies 19.89%, the production was 25.79 % share in the total vegetable production in the year 2019-20. Potato is grown almost in all states of India.

The states of Uttar Pradesh, West Bengal, and Bihar account for 61.44 % area and 68.37 % of the potato production in the country. The highest area and production from Uttar Pradesh followed by West Bengal and Bihar. The highest productivity of the crop is in Gujarat (30.64 t/ha) followed by Bihar (29.88t/ha) in the year 2019-20. Potato is one of the principal cash crops. Other major potato growing states are Gujarat, Madhya Pradesh, Punjab, Assam, Jharkhand, and Haryana. About 90% of the potato crop in India is cultivated on Indo-Gangetic Plains from October-March. About 10% of the area lies in the hills where the crop is grown during long days of summer months from April to September.

Potatoes are grown in about 150 countries throughout the world and more than a billion people worldwide eat potato. About 370.43 million tonnes of potato are produced in the world over an area of about 17.34 million hectares in 2019 (FAO State 2021).

The area under potato cultivation is almost constant and the same is the case with production. However, there is a slight decline in the yield. The top ten producers in the world are China, India, Russia, USA, Ukraine, Poland, Germany, Belarus, Netherlands, and France. These together contribute about 70% of the total production. India ranks second, contributing around 13.18 % to the world's production after China. Production-wise India has always remained in the top ten for the last twenty years. Europe is the largest per capita consumer, followed by North America and Latin America

Nutritive value

Potato is a wholesome food in terms of protein and energy. Apart from starch, it provides bodybuilding substances such as vitamins, minerals, and proteins. Carbohydrates constitute about 80% (range 63-86%) of the total solids found in potatoes. Starch is the major component of potato tubers. Potato is a low energy density food. Potato starch contains amylase and amylopectin. The amylase content in starch ranges from 18.5-32.0. Sucrose, glucose, and fructose comprise the major sugars of potato. The dietary fiber content ranges between 1-2% in fresh potatoes. Potatoes contain a higher concentration of lysine (4.2-5.7mg/g) than cereals, potato is a supplement for the cereal-based diet.

11.5.2 Sweet Potato

Sweet potato (*Ipomoea batatas*) is widely grown in the tropics and warm temperate regions of the world. It is the third most important tuber crop in India after potato and cassava. The root tubers are mainly used as a subsidiary food. The crop is grown in all the states of India except the states of Jammu and Kashmir, Himachal Pradesh, and Sikkim.

Sweet potato is an important tropical root and tuber crop as it ranks second after cassava among the tropical tuber crops. It ranks as the most important food crop on a fresh weight basis in developing countries after rice, wheat, maize, and cassava. Sweet potato roots (orange and non-orange) are a valuable source of vitamin C 20-30mg/100g, vitamin B complex and E. Vine tops have excellent micronutrient contents and adequate protein content (2-4% for use as a food. It is used as a staple food, vegetable (fleshy roots, tender leaves, and petioles), snack food, animal feed, industrial starch extraction and fermentation, and for processed products.

It is predominantly cultivated as a rainfed crop in eastern India especially

Horticulture And Allied Sectors in Orissa, Bihar, West Bengal, and Jharkhand. Orissa is the leading state in area and production followed by Uttar Pradesh and West Bengal. Even in eastern India, the crop is concentrated in a few districts only, Koraput, Sundargargh, Keonjhar, Ganjam, and Bolangir are the major sweet potato growing districts covering 50% area under crop in Odisha.

Area and Production

Sweet potatoes are grown about 7.77 million hectares, yielding 91.82 million tonnes, with an average yield of about 11.82 tonnes/ha in the year 2019 (FAO STAT, 2021). They are mainly grown in developing countries, which account for over 97% of world output. Sweet potato is a poor man's crop in Africa, with most of the production done on a small or subsistence level. China is the largest producer of sweet potatoes, accounting for more than 80% of the world's supply.

In India, it is grown on 0.13 million ha and production is 1.50 million tonnes and productivity is 11.50 tonnes/ha. in the year 2017-18. Sweet potato is predominantly cultivated as a rainfed crop in eastern India especially in Orissa, Bihar, West Bengal, and Jharkhand. Odhisa is a leading producer with 0.38 million tonnes production followed by Kerala 0.34 million tonnes, Uttar Pradesh 0.23 million tonnes, and West Bengal 0.22 million tonnes.

Food value and uses

Sweet potato roots (orange and non-orange) are a valuable source of vitamin C 20-30mg/100g, vitamin B complex and E. Vine tops have excellent micronutrient contents and adequate protein content (2-4% for use as a food. It is used as a staple food, vegetable (fleshy roots, tender leaves, and petioles), snack food, animal feed, industrial starch extraction and fermentation, and for processed products. The roots are rich in carbohydrates (starch, cellulose, hemicelluloses, pectins, and sugars). Starch accounts for 60-70% of the dry matter. The total sugars in cultivars show wide variations; with a usual range of 0.38-5.64. sucrose is the most abundant sugar in raw roots. It accounts for around 80-90% of the total dry matter content. The dry matter content varies depending on the cultivars, cultural practices, climate, etc., and is reported to range from 13- to 48%. The vine tips are a rich source of vitamin A (5580IU/100g, and calcium (74mg/100g). The most studied nutraceuticals in sweet potatoes are carotenoids and anthocyanins. The purple-fleshed sweet potatoes (variety Ayamurasaki) are a rich source of anthocyanins, which have medicinal value as anti-oxidant and cancer-preventing activity. Besides, in Japan, the coloured roots are used for extracting the pigment, which is further used in various food products. The β -carotene is the most abundant pigment in sweet potato and orange-fleshed varieties contain high as 16 mg/100g (fwb) and yellow-fleshed varieties have around 10 mg/100g.

The yellow and orange colour in tubers is due to β -carotene. Orange fleshed sweet potato (OFSP) has more advantages than others cultivars it can supply significant amounts of vitamin A and energy simultaneously-thus helping to address both VAD and undernutrition. The intensity of the orange colour reflects the amount of beta carotene present. Generally, the orange flesh varieties have the range of 250- 800 RAE/100g of fresh weight basis (fwb) 30-95 μ g/g. The current guidelines recommend that the provitamin A activity be expressed in retinol activity equivalents (RAE). The RAE defini-

tion is based on the assumption that 16.7% of the ingested beta carotene is observed and 50% is converted to retinol. This results in an average conversion factor of 12 units of beta carotene to form 1 RAE. OFSP is an example of a biofortified crop in which the mineral nutrient status of staple foods is enhanced through plant breeding to the point where the impact on micronutrient status can be achieved.

11.5.3 Cassava

Cassava (*Manihot esculenta* Crantz) is the most important crop among the tropical root and tuber crops. Cassava is one of the most important sources of food energy in several tropical countries. An estimated 70 million people in Africa and N.E Brazil get more than 500 cal/day from cassava. The crop is frequently identified as a famine reserve due to its tolerance to drought and infertile soils, and its ability to recover from disease and pest attacks. Cassava also offers the advantage of a flexible harvesting date, allowing for farmers to keep the roots in the ground until needed. The area of cassava under marginal environments has been continuously increasing, particularly for regions with poorer soils and long dry seasons.

Cassava is consumed either directly as cooked tubers or as the products prepared from cassava. Cassava in India is mainly used for human consumption, industrial, and animal feed sectors. In India, nearly 60% of cassava is used industrially in the production of sago, starch, and dry chips. Tapioca sago is generally known as Sago (sabudana in Hindi) in India. Sago is a produce, prepared from the milk of cassava root. The added value realized from industrial cassava makes this crop one of the most profitable choices for farmers.

Area and Production

Cassava is cultivated in an area of 0.17 million ha producing 6.06 million tonnes in 2019-20 in India. Tamil Nadu accounted for an area of 0.09 m ha, Kerala 0.05m ha, and Andhra Pradesh (0.01m ha). Cassava is grown as a rainfed crop in Kerala and Andhra Pradesh. But in Tamil Nadu, it is grown both as an irrigated crop and rainfed crop. The north-eastern region of Thailand is the world's biggest exporter of dried cassava. About 60% of the total planted area is in this region.

More than 800 starch and sago industries operate in and around the Salem and Namakkal districts of Tamil Nadu. The added value realized from industrial cassava makes this crop one of the most profitable choices for farmers. In India, Sago was produced first in Salem (Tamil Nadu). About in 1943-44, Some 50 years ago, sago production started on a cottage scale basis in India by pulping the tapioca roots, filtering the milk extract, and after settling the milk, forming globules and roasting these globules. Tapioca Root is the basic raw material for Sago and starch. There are about 30% to 35% starch contents generally in Indian tapioca roots. India is one of the leading countries in tapioca production. It is a very nutritious product as it contains Carbohydrates and an appreciable amount of Calcium and Vitamin C.

11.5.4 Carrot

Carrots (*Daucus carota*, 2n=2x=18) are grown all over India. It is taken in raw as well as cooked form. It is made into pickles and sweetmeat. A sweet preparation called *Gajar halwa* is a very famous dish in north India. Carrot

juice is a rich source of β -carotene and is sometimes used for colouring butter and other foods. Black carrot is a rich source of anthocyanins and is used for the preparation of a beverage called *Kanji* considered to be a good appetizer. The carrot contains about 87% water, rich in minerals and vitamins (B, C, D, E). Raw carrots are an excellent source of vitamin A, Potassium, vitamin C, vitamin B6, thiamine, folic acid, and magnesium.

11.5.5 Radish

Radish (*Raphanus sativus*) is a root vegetable suitable for tropical and temperate climates. The leaves and roots are consumed both as salad and as cooked vegetables. The radish roots are a good appetizer. The different preparations of radish are useful in curing liver and gall bladder problems. Roots are used in treating urinary complaints and piles. The juice of fresh leaves is useful as a diuretic and laxative.

Check Your Progress 11.2

Note: a) Use the space given below for your answers.

- b) Check your answers with those given at end of the unit.
- i. The edible part of cauliflower is..... a prefloral fleshy apical meristem.
- ii. The year.....was declared as the International year of potato by the United Nations.
- iii. largest producer country of sweet potato.
- iv. In, India nearly 60 % of cassava is used industrially in the production of
- v. Botanically carrot is called as.....
- vi. Black carrot is the rich source of.....
- vii. is a wholesome food in terms of protein and energy.
- viii. Family of cabbage is.....

11.6 LET US SUM UP

The total production of vegetable crops has jumped six times after independence. In the last one and half decades, the country’s vegetable production has almost doubled and the gross vegetable productivity of the country by one-and-a-half times. Important vegetables are tomato, brinjal, okra, beans, peas, cucurbits, melons, and cole crops. Presently, India’s share is 15 % of total world production of vegetables and occupies the second position next to China which has 47%. The present level of contribution of India has been achieved from one-third area of the total area of vegetable production in China. Due to the development of improved varieties and the adoption of hybrid technology, vegetable production in the country is getting the right momentum. The major challenge, which lies ahead, is to develop technologies that enhance the quality and productivity of vegetables under reducing land, declining natural resources, and increasing biotic and abiotic stresses. Solanaceous vegetable crops include tomato, potato, brinjal, chilli, sweet pepper. Tomato has wider coverage in comparison to other vegetables. Universally treated as a protective food, it is being extensively grown as an annual plant all over the world. It is not only a good source of income to small and marginal farmers but also contributes to the nutrition of the con-

sumers. Brinjal is adapted to a wide range of climatic conditions. In hilly regions, it is grown only in summer. A large number of cultivars are grown in our country depending on regional preferences for colour, size, and shape of fruits. Leafy green vegetables have more nutrition per calorie than any other food. Greens make up significant source vitamins A, C, E, and K as well as several B vitamins. They are rich sources of minerals such as calcium, magnesium, iron, and potassium. They are rich in fiber, extremely low in fat and carbohydrates, and provide an excellent source of protein. Cole crops include Cabbage, Cauliflower, Broccoli, Brussels sprouts, Kale, and Kohlrabi. The *Brassica* family is well adapted to cool-season production. These plants are quite cold resistant. The majority of *Brassica* vegetables are purchased and consumed as fresh vegetables, mostly following cooking. Onion and garlic are grown as bulbs vegetables and spices, used for flavoring the dishes. Besides culinary purposes, these are considered valuable medicinal items. The fungicidal and insecticidal properties of garlic are well identified. Dehydrated powder & flakes, and paste prepared out of onion and garlic provide a rich agro-industrial base for these commodities. In contrast to developed countries, where potato is a staple food crop, it is a vegetable in many developing countries including India. In these countries, traditionally potato goes together with the major staple food crops such as rice, wheat, and maize in the daily diet. Cassava is an important starchy staple crop in India. Besides being a staple food crop, cassava can be used as raw material for the production of industrial starch and ethanol. Cassava is cultivated as a monocrop or intercropped with other food crops, either as the dominant or subsidiary crop.

The sweet potato is a versatile plant offering various products and diverse uses ranging from consumption of fresh leaves or roots to processing into starch, flour, noodles, natural colorants, candy, alcohol, and animal feed. Besides these, another tuber crop such as cassava is also placed a significant position in the agro-industry. Root crops carrots, radishes are also consumed as vegetables providing nutritional security in the human diet.

11.7 KEYWORDS

Anthocyanin : Anthocyanin pigments are responsible for the red, purple, and blue colors of many fruits, vegetables, cereal grains, and flowers.

Bulb crop : A storage organ usually formed underground. The swollen portion consists mostly of fleshy, food-storing scales attached to a short flat stem and cloves. Onion and garlic are grown as bulbs vegetables

Cole crops : Cole crops originated from the word *caulis* (Latin), meaning stem or stalk of a plant.

Lycopene : Lycopene is a carotenoid and phytonutrient found in red fruits and vegetables such as tomatoes, pink grapefruits, watermelons, and papayas. It is the compound that is responsible for the red color in these foods.

Sago : Sago is a product prepared from the milk of cassava root.

11.8 SUGGESTED FURTHER READINGS

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11.9 ANSWER TO CHECK YOUR PROGRESS

Check Your Progress 11.1

- i. Protective
- ii. 300g
- iii. Tomato
- iv. *Beta vulgaris var. bengalensis*
- v. *Amaranthus tricolor*
- vi. Diabetic
- vii. *Abelmoschus esculentus*
- viii. $2n = 24$
- ix. Solanaceae

Check Your Progress 11.2

- i. Curd
- ii. 2008
- iii. China
- iv. Sago
- v. *Dacus carota*
- vi. Anthocyanins
- vii. Potato
- viii. Brassicaceae

11.10 UNIT END QUESTIONS

1. Why vegetables are called protective food?
2. What are the major causes for the low productivity of bulb crops in India?
3. "Potato is a wholesome food" justify.
4. Write a short note on the role of cassava in the agro-industry.
5. Comment on the nutritional value of sweet potato.
6. Which are the major potato-growing states of India?
7. What are the uses of carrot and radish?
8. How can we increase the productivity of vegetable crops to meet the dietary recommendations?

UNIT 12 FLOWER PRODUCTION

Structure

- 12.0 Objectives
- 12.1 Introduction
- 12.2 Development of Floriculture
 - 12.2.1 History
 - 12.2.2 Commercial floriculture
- 12.3 Global Bloom Business
- 12.4 Floriculture in India
 - 12.4.1 Traditional Flowers
 - 12.4.2 Cut Flowers under protected conditions
- 12.5 Emerging Avenues for Entrepreneurship
 - 12.5.1 Nursery industry
 - 12.5.2 Essential oil extraction
 - 12.5.3 Aromatherapy
 - 12.5.4 Dry flowers
 - 12.5.5 Waxing of flowers
 - 12.5.6 Pot pourri
 - 12.5.7 Nutraceutical and pharmaceutical pigments
 - 12.5.8 Natural dyes and pigments
- 12.6 Marketing
- 12.7 Export Potential of Floricultural Products
- 12.8 Let Us Sum Up
- 12.9 Keywords
- 12.10 Suggested Further Readings/ References
- 12.11 Answers to Check Your Progress

12.0 OBJECTIVES

After studying this unit, you should be able to:

- discuss the magnitude of flower business in the world;
- appraise the present status of Indian floriculture; and
- explain the potential business opportunities in floriculture.

12.1 INTRODUCTION

In India, floriculture is very closely associated with our culture. If you recall your childhood, you must have noticed that the art and science of growing flowers were mostly restricted to the backyard of individual houses or in the public or private gardens. However, with the liberalization of seed policy and the opening up of the economy, floriculture became a commercial enterprise during the late eighties. A wide range of conducive agro-climatic conditions across the country enables India to cultivate a large number of

Horticulture And Allied Sectors flowers, potted plants, foliage, and aromatic flowers almost throughout the year in one part or the other. The gradual shift from sustenance agriculture to self-sufficiency in agriculture brought about a change in lifestyles and increased the per capita income which in turn fuelled the growth of the floriculture sector in recent years. In this unit, we will understand the meaning of floriculture, its importance, and the relevance of the floriculture industry in the agro-industry.

12.2 DEVELOPMENT OF FLORICULTURE

As mentioned earlier, the scope of floriculture expanded with the evolution of the product mix in the floriculture sector. The humble flowers and ornamental plants, which used to enliven our surroundings, have transformed into an astounding business proportion in today's competitive world. The myth that floriculture includes only the growing of flowers was dispelled with the diverse uses of flowers and their products in the domestic and international markets. *Floriculture the study of flowers* encompasses cut flowers, loose flowers, cut foliage, potted plants, plug plants, dry flowers, pot pourries, essential oils, pigments, and natural dyes.

12.2.1 History

Our rich history indicates that floriculture is in our culture. Indian mythology made a vivid description of the glorious gardens of India that existed during ancient times. In the Ramayana, mention is made of the Ashokavana comprising of 'Ashoka trees (*Saraca indica*), in which Goddess Sita was held captive. Several trees, such as *Terminalia arjuna*, *Mesua ferrea*, *Ficus benghalensis*, *F. religiosa*, *Michelia champaka*, *Butea monosperma*, and *Casia fistula*, have been mentioned in the Ramayana. Similarly in the Sabha-Parva of Mahabharata candid description of the layout of gardens and parks and artificial lakes in the city of Indraprastha is given. The association of Lord Krishna with the Kadamba tree (*Anthocephalus indicus*) is well known. During the Buddhist period, gardens were laid out around the monasteries and stupas and there were beautiful gardens in Nalanda and Taxila. Legend says that Lord Buddha was born under a Pipal tree in a garden and similarly he attained wisdom under a tree.

Kalidasa (about 57 B.C.) in his play Shakuntala has mentioned the pleasure garden having a bower of the Madhavi creeper (*Hiptage madablota*) and several beautiful trees like Ashoka (*Saraca indica*), Kadamba (*Anthocephalus indicus*), Arjuna (*Terminalia arjuna*) Vakula (*Mimusops elengi*), Palasha (*Butea monosperma*), Parijata (*Nyctanthes arbortristis*) and Kavidara (*Bauhinia varieagata*).

We all recall our childhood lessons in which it was documented that the planting of roadside avenue trees was an important contribution of king Ashoka (233 B.C.). The art of gardening has been described by Saragadhara (A.D. 1300) in his *Upavana Vinoda*, and *Sarangadhara Paddhati*, wherein mention is also made of some trees. Vatsyayana (A.D. 300-400) has also rendered interesting accounts of four kinds of gardens, namely, *pramadodyan*, *udyan*, *vrikshavatika* and *nandanavana*. Classical Sanskrit literature, as mentioned above, as well as the flower and tree motifs delineated in old sculptures and the architecture of Mathura (Kanishka period A.D.78-101),

Bharhut, Sanchi, and several others and displayed in the Ajanta frescoes (A.D.100-600) bear testimony to the importance of gardening and flowers in Indian culture.

12.2.2 Commercial Floriculture

The large scale cultivation of flowers for trade and commerce picked up during the 1980s and 1990s. Indian floriculture is predominantly dominated by loose flowers, which are used for worship, decorations, and personal adorning. In India, no religious ritual or function is complete without flowers. The flowers are entwined in the social fabric of the entire nation. The advent of state-of-the-art greenhouse technology during the early 90s paved the way for the commercial cultivation of cut flowers for export. A large number of corporate houses established intensive production centers across the country to produce international standard cut flowers. As the world ushered into the new millennium, for the first time in the history of Indian Floriculture, two chartered Boeing 707 flights airlifted 180 tones (6 million stems) of precious roses worth Rs. 25 crores from Bangalore alone to global auction houses located in the Netherlands, to catch up with a single occasion the Valentine's Day during 2000. Export of roses, which was almost non-existent just six years ago, has assumed the distinction of being one of the fastest growing industries in the history of India. Before we understand the intricacies of Indian floribusiness, we must understand the magnitude of bloom business across the world.

12.3 GLOBAL BLOOM BUSINESS

When we observe critically, all over the world, the floricultural sector is experiencing rapid changes. Due to globalization and its effect on income generation in different parts of the world the per capita consumption of flowers in most countries is increasing. Besides the traditional centers of production (The Netherlands, Columbia, Israel, and Kenya), new production centers are developing in Latin America, Africa, and Asia and the production is increasing many times compared to a decade ago. The Asian countries, like India, China, Korea, Vietnam, etc., are moving in the direction of more intensive floriculture. In the traditional centers, the total area under production will remain stable or increase slightly due to stringent environmental protection measures adopted by the respective countries.

Do you know that the world's largest exporter of horticultural products is by far the Netherlands? Yes, it is interesting to note that it is responsible for about 60% of international exports. The international trade in cut flowers and potted plants is growing every year. From the total production of cut flowers and potted plants, only a small part is exported to the international market. About 75% of the international trade comes from within Europe. Germany alone accounts for 30% of the world's imports of cut flowers. Besides Germany, the United States, France, and the United Kingdom are big importers. The Netherlands, Columbia, Israel, Kenya, and Ecuador are the biggest exporting countries in the world. The position of the Netherlands is very dominant in the total export (about 65%).

The world's largest flower auction located at Aalsmeer in the Netherlands sells more than 20 million flowers and plants every day. More than 7000

Horticulture And Allied Sectors specialized growers from all over the world offer their flowers and plants via Bloemenveiling Aalsmeer every day. The auction has an essential 'break-bulk' function: large lots are sold within a couple of hours and divided into smaller lots. The customers who are situated at the auction (wholesalers and exporters) can be on their way to the consumer, anywhere in the world, within a few hours. You will be surprised to note that with about 1 million m² of floor space, the auction building is the largest commercial building in the world, according to the Guinness Book of Records. Bloemenveiling Aalsmeer turns over NLG 12.5 million (EUR 5.75 million) every day.

Sources: <http://www.icangarden.com/pix/gwaamsterdambelgium2006-3a.cfm>

<http://imi-inc.net/amsterdam.htm>

The Netherlands, Colombia, Ecuador, Kenya, and Israel are the main exporting countries. Relatively new to flower farming is Ethiopia. With the bulk of the flowers destined for sales through the American and European retail chains, the flower farms in new emerging countries will have to meet more demanding production standards.

12.4 FLORICULTURE IN INDIA

Floriculture has been part of Indian culture and is entwined in the social fabric of our customs. A wide range of conducive agro-climatic conditions across the country enables India to cultivate a large number of flowers, potted plants, foliage, and aromatic flowers almost throughout the year in one part or the other. The gradual shift from sustenance agriculture to self-sufficiency in agriculture brought about change in lifestyles and increased the per capita income, which fuelled the growth of the floriculture sector in recent years.

The floriculture industry in India is characterized by growing traditional flowers (loose flowers) and cut flowers under open field conditions and protected environment conditions respectively. India also has a strong dry flower industry, which provides a major contribution to the overall trade. Other segments like fillers, potted plants, seeds, planting material, turfgrass industry, and value-added products also contribute a share in the overall growth of the floriculture sector. The traditional flower cultivation, comprising of growing loose flowers mostly for worship, garland making, and decorations, forms the backbone of Indian floriculture, which is mostly in the hands of small and marginal farmers. The globalization of the Indian economy and subsequent liberalization of the seed act paved the way for the advent of protected cultivation in India during the early 1990s. Over the last 15 years, the organized sector of floriculture focusing on exports witnessed enormous growth.

12.4.1 Traditional Flowers

Growing traditional loose flowers for worship and decorations is the mainstay of Indian Floriculture, which occupies about 27000 ha area during 2019-20 with a production of 2.32 million tonnes. The flowers are grown in the open field and are marketed through highly unorganized marketing channels. The area under loose flowers crops is hardly 0.11% of the total area available for horticulture with a share of 0.07% in the overall production of horticultural crops.

The major flower producing states include Tamil Nadu (17.33 %), Andhra Pradesh (15.40 %), Karnataka (11.63 %), Madhya Pradesh (10.15 %), and West Bengal (10.03 %) in the year 2017-18. The other major flowers producing states area are Chhattisgarh, Gujarat, Uttar Pradesh, Assam, and Maharashtra.

12.4.2 Cut Flowers under Protected Conditions

India produced about 676000 metric tonnes of cut flowers per annum (2019-20) for domestic and export markets. The cut flower production centers are located primarily in the southern and western parts of India owing to the favorable climatic conditions. States like *Maharashtra, Karnataka, Andhra Pradesh, Haryana, Tamil Nadu, Rajasthan, and West Bengal* have emerged as major flower producing states. *North-Eastern states and other Himalayan states* have in recent times have become major hubs for growing quality cut flowers. *The Anthuriums from Mizoram, the carnations from Himachal Pradesh, Orchids from Sikkim, gerbera from Uttarakhand* made a significant impact in recent times.

Cut flowers contribute about 60 percent of the world's flowers trade and the remaining are live plants, cut foliage, dry flowers, etc. Since India is situated comparatively closer to major flower consuming countries than its Asian counterparts, it has very good scope and potential in the flower trade, The severe winter in major flower producing European countries is also an advantageous factor to India, especially areas like Bangalore, Pune, Hyderabad, Nasik, North East (for Orchids and Anthuriums) which enjoy moderate climate all through the year. The prospect of an auction market for floricultural products coming up shortly in Singapore gives an added advantage to India.

The hi-Tech floriculture industry is still in its infancy. The corporate sector started its entry into the floriculture sector in the early 1990s. Most of the floriculture projects have adopted technology from either the Netherlands or Israel. The average investment in each floriculture project ranges between Rs. 3-4 crores per hectare. Most units are around 3-4 hectares in size. One of the largest projects is CCL Flowers Ltd., Bangalore, which has around 15 hectares of growing roses. The major producing states include West Bengal, Maharashtra, and Andhra Pradesh that contribute more than 50% of production in the country.

Check Your Progress 12.1

- Note:** a) Use the space given below for your answers.
b) Check your answers with those given at end of the unit.

1. What are the produce/products included in the floriculture?
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.....
.....
.....
2. Which factors led to commercial floriculture in India?
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.....
.....
3. Which are the major flowers producing states in India?
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.....
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.....

12.5 EMERGING AVENUES FOR ENTREPRENEURSHIP

The emerging avenues for entrepreneurship in the floriculture sector are discussed as under:

12.5.1 Nursery Industry

1. **Production of quality planting material: Satellite nurseries:** It is an evolving concept in rural development which is based on the concept of developing small nurseries by individual families and networking them to a bigger nursery in the region. The development of satellite nurseries for the welfare of locals is a well-established fact in other States supported by International Fund for Agricultural Development (IFAD). The scheme envisages the idea of mass multiplication of certain popular varieties of flower crops and channelizes them through a bigger local nursery.
2. **Pot Plant Production and rentals:** Due to rapid urbanization and industrialization the land under agriculture and forestry is fast depleting. In a quest to bring nature to drawing rooms the urban populace is more inclined to purchase and grow plants in their houses, which has opened the avenue for the large-scale production of potted plants and their marketing. It has also opened up a newer avenue of plant rentals for interior decoration in corporate houses.
3. **Plug plant Production:** Many bedding and annual flowers are produced in highly automated greenhouses in the west to produce billions of plants for corporate and public landscaping. Due to increasing fuel costs and labour costs in the west, there is little scope for further expansion of these hi-tech industries in the developed world. Due congenial environment across our country we have the unique advantage of diversifying into large-scale production of seedlings of annual flower crops as well as vegetable crops.

4. **Corporate Landscaping:** The avenues for corporate landscaping are fast expanding due to increasing industrialization and environment regulation and the quest to beautify the surroundings. Progress in corporate landscaping has synergized the growth of the conventional nursery industry, which now specializes in specific items like turf grass, succulents, cacti, aquatic plants, etc.,
5. **Plant tissue culture:** Plant tissue culture activities in India are at present confined to the production of ornamental and flowering plants, which have a large global export market. Cheap labour and incentives provided by Government are likely to give a further boost to set up more units for commercial production. Demand for flowers is increasing globally. India is expected to emerge as a strong player in the consumer market of biotechnology products in the coming years. In India, many tissue culture units are producing mostly foliage and flowering potted plants. The Global biotechnology business is about 150 US \$ billion and about one-tenth of it is contributed by plant biotechnology alone.

The global demand for tissue culture products is constantly increasing at a rate of 10% per annum. The present installed production capacity is about 100 million plants per annum but only fifty percent of the capacity is being utilized. The R&D efforts in Indian organizations resulted in the development of reproducible, high-frequency regeneration protocols for most of the ornamental crops, which are tailor-made for the Indian conditions and are available for implementation by the Indian centers.

6. **Seed Production:** Certain location-specific pockets have been developed for seed production of hybrids of annual flowers like petunia, pansy, viola at high altitudes and plains. The state of Punjab leads in seed production of annuals followed by Karnataka. The Concept of Seed Villages needs to be encouraged to produce large quantities of seeds of Hybrid Flowers with technical input and incentives from the state government.

12.5.2 Essential Oil Extraction

You must have observed that anyone who comes across a flower tries to smell it before they admire the beauty. Flowers are synonymous with fragrances. Therefore, another great opportunity exists for floral extracts, which have a high potential market in domestic and export trade. Floral extracts like essential oils, alkaloids, saponin, pigments, dyes, etc., have tremendous demand in both domestic and international markets. Damask rose is widely cultivated particularly for extraction of essential oil, rose water, attar and for preparation of Gulkand, etc. Jasmine and tuberose concrete find major use in the perfumery and cosmetic industry. The individuals can be trained in steam distillation techniques and can be encouraged to grow or collect the required raw material from the wild to evolve a low-cost extraction industry.

The major flower crops important for essential oil extraction include rose, jasmine, tuberose, vanilla, etc., The major producers of essential oils are

Horticulture And Allied Sectors Brazil, China, the USA, Egypt, India, Mexico, Guatemala, and Indonesia. All of them except the USA are developing countries with low-cost, peasant-type economies. The major consumers are the USA (40%), Western Europe (30%), and Japan (7%). The demand for the essential oils progresses at a rate of 7-9% per annum and offers unique scope for large scale cultivation of essential oil bearing crops and their processing using both conventional and ultra modern vacuum distillation/ solvent extraction/ liquid CO₂ methods.

12.5.3 Aromatherapy

Since the beginning of civilization, humankind has been aware of the effects of scent on the body, mind, and emotion. Flowers were used to attracting love, food, and protection. Fragrant plants were worn to heal the body. Not only flowers are fun to grow, lovely to look at, and wonderful to smell, but their essential oils provide us with a variety of therapeutic benefits. Following are some of the most commonly used essential oils from flowers, their uses, and their healing properties are summarized in Table 12.1.

Table 12.1: Important essential oils from flowers and their uses

Oil Name	Used Primarily for and Effects
Geranium	Skin disorders, menopause, depression, acne, PMS, calming, balancing, very uplifting
Jasmine	Cramps, back pain, joint and muscle pain, dermatitis, emotional suffering, fear, depression
Rose	Antiseptic, nervous heart, fever, migraine, disappointment, sadness encouraging, patience, and love

With the increasing emphasis on naturo-therapy for common ailments, the concept of aromatherapy is widely practiced in the west. This increasing demand for the natural fragrances from flowers offers unique scope for India to produce these oils and export. The concept of aromatherapy is also gaining importance in India as well and scope exists for diversifying into cultivation, extraction of aromatic principles with known therapeutic values.

It can also soothe away moderate anxiety and depression, sleeping problems, digestive disorders, headaches, and muscular aches and pains. Many essential oils are also superb skincare agents. They help to balance sebum (the skin's natural oil secretion), and to tone the complexion by supporting capillary function. Similarly, plant essences can be used in hair and scalp formulas to improve the circulation of the scalp, prevent dandruff and promote healthy hair growth. Applied without massage, essential oils can heal skin problems such as athlete's foot, cold sores, ringworm, and scabies. Used in steam inhalations, they can alleviate cold and flu symptoms. They are also efficacious for problems such as coughs, tonsillitis, sore throats, sinusitis, and acute bronchitis.

12.5.4 Dry Flowers

You will be surprised to note that nearly 70% of floriculture exports com-

prise dry flowers. Tuticorin in the south, Kolkata in the east are the major centers of production in the country. Dry flowers and plants are becoming more popular due to longer indoor life because of the non-perishability of the produce. Theoretically, any kind of plant and flowers can be dried and used in making bouquets, flower arrangements, greeting cards, pot-pourries, etc. This dry flower industry though operational on small scale, contributes a major share to the floriculture exports from our country. The scientific survey of the flora and fauna in India can help in the identification of useful materials for making dry flowers. The rural population especially women folk can be trained in processing and making dry flowers. To begin with, the women and children can be encouraged to collect the plant parts and flowers from the wild and can be trained to process and preserve them. Alternatively, they can be encouraged to grow flower crops like dahlias, marigold, jute flowers, wood roses, wild lilies, helichrysum, lotus pods, etc. which can be easily processed and preserved as dry flowers. They can also be trained to make value-added products utilizing such processed dried flowers to generate employment and also evolve a cooperative cottage industry.

One can enjoy the freshness of a flower garden throughout the year by cutting and drying the favorite flowers. Sand-drying and air-drying are the two easiest and least expensive methods of drying a wide variety of flowers, such as roses, tulips, dahlias, marigolds, and snapdragons. Few flowers like daylilies last only one day and do not dry well. There are some flowers such as asters, azaleas, chrysanthemums, geraniums, petunias, phlox, pinks, poppies, or violets that should not be dried.

12.5.5 Waxing of Flowers

Just melt some paraffin wax and plunge each flower into the wax. Remove and shake the excess wax off each flower. Put it into the refrigerator to set and harden. Having dried, preserved flowers in your home year-round can brighten it up. You may want to give dried flower arrangements as Christmas gifts. It is a wonderful, satisfying hobby to preserve your flowers. You can also make lovely cards by pressing your flowers and covering them with clear mac-tac on a piece of construction paper.

Source: <https://pioneerthinking.com/how-you-can-dry-flowers-wax-fresh-flowers/>

12.5.6 Pot Pourri

Flowers, herbs, and spices have been used for thousands of years to add fragrance to our lives. From the earliest writings, we have found evidence of the importance various scents have played in our history. Potpourri is a mixture of dried, sweet-scented plant parts including flowers, leaves, seeds, stems, and roots. The basis of a potpourri is the aromatic oils found within the plant.

12.5.7 Nutraceutical and Pharmaceutical Pigments

The anthocyanins, flavonols, carotenoids, and Xanthophylls are common plant pigments that are responsible for a variety of hues we normally observe. At present, the technology for the isolation of xanthophyll pigments present in Marigold has been perfected and large-scale cultivation of Mari-

gold is being attempted in parts of India in association with the extraction Industries. The marigold pigment is widely used in the poultry industry to enhance the color of the meat as well as the yolk of the eggs besides its usage in the food and textile industry. Similarly, many native flowers possess valuable pigments, which can be isolated and used for varied applications including pharmaceuticals.

Lutein and zeaxanthin are xanthophylls, which belong to carotenoid pigments consisting of more than 600 members. Lutein is a yellowish pigment found in kale, spinach, broccoli, and marigold and gives yellow colors to corn and egg yolk, and various fruits, vegetables, and flowers. Zeaxanthin is chemically very close to lutein, and occurs in most lutein preparations (extracts) as a minor constituent. Zeaxanthin shares health benefits with lutein, and can be either taken from food or produced in our body from lutein by biochemical conversion. Lutein of commerce in dietary supplement products are isolated from marigold flower petals and include about 5% of zeaxanthin as a “contaminant”, which, in this case, is a desirable one.

Dried marigold petals and concentrates are used as feed additives to improve the pigmentation of the poultry skin and the eggs of laying hens. The pigment prepared from dried and ground flower petals of *Tagetes* is mixed in the feed at levels of 0.125-0.250%. The pigment index of egg yolk is 14-16 when the feed is mixed with *Tagetes* additives as compared to 2 for a pigment-free diet. The use of *Tagetes* meal from dried, ground petals mixed with not more than 0.3% ethoxyquin is permitted in chicken feed under the United State Federal Food Drug and Cosmetic Act.

In addition to anti-oxidant actions, beta-carotene converts in our body to Vitamin A, which is essential for our body functions including vision. Like beta-carotene, lutein is a carotenoid found commonly in diets. Studies indicate lutein and zeaxanthin are essential nutrition for healthy eyes and vision.

Lutein found in flower petals is chemically bound to various types of fatty acids. In these cases, it is said that Lutein is esterified and is commonly known as lutein ester. Lutein can be obtained from extracts of marigold flowers (*Tagetes erecta*) that contain a high concentration of lutein ester. Lutein ester extracted from marigold flowers is a rich, safe, and natural source of lutein. Naturally, zeaxanthin esters add to the carotenoid profile of natural lutein ester. Lutein diester provides a source of lutein and zeaxanthin preserved in the natural form of lutein ester and zeaxanthin ester from marigold flowers. Many carotenes and carotenoids such as lutein esters/lutein are effective in preventing/controlling the free radical generation, preventing free radical / oxidation damage associated with cancer, coronary heart disease, cataract, and age-related macular degeneration. Carotenoids as chain-breaking antioxidants protect cells and other body components from free radical attacks. Lutein Esters and zeaxanthin esters extracted from the marigold flower are rich, safe, and natural sources of lutein. Lutein and zeaxanthin esters are readily broken down (hydrolyzed) in the digestive tract so that lutein and zeaxanthin can be absorbed. A Hyderabad based company Naturnutra utilizes a patent-pending extraction procedure in a fully computerized state-of-the-art Super Critical Fluid Extraction (SCFE) facility (without the use of harsh and harmful organic solvents) to produce Lutein esters

along with zeaxanthin esters, as they exist in the marigold flower without any chemical structural change.

12.5.8 Natural Dyes and Pigments

The indigenous technical knowledge (ITK) possessed by the locals in extracting and isolating natural dyes from flowers can be encouraged to grow such crops to evolve ancillary cottage industries. Similarly, their knowledge on the medicinal value of the ornamental plants available in wild can be made used to encourage them to cultivate such plants for supplying the raw material to the traditional ayurvedic drug industry. Launching a cooperative movement among the locals would ensure organized cultivation and collection of plant products for the needy industry.

Check Your Progress 12.2

Note: a) Use the space given below for your answers.

b) Check your answers with those given at end of the unit.

1. What is Aromatherapy?

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2. Why dry flowers and plants are becoming more popular?

.....

12.6 MARKETING

Flori-business in National Capital: Delhi is Asia's largest flower market.

There are three flower markets in Delhi

- i) Market near Hanuman Mandir, Connaught Place for the sale of cut flower, cut foliage, and dried flowers
- ii) Wholesale flower market at Mehrauli.
- iii) Fatehpuri/ Chandani Chowk market for loose flowers trade
- (i) Market near Hanuman Mandir, Connaught Place:** Hanuman mandir market is a temporary market that starts at 4 am and disappears by 9 am. Traders display their offerings during this time for retailers and decorators, and consumers. Mostly traded flowers in this market are Rose, Chrysanthemum, Gerbera, Liliun, Carnation, tuberose, Gladiolus, orchids, and some of the specialty cut flowers like Bird of Paradise, Anthuriums, Heliconia, etc. Cut foliage trade is worth Rs. 20 crores in Delhi market and these cut greens come from various states of the country like Karnataka, Uttar Pradesh, Uttrakhand, Himachal Pradesh, etc. The most important cut foliage species are Thuja, Palms,

Ferns, Cycads, Dracaena, Ficus, Asparagus, Gypsophila, Bottlebrush, Eucalyptus, etc. There is a significant amount of dried flower trade in the Delhi market and most of the dried flower products sold in this market come from West Bengal and about 20-25 % comes from South Indian states. Pot pourris also have a major contribution to the dried flower market. There is other ancillary industries business which includes bamboo baskets, floral bricks, flower dyes, small instruments like scissors, secateurs, mesh wire, and other related items which are used for either making flower arrangements, bunches, bouquets or used during decorations with flowers.

In Delhi market Roses are available throughout the year. However, arrival is more during April and May from local sources. Marigold is received between October to December, Chrysanthemum during December- January. Motia is being received from May to June. Gladiolus is available in two seasons i.e. December to March and July to August. Rajnigandha is received mainly from August to September. In addition to local produce in the Delhi market, produce comes from different parts of the country like Bangalore, Pune, Kerala, Maharashtra, Uttrakhand, Himachal Pradesh, Sikkim, Haryana, Delhi NCR, Calcutta, etc. Marigold and chrysanthemum are received from Uttar Pradesh, Haryana, and Delhi NCR. Roses arrive from local sources as well as imported from Pune, Nasik, Ajmer, and Madhya Pradesh. Gladiolus is received from Himachal Pradesh, Sikkim, and Uttar Pradesh. Motia mainly comes from Haryana. Carnation and Lilium come from Himachal and Uttranchal and Uttrakhand. Gerbera comes from Himachal, Pune, Nasik, Uttranchal, and Uttar Pradesh. Rajnigandha comes from Hapur, Khatauli, and Kolkatta. Orchids come from Sikkim and are also imported from Thailand and Singapore. Some specialty flowers like Anthuriums, Bird of Paradise, and Heliconia arrive in the market from Bangalore and Kerala. The flower grown in neighboring states are transported by roads. The railway is being used from places where it is well connected with fast trains. Flowers from Bangalore, Calcutta, Kerala, and Sikkim are generally transported by air.

In Delhi, the common marketing Channel is Producer to Commission agent/Trader to Retailers and then finally to the Consumer. Usually, the products bring to market for sale through commission agents. For Flowers from outstations, the traders get the supplies on receipt of the consignments to arrange for sale. In the Hanuman Mandir market, there are approximately 800 sellers out of which 500 are traders/commission agents. In this market method of sale is either negotiation or auction. The rate of commission varies from 7-10 percent. It is collected from the seller and there are no other charges.

The flowers which are required for bouquets and arrangements like carnations, Lilium, and gerberas are wrapped in cellophane bags. Flowers like roses are packed in corrugated paper/ cardboard. The produce which is brought from nearby areas like tuberose and

gladiolus are packed in Hessian clothes, gunny bags, etc. The flowers are wrapped in newspaper and packed in Hessian cloth and placed in cardboard cartons.

- (ii) **Flower market at Mehrauli:** The flower market is located on the main road of Mehrauli near Qutub Minar, the flower market is 20 years old and remains open throughout the day. This market is famous for its collection of exotic flowers. Here a large variety of roses, marigolds, chrysanthemums, sunflower, carnations, Rajnikanth, gladiolus, gerbera, orchids, tulips, and daisies is also available. Here one can get a range of dry flowers, bamboo sticks, Ashok tree leaves that are generally used with marigold flowers for decoration.
- (iii) **Fathehpuri flower market:** The flower market at Fatehpuri Masjid, Chandani Chowk is open until 9 a.m., after which it is replaced by the spice market. This market is famous for marigolds in bulk as it sells only marigold flowers in loose form.

12.7 EXPORT POTENTIAL OF FLORICULTURAL PRODUCTS

India is endowed with proximity to markets in Japan, Russia, South-East Asia, and Middle-East countries. The Government allows subsidies on air freight for the export of cut flowers and tissue-cultured plants. Freight rates are subsidized for export to Europe and West Asia, South East Asia. Import duties have been reduced on cut flowers, flower seeds, and tissue-cultured plants. Floricultural exports from India comprise fresh cut flowers (to Europe, Japan, Australia, Middle East, and USA), loose flowers (for expatriate Indians in the Gulf), cut foliage (to Europe), dry flowers (to USA, Europe, Japan, Australia, far East, and Russia) and potted plants (limited to very few countries). Out of these components, dry flowers contribute a major share to the total export. The country made significant strides in the production of cut flowers which were either exported or consumed in the domestic markets. The floricultural exports registered phenomenal growth during the last two decades.

India's total export of floriculture was Rs. 575.98 Crores/77.84 USD Million in 2020-21. The major importing countries were USA, Netherland, United Arab Emirates (UAE), United Kingdom (UK), and Germany. There are more than 300 export-oriented units in India. More than 50% of the floriculture units are based in Karnataka, Andhra Pradesh, and Tamil Nadu. With the technical collaborations from foreign companies, the Indian floriculture industry is poised to increase its share in world trade.

(http://apeda.gov.in/apedawebsite/six_head_product/floriculture.htm)

Table 12.2: India's Export Statement on Floriculture

Country	2018-19			2020-21			% age share in 2020-21
	Qty in MT	Rs. Lacs	US\$ Mill	Qty in MT	Rs. Lacs	US\$ Mill	
USA	4,038.07	14,692.43	21.09	3,139.19	15,895.51	21.51	27.6

Netherland	1,518.92	7,789.14	11.23	1,603.87	10,930.30	14.74	18.98
UAE	1,871.24	3,434.08	4.89	1,659.88	3,443.22	4.67	5.98
UK	1,530.01	4,470.63	6.36	860.91	3,312.10	4.51	5.75
Germany	1,251.71	3,938.55	5.69	1,054.69	3,213.11	4.32	5.58
Japan	310.37	1,574.58	2.26	114.16	2,614.74	3.48	4.54
Canada	878.99	2,341.81	3.37	485.65	2,301.48	3.1	4
Italy	403.24	1,578.90	2.25	235.31	1,767.47	2.4	3.07
Other countries	7,924.02	17,321.16	24.80	6,541.66	14,120.52	19.13	24.52
Total	19,726.57	57,141.28	81.94	15,695.32	57,598.45	77.86	100

Source:http://agriexchange.apeda.gov.in/indexp/Product_description_32headChart.aspx?gcode=0101

Indian exports mostly target the major floricultural important events like Christmas Day (December) New Year Eve, Valentine’sDay, and Mother’s Day (May). The major factors are the unfavorable weather conditions during winter in major production centers in the Northern Hemisphere that limit the production. Therefore, markets are open to producing that comes from more favorable climates from the Southern Hemisphere. India, therefore, finds itself competing with other equally favorable countries like Kenya, Ecuador, Morocco, etc. during such events.

Major Export Destinations included the United States, Germany, Netherlands, United Kingdom, and Japan. The major produce that is exported is summarized in Table 12.3.

Table 12.3: Floriculture produce exported from India

Bulbs, Tubers, Tuberous Roots	Plants For Tissue Culture
Bulbs Horticultural	Flowering Plants
Other Live Plants	Cut Flowers For Bouquet’s / Fresh
Unrooted Cuttings	Moosses & Lichens For Bouquet Fresh
Cactus	Rhododendrons (Grafted Or Not)
Other Foliages / Buds For Bouquet Fresh	Roses Grafted Or Not
Foliages/ Branch / Buds Not Fresh	Dry flowers

• **Initiatives to promote exports**

Six Agri Export Zones on floriculture have been set up in Sikkim, Tamil Nadu, Uttarakhand, Karnataka, and Maharashtra. The APEDA has also taken several measures to facilitate floriculture exports. Some key Indian airports like New Delhi, Mumbai, Hyderabad, Bangalore, Chennai, Thiruvananthapuram, and Cochin now have cold storage and cargo handling facilities. More airports will have these facilities in the future. Among other things, flower auction centers have come up in Bangalore, Mumbai, Noida (near Delhi), and Kolkata. These are readymade market facilities for trading and price discovery for a variety of flowers, both for export and domestic markets. India has to achieve the ambitious export target of Rs.1000 crore per annum over the next 5 years, a paradigm shift is required. The

key issues that need to be addressed in the Indian context are; economics of scale, product range/latest varieties, year-round exports, quality control and certification, cold chain management. The APEDA has been addressing these issues through various forums on a concerted basis given its mandate to promote floricultural exports from India.

Check Your Progress 12.3

Note: a) Use the space given below for your answers.

b) Check your answers with those given at end of the unit.

1. Name the major flower market in Delhi?

.....

2. Name the major importing countries of floriculture produce.

.....

12.8 LET US SUM UP

The demand for floricultural produce is expected to increase continuously. Due to stringent environmental regulations, increased energy costs, ever-increasing wages, shrinking agricultural lands, and worsening climates during winter, the floricultural developed nations would not be in a position to expand their production and hence the demand has to be met from the developing nations. India holds a fair chance in such a scenario. Due to rich diversity in agro-climatic conditions, we have the distinction of producing a cacophony of floricultural crops both tropical and temperate. Besides the export growth, the domestic demand for cut flowers is expanding at an impressive rate of 7-8% which opens up new avenues for greater investment in this sector. Hitherto the floriculture industry in India is over-dependent on the cultivation of roses and it’s time for us to diversify into other crops like orchids, anthuriums (for far off markets), gladiolus, and tuberose for destinations in proximity.

12.9 KEYWORDS

Aromatherapy : Aromatherapy is a form of alternative medicine that uses volatile plant materials, known as essential oils, and other aromatic compounds to alter a person’s mind, mood, cognitive functions, or health.

Entrepreneurship : Entrepreneurship is the act of being an entrepreneur, which can be defined as “one who undertakes innovations, finance, and business acumen to transform innovations into economic goods”.

Essential oils : An essential oil is a concentrated hydrophobic liquid containing volatile aromatic compounds from plants.

Horticulture And Allied Sectors Floribusiness : The business is associated with floricultural produce.

Floriculture : The study of flowers encompasses cut flowers, loose flowers, cut foliage, potted plants, plug plants, dry flowers, pot pourries, essential oils, pigments, and natural dyes.

Nursery : A nursery is a place where plants are propagated and grown to usable size.

Nutraceuticals : **Nutraceutical is a combination of the words nutrition and pharmaceutical, is a food or food product that reportedly provides health and medical benefits, including the prevention and treatment of disease.**

Pharmaceutical : **Pharmaceutical compound is any product that reportedly provides health and medical benefits, including the prevention and treatment of disease.**

Plug plants : A plug plant is any developing plant whose growth cycle is initiated well in advance of its actual planting in a plug tray. Plug plants are designed to be introduced to your garden or landscape with substantial growth already established. Once assimilated, the plant can begin to produce flowers, fruit, or vegetables much sooner than traditional seed planting.

Pot plants : A potted plant is a plant that is grown in pots mostly indoors in places such as residences and offices. Houseplants are commonly grown for decorative purposes, positive psychological effects, or health reasons such as indoor air purification.

12.10 SUGGESTED FURTHER READINGS/ REFERENCES

- Randhawa G. S., A.N. Mukhopadyay, and A. Mukhopadhyay, 1998. Floriculture in India, Allied Publishers Pvt Ltd
- Desh Raj. 2017. Floriculture At A Glance, Kalyani Publishers.
- You may refer to the following databases for updated information on trade and exports.
 - a. **Indian Horticulture Database**
 - b. **DGCIS Export Annual**
 - c. **APEDA database**
 - d. **UNCTAD database**

12.11 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 12.1

- 1) Cut flowers, loose flowers, cut foliage, potted plants, plug plants, dry flowers, pot pourries, essential oils, pigments, and natural dyes
- 2) Growing demand for flowers for various purposes, development of greenhouse technology, export avenues, etc.
- 3) Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh, and West Bengal are the major flowers producing states in India.

Check Your Progress 12.2

- 1) Not only flowers are fun to grow, lovely to look at, and wonderful to smell, but their essential oils provide us with a variety of therapeutic benefits.
- 2) Dry flowers and plants are becoming more popular due to longer indoor life because of the non-perishability of the produce.

Check Your Progress 12.3

- 1) There are three major markets in Delhi:
 - i) Market near Hanuman Mandir, Connaught Place for the sale of cut flowers, cut foliage, and dried flowers
 - ii) Wholesale flower market at Mehrauli.
 - iii) Fatehpuri/ Chandani Chowk market for loose flowers trade
- 2) USA, Netherland, United Arab Emirates (UAE), United Kingdom (UK), and Germany are major importing countries.



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UNIT 13 LIVESTOCK ENTERPRISES

Structure

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13.0 OBJECTIVES

After studying this unit, you will be able to:

- justify the importance of livestock in the farmers and Indian economy;
- explain the principles and pillars of livestock management;
- summarize the care and management of different livestock species; and
- describe poultry and fish farming.

13.1 INTRODUCTION

In the previous unit, you learned about floriculture. Having learned about the cultivation of flowering and ornamental plants, it is time for you to learn about the basics of Livestock and their management. You are aware that India is the largest agricultural economy in the world, where every sixth Indian is dependent on agriculture. About 70% of the population depends on agriculture and allied sectors for their livelihood. Though agriculture is

the main occupation practiced by the majority of our farming community, in recent times, farmers are also opting for other allied sectors like dairy, poultry, fisheries, etc. as a subsidiary occupation to minimize the risk involved in agriculture due to crop failure and natural calamities. In India, the animals are generally maintained on grazing and agricultural by-products. Livestock rearing is generally practiced by the small and marginal farmers having landholding of 12 to 2 acres maintaining 2 to 3 animals. Livestock acts as a continuous source of income to farmers and reduces seasonality in livelihood patterns of the rural mass and also helps in counteracting the income loss due to crop failure. The livestock sector not only gives subsidiary income to the farmers but also helps in employment generation as well as provides nutritional security in the form of milk, meat, and egg. In this unit, you will learn about the basics of farming of different livestock species *viz.* cattle, buffalo, sheep, goat, pig, poultry, and fish farming.

13.2 LIVESTOCK WEALTH IN INDIA

Can you define what livestock means? Yes. Livestock means stock (items of property) that is alive and is used for the production of items for business and/or domestic consumption. They include all animals and birds used for producing items human use. Livestock produces several useful commodities and services which can be divided into six major categories:

- **Nutritious Food:** Livestock is a good source of food that can help in the eradication of hunger and malnutrition. It is a rich source of protein which is the building block of our body. The food products obtained from different livestock species include:
 - Milk and its products from Cattle, Buffalo, and Goat
 - Egg and its products from Chicken, Duck, Quail, and Turkey
 - Meat and its products from Chicken, Buffalo, Sheep, Goat, Pig, Poultry and Fish, and shellfish
- **Energy, Power, and Fuel:** Livestock also provides power/energy for ploughing of agricultural fields and transportation. The common draught animals used for this purpose are oxen, bullocks, male buffaloes, camel, horse, and donkey. Animal dung/faeces act as fuel for cooking as well as nourishing the soil. For cooking in the form of dung cake and gobar gas. For crop production in the form of dung as manure or fertilizer,
- **Fiber and Hide:** The livestock also contributes to the production of wool, hair, hides, and pelts. Hide/ skin is converted into leather, which is used for manufacturing various products like jackets, belts, shoes, etc. Wool from sheep is used for manufacturing shawls, sweaters, etc. which helps to protect us from cold weather conditions.
- **Raw materials:** We get a large number of raw materials from the dead or slaughtered animals in the form of bones, horns, hoof, animal fat (tallow from cattle, lard from pig) and a number of products for pharmaceutical and industrial use.
- **Land Management:** Livestocks are used as biological control of brush and plants. The grazing of livestock is sometimes used as a

way to control weeds. Similarly, in areas prone to wildfires, goats and sheep are set to graze on dry vegetation which removes combustible material and reduces the risk of fires.

- **Other utilities:** Livestock are considered as ‘moving banks’ because of their potentiality to dispose off during emergencies. They serve as capital and in cases of landless agricultural labourers many times, it is the only capital resource they possess.

To sum up, can you tell how livestock is useful to the farming community? Yes. The livestock serves the farmers in different ways viz. source of Income, employment, balanced nutrition, social security, draught power, fuel (dung cakes), fertilizer (farmyard manure), and plastering material (poor man’s cement).

13.2.1 Indian Livestock Industry

Having read about livestock and its importance, can you tell the role of livestock in the Indian economy? Livestock plays a significant role in the agricultural as well as Indian economy. About 20.5 million people depend upon livestock for their livelihood. Livestock contributed 16% to the income of small farm households as against an average of 14% for all rural households. Livestock provides livelihood to two-thirds of the rural community. It also employs about 8.8 % of the population in India. India is bestowed with abundant livestock resources. Livestock census is conducted every five years and the latest livestock census document can be accessed from the Department of Animal Husbandry and Dairying website. As per the 20th Livestock census (2019), India is bestowed with 303.76 million bovines (Cattle, Buffalo, Mithun, and Yak species), 223.14 million sheep, and goats, 9.06 million pigs, and 851.81 million poultry. According to National Statistical Office (NSO), MoSPI data (2021), the Gross Value Added (GVA) of the livestock sector is about Rs. 9,62,682 crores during 2019-20 which is about 28.36% of Agricultural and Allied Sector GVA and 5.21% of total GVA. The livestock sector has always shown positive growth trends. India is the largest milk producer in the world which was 198.40 million tonnes during 2019-20. The per capita availability of milk was around 406 grams/day in 2019-20 which much higher than the World average. Egg production was around 114.38 billion during 2019-20 and the per capita availability was around 86 eggs per annum. Wool and meat production was 36.74 million kg and 8.60 million tonnes, respectively in 2019-20. To get the latest information on livestock census and animal husbandry statistics, you can visit The Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry & Dairying website (www.dahd.nic.in).

Check Your Progress 13.1

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1) Define Livestock.

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2) Name any two commodities and services we get from Livestock.

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13.3 PRINCIPLES OF ANIMAL HUSBANDRY

Before learning about the care and management of different species of livestock, you should be aware of the management principles. The four pillars of livestock management include feeding, breeding, weeding, and heeding. 'Feeding' is the most important pillar of livestock management because it constitutes 70-80% of the cost of milk or meat production. 'Breeding' is another important managerial aspect that affects the economics of the farm. If the father (sire) or mother (dam) of the next generation is not selected properly, it may lead to huge production as well as economic losses. 'Weeding' aims at culling the uneconomic stock at the proper time. In a traditional management system, 'Heeding' implies good livestock management and general supervision including housing, hygiene, sanitation, and care of animals.

13.3.1 Breeds of Livestock

Before learning about the different breeds of cattle and buffaloes, can anyone explain what a breed is? The breed is a group of animals of common origin within a species that has certain special distinguishing characteristics, which are not found in other breeds of the same species. Some of the common livestock breeds are:

- **Cattle Breeds:** Common breeds reared for their milk production (Milch breeds) are Deoni (Dongarpatti), Gir (Kathiawarhi, Surti, Decan), Red Sindhi (Sindhi, Malir, Red Karachi), and Sahiwal (Lola, Montgomery, Lambi-Bar, Multani). Popular breeds reared for both milk and work purposes (Dual purpose breeds) are Haryana, Kankrej (Bannai, Nagar, Waged, Vadhiyar, Sanehore), Ongole (Nellore), and Tharparkar (Thari, White Sindhi).
- **Buffalo Breeds:** Important breeds of buffalo are Bhadawari, Jaffarabadi, Murrah, Mehsana, Nagpuri, and Nili-Ravi.
- **Sheep Breeds:** Meat type breeds include Hassan, Kilakaraisal, Madras Red, Mandya (Bannur, Bandur), Mecheri (Maiylambadi, Thuvaramchambali), Nellore, Ramnad White, Tiruchi Black, and Vembur (Karandhai). Some popular woolly breeds are Hissardale, Changthangi, Chokla, Gaddi, Gurez, Jaisalmeri, Marwari, Poonchi, Pugal, Bellary, Chottanagpuri, Coimbatore, Deccani, Ganjam, Jalauni, Kathiawari, Malpura, Muzaffarnagri, Shahabadi, and Sonadi.
- **Goat Breeds:** Important dairy goat breeds are Beetal, Jhakrana, Malabari, Mehsana, Surti, and Zalawadi. The dual-purpose breeds (milk or hair and meat) include Barbari, Gaddi, Chegu, Changthangi, Jamunapari, Marwari, Osmanabadi, and Sirohi. Some of the meat type

goat breeds are Black Bengal, Kannaiadu, Kutchi, Ganjam (Dalua), and Tellicherry.

- **Pig Breeds:** Most of the pigs you see on the roadside which are small in size and non-descript or indigenous animals which do not have specific characteristics. Important exotic pig breeds of commercial importance are Large White Yorkshire, Landrace, Hampshire, Berkshire, Duroc
- **Poultry Breeds:** Some of the important chicken breeds are New Hampshire, Plymouth Rock, Rhode Island Red, Cornish, and White Leghorn. Khaki Campbell and Indian Runner are the common egg-type ducks reared in India.

13.3.2 Nutrition

Livestock feeds provide the basic nutrients required for animal production, including energy, proteins, minerals, and vitamins which play a major role in the proper functioning of the body. Since feeding cost constitutes two-thirds of the cost of milk production, proper feeding is key for economic dairy farming. Do you know how many types of feedstuffs are used for feeding livestock? Yes, feedstuffs can be classified into two major classes *viz.* Concentrates and Roughages. Concentrates are feeds that contain a high density of nutrients (energy and proteins) and are usually low in crude fiber content (less than 18% of dry matter) *e.g.* Groundnut cake, Mustard cake, grains/ cereals (maize, oats, Jowar, etc.) and their by-products (rice/wheat bran or rice polish, etc.). Roughages are feeds with a low concentration of nutrients but high in fiber content (more than 18%) *eg.* cereal fodder crops like Maize, sorghum, bajra, etc. and cultivated grasses like Para grass, Guinea grass, Hybrid Napier, Anjan grass (Green fodder); Straw, stover, silage, hay, etc. (Dry fodder). Usually, in large animals, edible dry matter is given at the rate of 2.5-3.0 kg per 100 kg body weight. This can be provided through fodder (green and dry) and concentrates in the ratio of 2:1. In milch animals, for every 2.5 kg of milk production, a cow should be given 1.0 kg concentrates and in the case of buffaloes, for every 2.0 kg of milk production, 1.0 kg of additional concentrates should be fed. On average, an adult sheep needs 1.5 kg of dry matter for maintenance and wool production. Goats prefer to stand on their hind limbs and pluck the tender leaves of herbs, shrubs, bushy plants, and small trees known as “browsing”.

13.3.3 Housing

As we live in our houses, similarly, animals do require housing. Do you know why animals should be kept in animal houses? Housing is required for providing a comfortable environment to the animals by protecting them from extreme weather conditions (heat and cold) as well as from wild animals/predators and rodents. Can you tell what is the name given to a house where cattle and buffaloes are maintained? It is called ‘Shed’ or ‘Pen’ or ‘Barn’ or ‘Byre’. There are two main types of housing systems practiced in Cattle and Buffaloes *viz.* loose houses and conventional barns. In loose housing, animals are kept loose in an open paddock throughout day and night except during milking. This type of housing is suitable for most parts of the country except temperate and high-rainfall regions. Whereas, In Con-

ventional barns, cows are confined together on a platform and secured at the neck by neck chains or neck ropes. Animals in barns are less exposed to outside weather conditions and hence are suitable for the temperate Himalayan region and cooler parts of the country. A house in which sheep are maintained is called 'Pen' or 'shed'. Normally, sheep do not require elaborate housing facilities, but minimum provisions will definitely increase productivity, especially protection against extreme weather conditions and predators. A house in which goats are maintained is called 'Pen' or 'shed'. Goat sheds are similar in design to cattle sheds except that they need not be as elaborate and strong. A house in which pigs are kept is called 'Sty'.

13.3.4 Health Care

As we suffer from many health ailments, animals also get affected by various diseases. These diseases are caused by micro-organisms/microbes and parasites which enter the body through feed/fodder, water, air, etc., and may affect vital organs. In addition, certain metabolic and nutritional diseases/disorders are also possible due to faulty feeding and management. If they are not diagnosed and treated in time, they may affect their health and performance and may even lead to death. The common diseases of cattle and buffalo are Coccidiosis, Babesiosis, Theileriosis, Fasciolosis/Amphistomiasis, Anthrax ('Tilli Jwar', 'Pleeha Disease'), Tuberculosis, Johne's Disease, Haemorrhagic Septicaemia ('Ghudka', 'Zaharbad', 'Gargati'), Brucellosis, Black-Quarter (Black disease), Mastitis, Foot and Mouth Disease (FMD), Cow Pox, Rabies, Milk fever, Ketosis, and Bloat. Sheep are mostly affected by Fasciolosis/Amphistomiasis, Anthrax, Johne's disease, Brucellosis, Foot and Mouth Disease, Sheep Pox, Blue Tongue, Enterotoxemia, Pregnancy Toxemia, and Bloat. Similarly, Fasciolosis/Amphistomiasis, Anthrax, Johne's disease, Brucellosis, Foot and Mouth Disease (FMD), Goat Pox, *Peste des Petits Ruminants* (PPR), and Bloat are the most common diseases which affect Goat. In pigs, the common diseases are Foot and Mouth Disease (FMD), Tetanus, Brucellosis, Anthrax, and Swine fever. Some of the common fish diseases include Epizootic Ulcerative Syndrome (EUS) disease, furunculosis, whirling disease, white spot disease, Fin rot, etc.

Check Your Progress 13.2

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1) List the four pillars of livestock management.

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2) Name any two popular dual-purpose cattle and goat breeds.

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3) Fill in the blanks with the correct answer:

- (i) In milch animals, for every ____ kg of milk production, a cow should be given 1.0 kg concentrate.
- (ii) Goats prefer to stand on their hind limbs and pluck the tender leaves of herbs, shrubs, bushy plants, and small trees known as _____.
- (iii) A house in which pigs are kept is called as _____.
- (iv) Enterotoxemia is a common disease of _____.

13.4 CATTLE AND BUFFALO FARMING

Management procedure varies at each stage in the life of cattle and buffaloes. For example, calf management is different from the management of milch animals.

a) Pregnant Cow and Buffalo

- All pregnant animals should be handled and looked after carefully.
- They should not be made to walk long distances, run fast, be frightened, or be allowed to fight.
- The pregnant animal should be provided with a light, easily digestible diet and clean *ad libitum* drinking water.
- One week before calving, animals should be transferred to an individual calving pen which should be quiet, comfortable, hygienic, and well bedded.

b) Lactating Cow and Buffalo

- Keep up the regularity of feeding. Provide green forage together with leguminous hay or straw to the extent the animal can consume, so that all its maintenance requirements are met through forage only.
- Provide extra concentrate @ 1 kg for every 2 kg (in cows) and 2.5 kg (in buffaloes) of milk produced.
- Regularity in milking is essential. Milking thrice is advisable than twice since 10-15% more milk can be produced.
- Rapid, continuous, dry full hand milking technique should be practiced. Avoid stripping and knuckling techniques as they may injure the teats.
- Cows should be trained to let down milk without calf suckling which will help in early weaning.
- Wallowing of buffaloes or water spraying on their bodies will keep the buffaloes comfortable especially during summer.
- Provide 60-90 days dry period between calving. If the dry period is not sufficient, milk yield in subsequent lactation will be reduced.

- Check for mastitis regularly.
- Every animal should be numbered and data on milk yield, fat%, feed intake, breeding, and calving dates should be recorded.

c) New-born Calf

- Immediately after birth, any membrane or mucous adhering to the mouth, nostrils, eyes, and ears of the newborn calf should be removed using a clean dry cloth to facilitate normal breathing.
- Normally, a cow will lick her calf dry. However, licking can be induced by sprinkling a little common salt on the calves' body.
- The navel cord of the calf should be tied 2.5 cm away from its body and cut about one centimeter below the knot. Apply antiseptics to the cut end for 2-3 days.
- Feed colostrum within half an hour after birth and should be continued for the first 3-4 days of life.
- A calf should be shifted to a warm, well-ventilated house.

d) Heifers

- Feed the heifer sufficiently for normal growth as they constitute the replacement stock. Most heifers grow well if excellent hay is given as much they can eat.
- The size rather than the age of a dairy heifer at the breeding time is important. Breeding under-sized animals are never profitable. Small heifers are more likely to have difficulty in calving.
- The heifer should be growing and in good flesh at the time of calving. This is necessary so that she can produce milk at the most profitable level.
- Place heifer in a separate shed about 6-8 weeks before calving.
- Maintain the health of the heifers by hygienic housing, water balanced feeding, and taking necessary preventive steps against common diseases.
- Periodically, heifers should be checked for proper growth and health conditions. Those lagging below the required standards should be culled.

e) Breeding Bull

- They should be housed separately in a "Bull Shed" with sufficient space.
- The breeding bull should receive plenty of exercises.
- A balanced ration should be fed containing adequate energy, proteins, minerals, and vitamins. Green fodder must be available both before and during the breeding season.
- Ferocious Bulls should be controlled properly using nose rings.
- For breeding bulls, two matings a day is optimum.

Horticulture And Allied Sectors **Check Your Progress 13.3**

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1) Fill in the blanks with the correct answer:

i) ___ week(s) before calving, animals should be transferred to an individual calving pen.

ii) Provide ___ days dry period between calving.

iii) Wallowing of _____ keep them comfortable especially during summer.

iv) _____ should receives plenty of exercise.

2) Briefly describe the care and management of a new-born calf.

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13.5 SHEEP, GOAT, AND PIG FARMING

Sheep are mostly reared by small and marginal farmers having landholding of $\frac{1}{2}$ to 2 acres. They are easily manageable and require a low initial investment and working capital as they require minimal housing and can be maintained through grazing. Goats are considered as “poor man’s cow” since it provides livelihood and nutritional security to small and marginal farmers with minimum investment and management. They can be managed only on browsing and can yield $\frac{1}{2}$ to 1 liter of milk. Pig rearing is not popular in our country. Pigs are mostly reared in the Uttar Pradesh, West Bengal, and north-eastern states of the country. These indigenous pigs can be easily managed and do not require elaborate feeding and management. In this section, we will discuss the broader aspects of sheep, goat, and pig farming.

13.5.1 Care and Management of Sheep and Goat

The management procedure varies at each stage in the life of sheep and goats. The different managerial procedures to be followed for different categories of sheep and goats are as follows:

a) *Pregnant and Lactating Ewes and Does*

Careful management of the pregnant and lactating ewes will have a marked influence on the percentage of lambs or kids dropped and reared successfully. So, the following steps should be followed properly:

- Flushing the ewes before and during mating season ensure higher conception rates. It is a good system to put the ram with ewes at night and not allow it to run with them during the day since. Rams worry the ewes and interfere in their grazing.
- Do not handle the pregnant ewes or does too frequently.

- Separate the advanced pregnant ewes or does from the main flock and take effective care in their feeding and management.
- Ensure adequate and balanced ration for pregnant ewes or does. Extra feed during 3-4 weeks before parturition will be beneficial for the condition of the pre-parturient ewes or does which will help in improving milk production of ewes or does, birth weight, and growth of lambs and kids.
- Inadequate and poor nutrition may result in pregnancy toxemia, abortion, and premature birth of weak lambs and kids.
- Bring lambing ewes or does into lambing or kidding pen/shed 4-6 days before parturition and provide maximum comfort. If possible, provide soft, clean bedding and individual lambing or kidding pens.
- Watch gestation length, which ranges from 142 to over 150 days. Early maturing breeds have a slightly shorter gestation period.
- Protect pregnant ewes and does from cold and chilly weather.

b) *Care of Lambs and Kids*

The lamb and kids should be taken care of properly during the early period of life. This will also ensure better survival. The following steps should be taken for ensuring better growth and survival of lambs and kids:

- Immediately after birth, the nose of the lamb or kids should be cleared of any membrane or mucous to prevent suffocation.
- The navel cord of the calf should be tied 2.5 cm away from its body and cut about one centimeter below the ligature/knot. Apply antiseptics to the cut end for 2-3 days.
- Colostrum should be fed within 30 minutes which helps in protecting the lamb and kids from various diseases.
- Ensure proper suckling of lambs or kids. Examine udder for the blindness of teats or mastitis.
- Take care of indifferent mothers and arrange suckling of lambs or kids by restraining such types of ewes or does.
- Protect newborn kids from extreme weather conditions and predators.
- Provide creep feed (good quality hay with or without concentrate mixture) to suckling lambs or kids in addition to the suckling of milk from the tenth day to weaning age.
- If possible, make available green leguminous fodder or fresh tree leaves to lambs or kids to nibble during the suckling period.

c) *Weaning and Care of Weaners*

The management of weaners plays an important part in good sheep and goat husbandry. The following steps are important in the proper care and management of weaners:

- All lambs should be weaned at 3 to 3½ months of age to enable the ewes to recoup their health before the next breeding season.
- Weaning should preferably be done at 90 days, although in breeds with low milk production or where re-breeding is desired, it can be done around 60 days.
- Supplementary feeding and good clean pastures for growing weaners should be provided.
- Weaned lambs or kids should be drenched against gastrointestinal parasites by the first month; and vaccinated against enterotoxaemia and sheep pox.
- Weaners should not be grazed on thorny types of pasture since it could cause skin irritation, injury to the eyes, and damage to wool or skin.

13.5.2 Care and Management of Pigs

The managerial procedure varies at every stage in the life of pigs.

a) *Management of pregnant sow*

- The pregnant sow should be shifted to a clean, dry, well-bedded farrowing sty a few days before the expected date of farrowing.
- Reduce the ration by 1/3rd till farrowing.
- Farrowing sty should contain guard rails to prevent the mortality of newborn piglets from crushing by mother.

b) *Care and Management of Piglets*

- Immediately after birth, clean the snout of the piglets of all the mucous to ensure proper breathing.
- Remove the piglets immediately and keep them in the warmth under a heat source.
- The naval cord should be tied 2.5 cm away from the body and cut one cm away with a pair of scissors and disinfect with the tincture iodine solution.
- Feed colostrum to the newly born piglets within 30 minutes.
- Clip the needle teeth of the piglets just after birth with the help of tooth clippers to protect the sow's teats from injury and to protect other piglets as it may inflict injury and wounds while fighting.
- Wean the piglets at 5-8 weeks of age.
- Protect the piglets from cold weather conditions as they are highly susceptible.

Check Your Progress 13.4

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1) Fill in the blanks with the correct answer:

- i) Flushing the ____ before and during mating season ensures higher conception rates.
 - ii) All lambs should be weaned at ____ months of age.
 - iii) Gestation period of Sheep and Goat range from ____ to ____ days.
 - iv) Farrowing sty should contain ____ to prevent mortality of new-born piglets.
- 2) Briefly describe the care and management of pregnant sows.

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13.6 POULTRY FARMING

‘Poultry’ refers to domesticated birds which are reared for their flesh (meat), eggs, and feathers and it includes a number of avian species such as chicken, duck, emu, geese, guinea fowl, ostrich, partridge, peafowl, pheasant, pigeon, quail, swan, and turkey. In India, Chicken is the most popular among the domesticated poultry species followed by ducks, Japanese quails, turkeys, and emus in that order. Generally, chicken can be classified into two broad categories *viz.*, Broilers (Chicken reared for meat) and Layers (Chicken reared for eggs). The poultry farming system is the method of rearing birds based on the purpose for which they are reared. There are different types of poultry farming systems practiced in our country from backyard to commercial unit, small to big farm and for production of fertile eggs to table eggs. Backyard Poultry Farming, by and large, is a low input or no input activity and is characterized by indigenous night shelter, the scavenging system with little supplementary feeding, natural hatching of chicks, poor productivity of birds (low egg production and reduced weight gain), local marketing and no health care practice. Whereas, in commercial intensive poultry farming, there are many managerial techniques followed to increase the net profit. Poultry is also best suited for the mixed farming system by integrating different components like a pig, poultry, duck, and fish.

The poultry can be housed in many ways. In an extensive system, the birds are left free outside and provided a house or shelter only during the night. In a semi-intensive system, the birds are provided a separate shelter during the night for providing water and some feed. The “Intensive” system is the most common housing system practiced by commercial poultry farmers where the birds are totally indoors. Deep litter and cage systems are the most prevalent intensive systems of rearing chicken. In the Deep litter system, which is mostly practiced in broiler farming, birds are left free on the floor. Whereas layers are mostly reared in a cage system in which birds are totally restricted to meshwork compartments (cages).

The points to be considered while rearing poultry birds are:

- Broilers are reared for 6-8 weeks. They attain 1.8 to 2.0 kg mean body weight in only 38-42 days.

- Horticulture And Allied Sectors**
- Chicks cannot maintain body temperature soon after they are hatched. Hence, brooding (provide the chicks warmth) is necessary for the first 4 weeks.
 - Broilers are given feed *ad libitum*. Broiler starter (1-14 days), grower (15-28 days) and finisher (29-42 or 49 days) ration are available in the market.
 - Since broilers are reared only for about 42 to 49 days, they are vaccinated against only two important diseases namely, Ranikhet Disease (RD) or New Castle Disease (ND) and Infectious Bursal Disease (IBD).
 - Layers are reared for 72 weeks. Hybrid layers of today lay on an average of 310-320 eggs per year compared to 140-200 eggs 30 years back.
 - Layers are usually grown till the start of lay in “Brood-grow house” (BGH) and later on shifted to “Cage layer house” (CLH). It is also a general practice to rear birds on litter (similar to broilers) till the start of lay and shift to cages during egg production.
 - Starter, grower, and layer ration are available in the market.

13.7 FISH FARMING

Aquaculture is a term used in recent times for the science of growing all aquatic animals and plants in water; freshwater, brackish water, and in the open sea. Fish can be broadly classified into three:

- Freshwater fishes: Fishes grown in freshwater systems such as ponds, rivers, lakes, etc. eg. Catla, Rohu, Mrigal, Silver carp, Catfishes, etc.
 - Brackish water fishes: Fishes grown in brackish water which is a natural mixture of fresh as well as seawater. eg. Mulletts; Milkfish, sea bass, Tilapia, pearl spot, etc.
 - Marine fishes: Marine cultivable fishes thrive/ spend all their life cycle in high saline seawater. eg. Salmon, Groupers, Cobia, Snappers, Pompano, Pomfrets etc.
- a) **Farming methods:** In general, fishes are farmed in many methods: i) Monoculture: using one/single species in culture system; ii) Biculture: wherein a carnivorous fish is grown along with another species; iii) Polyculture: Farming of more than one species together in a farm; and iv) Ranching: in which fish seed of ideal species are produced in hatcheries and once they reach fingerling stage, they are released into bays or large enclosures of the sea, sometimes enclosed using nets.
- b) **Feeding:** Like all animals, fish also get their energy from food. Food of farmed fish is of two categories:
- **Natural food** is produced in the natural system with the help of nutrients. The phytoplankton is mostly formed of tiny, one-celled floating plants. The zooplankton is made of tiny animals

as well as larval forms of fishes and other animals living in the water. They also feed on phytoplankton.

- **Supplementary feed** which is synthesized and given to the fish by humans. When the fish population is high in numbers, the natural food available in the pond may not be adequate and in this case, supplementary (additional) food may have to be provided. The ingredients mainly used in the preparation of supplementary feed are also natural products such as rice bran, wheat bran, cereals, plants, vegetable waste, brewer waste, coconut cake, gingelly oil cake, fish waste, etc. Supplementary feed is commercially produced in factories in the form of various-sized pellets. Every day depending on the stock of fish available in the pond, the mixed ingredients are broadcasted in the pond.

- c) **Rearing and Harvesting:** The real farming of fish to harvestable size is done in grow-out ponds. The grow-out phase varies from 6 months to one year depending on the species farmed. Stocking means the number of juveniles farmed in a pond/tank of unit area. This varies with regard to species and the type of grow-out system. Stocking rate depends on many factors such as the fertility of water, rate of water exchange, availability of natural food, etc. When the farmed fish reach marketable size, they have to be harvested. The marketable size of farmed fish also depends on the local needs /taste of the consumers. Harvesting can be partial or complete. In partial harvest, only those fishes which have attained marketable size are alone harvested. In other words, fishes are selectively harvested in such a way that the smaller fish will grow quickly in a short period. In complete harvest, the whole population is harvested. Many methods are used in fish harvesting using a variety of nets. In recent times, modern automated fish harvesting machinery is also available and is used in developed countries. Various types of nets are used in the harvest of fish of various species e.g. Gill net (a vertically hanging net); the Seine or encircling net (a lengthy bag like a net with weights at the bottom and floats on top to stay up in water) and cast nets (for fishes stocked in small earthen ponds).

Check Your Progress 13.5

Note: a) Use the spaces given below for your answers.

- b) Check your answer with those given at the end of the unit.

1) Fill in the blanks with the correct answer:

- i) _____ are chicken reared for meat whereas, _____ are chicken reared for eggs.

- ii) Layers are usually grown till start of lay in _____ and later shifted to _____.
 - iii) _____ is farming of more than one species together on a farm.
 - iv) Supplementary feed for fishes is commercially produced in factories in the form of various sized _____.
- 2) Briefly describe the housing of Poultry.

.....

.....

.....

- 3) Explain the harvesting of fish.

.....

.....

.....

13.8 LET US SUM UP

Livestock acts as a continuous source of income to farmers and reduces seasonality in livelihood patterns of the rural mass and also helps in counteracting the income loss due to crop failure. Livestock produces a number of useful commodities and services viz. Nutritious food, energy, power, fuel, fiber/hide, raw materials, etc. India is bestowed with abundant livestock resources. The four pillars of livestock management include feeding, breeding, weeding, and heeding. Feeding cost constitutes two-thirds of the cost of milk production, proper feeding is a key for economic dairy farming. There are two main types of housing systems practiced in Cattle and Buffaloes viz. loose houses and conventional barns. The management procedure varies at every stage in the life of cattle and buffaloes. All livestock at different stages of life should be taken care of properly as per scientific management practices for ensuring better growth, survival, and optimum productivity. Poultry is best suited for the mixed farming system by integrating different components like pig, poultry, duck, and fish. Fishes are farmed in many methods viz. Monoculture, Biculture, Polyculture, and Ranching.

13.9 KEYWORDS

<i>Ad libitum</i>	:	Without restriction; free of choice
Bull	:	Adult males above 3 years of age used for breeding
Calf	:	Young one of either sex below one year of age
Calving	:	Process of a cow/heifer giving birth to a calf.
Colostrum	:	The first milk secreted at the time of delivery, rich in antibodies that confer passive immunity to the newborn.

Concentrate	:	A feed that is rich in energy, low in fiber content, and highly digestible.
Cow		Adult female that has calved at least once.
Dry matter	:	Plant or animal tissue residue after it has been heated to a constant weight and all of the moisture in the sample has been driven off by gentle heat.
Flushing	:	The practice of giving extra feed to ewes/sows/gilts from 1-2 weeks before mating and returns to normal feeding after mating.
Gestation	:	The period from conception to birth, during which the developing foetus is carried in the uterus.
Heifer	:	A female above one year and less than three years of age which has not yet given birth to a calf.
Lactation	:	Process of secretion and release of milk
Non-descript	:	An animal is usually of inferior quality that cannot be distinguished as belonging to a specific well-defined breed.
Parturition	:	Act or process of giving birth
Weaning	:	Act of separating the young ones from the mother

13.10 SUGGESTED FURTHER READINGS/ REFERENCES

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13.11 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 13.1

- 1) Livestock means stock (items of property) that is alive and is used for the production of items for business and/or domestic consumption.
- 2) Nutritious food like egg, milk and meat, draught power, fuel, energy, power, fiber and raw materials.

Check Your Progress 13.2

- 1) The four pillars of livestock management include feeding, breeding, weeding, and heeding.
- 2) Cattle: Hariana, Kankrej (Bannai, Nagar, Waged, Vadhiyar, Sanehore), Ongole (Nellore), and Tharparkar. Goat: Barbari, Gaddi, Chegu, Changthangi, Jamunapari, Marwari, Osmanabadi, and Sirohi
- 3)
 - i) 1.0
 - ii) Browsing
 - iii) Sty
 - iv) Sheep

Check Your Progress 13.3

- 1)
 - i) One
 - ii) 60-90
 - iii) buffaloes
 - iv) Breeding bull
- 2) Immediately after birth, any membrane or mucous adhering to the mouth, nostrils, eyes, and ears should be removed using a clean dry cloth to facilitate normal breathing. The navel cord should be tied 2.5 cm away from its body and cut about one centimeter below the knot. Apply antiseptics to the cut end for 2-3 days. Feed colostrum within half an hour after birth and should be continued for the first 3-4 days of life. A calf should be shifted to a warm, well-ventilated house.

Check Your Progress 13.4

- 1)
 - i) Ewes
 - ii) 3 to 3½
 - iii) 142 to 150
 - iv) guard rails
- 2) Pregnant sow should be shifted to a clean, dry, well-bedded farrowing sty a few days before the expected date of farrowing. Reduce the ration by 1/3rd till farrowing

Check Your Progress 13.5

- 1)
 - i) Broilers; Layers
 - ii) “Brood-grow house” (BGH); “Cage layer house” (CLH)
 - iii) Polyculture
 - iv) Pellets

- 2) Poultry can be reared in extensive (left free outside), semi-intensive (provided separate shelter during the night), and intensive (totally indoors) systems. Deep litter and cage systems are the most prevalent intensive systems of rearing chicken. In the Deep litter system, which is mostly practiced in broiler farming, birds are left free on the floor. Whereas layers are mostly reared in a cage system in which birds are totally restricted to meshwork compartments (cages).
- 3) Harvesting can be partial or complete. In partial harvest, only those fishes which have attained marketable size are alone harvested. In complete harvest, the whole population is harvested. Many methods are used in fish harvesting using a variety of nets. In recent times, modern automated fish harvesting machinery is also available and is used in developed countries.



UNIT 14 ALLIED SECTORS

Structure

14.0 Objectives

14.1 Introduction

14.2 Apiculture

14.2.1 Importance and scenario of apiculture

14.2.2 Beekeeping enterprise

14.2.3 Honey bee species

14.2.4 Colony organization and division of labour

14.2.5 Hive products

14.2.6 Strategies for honey marketing

14.3 Sericulture

14.3.1 Meaning and importance of sericulture

14.3.2 Types of silk

14.3.3 Silk producing states

14.4 Agroforestry

14.4.1 Scope and importance of agroforestry

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14.4.3 Agroforestry - Industry linkages

14.4.4 Market prospects of agroforestry

14.5 Mushroom

14.5.1 Prospects of mushroom cultivation as an agribusiness vocation

14.5.2 Why grow mushrooms

14.5.3 Types suitable for cultivation

14.6 Let Us Sum Up

14.7 Keywords

14.8 Suggested Further Readings/References

14.9 Check Your Progress: Possible Answers

14.0 OBJECTIVES

After going through this unit, you will be able to:

- discuss the importance and scope of apiculture and describe the hive products and strategies for honey marketing;
- identify the potential of the sericulture industry and explain the various types of silkworms and their rearing technology;
- appraise the scope, benefits, and types of agroforestry based industries and their marketing; and
- explain the importance and different types of mushrooms under cultivation;

14.1 INTRODUCTION

The agriculture sector comprises various sectors such as field crops, horticulture, livestock, etc. Apiculture (beekeeping), sericulture, agroforestry, and mushroom cultivation are other important sectors of agriculture that significantly contribute to agricultural income and employment. Indian agriculture is characterized by the predominance of rainfed farming which is often affected by drought, soil erosion, and crop fluctuations. The irrigation facilities are likewise inadequate. All these factors are key impediments to the rural economy. Hence, the integration of agriculture with other agro-allied sectors such as beekeeping, sericulture, agroforestry, and mushroom has come up as one of the befitting alternatives to augment rural income.

The scope of Indian beekeeping has been broadened by a more recent comprehensive definition, 'Beekeeping covers the entire scope of management of honey bee resources, beekeeping practices, bee products, pollination services, and their interface with socio-economic, cultural, natural heritage and environmental integrity. India, being very rich in floral availability and diversity and diverse climatic conditions from the north to south and east to west offers a great potential for beekeeping enterprise.

Tree growing has been an integral part of human development. The patterns of trees growing in different areas have gotten attention these days due to climate change. Trees have the potential to sequester greater carbon in their biomass and thus help mitigate the negative impacts of climate change, particularly in the atmosphere. The age-old practice of growing trees in the home yard (home gardens) has attracted the attention of researchers as a rich sink of biodiversity and carbon. At the same time, growing trees in agricultural lands have been described as agro-forestry. Thus, the agroforestry practices manifest socio-cultural linkages as well.

Mushroom cultivation is another growing agriculture sector that has tremendous growth prospects. The agro-climatic conditions are well suited to the cultivation of mushrooms in different parts of India. The demand for the consumption of mushrooms is also increasing due to their nutritional and health benefits. The present unit highlights the definition, scope, importance, types, and business prospects of beekeeping, sericulture, agro-forestry, and mushroom cultivation.

14.2 APICULTURE

Beekeeping is quite different from other agro-based subsidiary industries, as it needs more art and skill and less physical involvement than that required in any other agro-based enterprise. Beekeeping should be started with clear objectives such as either as a hobby or subsidiary enterprise or a whole-time activity.

14.2.1 Importance and Scenario of Apiculture

Apiculture is an agro-based subsidiary as well as a whole-time economic activity. This is particularly beneficial, among the various other components or activities of diversification in agriculture, for landless, and small and marginal farmers where traditional agriculture would not be economically

viable, and also among strata with limited economic resources, as apiculture needs little land or meager monetary resources.

Honey bees not only provide us honey but also several other hive products viz. pollen, propolis, beeswax, royal jelly, and bee venom which have very high economic value. Commercial production can result in a phenomenal increase in apiary profits. Further, bees do a yeoman service to humanity by providing their services as efficient pollinators of the crops and thereby augment the crop yields both quantitatively as well as qualitatively. Apiculture is such an enterprise that is being considered important not only for augmenting our crop productivity but also for rural upliftment and economic liberation of our villagers and in generating ample employment opportunities. It is also very important in the maintenance of ecological biodiversity; is eco-friendly and organic enterprise; helps in overcoming problems of malnutrition and health in rural areas as its products improve nutrition and are thus important for ensuring nutritional security, besides being useful in ameliorating the health status.

In many developed countries, honey bee colonies are professionally rented out by beekeepers for crop pollination purposes, and this component of apiculture, with the rising awareness about the importance of crop pollination, is also picking up in India.

In India, honey production has increased from 76,150 MTs (2013-14) to 1,20,000 MTs (2019-20) which is 57.58 % increase. The export of honey has increased from 28,378.42 MTs (2013-14) to 59536.74MTs (2019-20) which is a 109.80 % increase. Sixteen Integrated Beekeeping Development Centres (IBDCs) as a role model of beekeeping have been commissioned in India, one each in the States of Haryana, Delhi, Bihar, Punjab, Madhya Pradesh, Uttar Pradesh, Manipur, Uttarakhand, Jammu & Kashmir, Tamil Nadu, Karnataka, Himachal Pradesh, West Bengal, Tripura, Andhra Pradesh, and Arunachal Pradesh. (Source: <https://pib.gov.in/PressReleaseDetailm.aspx?PRID=1697113>, 11 FEB 2021). *North East Region of India and Maharashtra are the key areas for natural honey production.* Major export destinations in the 2020-2 are U S A, Saudi Arab, United Arab Emirates, Bangladesh, Canada (http://apeda.gov.in/apedawebsite/SubHead_Products/Natural_Honey.htm, 24.09.2021)

Check Your Progress 14.1

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1) What is the comprehensive definition of apiculture?

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2) What is the importance of apiculture from a crop pollination point of view?

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 3) What do you understand by diversification of apiculture?

14.2.2 Beekeeping Enterprise

Beekeeping is considered such an agricultural activity that does not require one's own agricultural land, sheds, or structures, involves the least time and labour and minimum drudgery, and hence, is regarded as a very low cost enterprise. The bees, if managed skillfully, start giving rewards the same year by way of yielding honey and beeswax coupled with the simultaneous increase in bee population; the profits start pouring in the same year. Beekeeping in the country, in general, and in the north-western states, in particular, has got an impetus and has become commercialized and industrialized only in recent times due to mass-scale adoption of high-yielding exotic honey bee species, the European honey bee, *Apis mellifera* Linnaeus. This bee, however, can not withstand the long floral dearth period and, thus, migration is almost mandatory in this case. Small beekeepers, however, do not practice much migration and prefer to feed the honey bee colonies. However, larger apiarists and progressive beekeepers usually migrate their honey bee colonies and avoid artificial feeding, achieve higher colony growth and realize multiple honey extractions, and, thus, earn more profits after meeting the expenses on migration.

Important Considerations for Starting-up Beekeeping Project

Thorough planning, interest, zeal, confidence, and enthusiasm in starting beekeeping and timely adoption of various management operations play a great role in its success. The following points may be taken up into consideration for initiating a good beekeeping project.

1. **Training from a recognized institute:** A beginner must acquire critical knowledge and practical skill by undergoing beekeeping training from some recognized institution and by reading relevant literature.
2. **Purchase of essential equipment:** The essential bee equipment including bee hives must be arranged well before starting beekeeping.
3. **Selection of suitable site:** A locality where a series of bee forage crops/ plants, one after the other are available throughout the year and has an easier approach, has greater potential for starting beekeeping.
4. **Suitable season for starting beekeeping:** Suitable season for starting beekeeping coincides with moderate climatic conditions and availability of bee flora in plenty. Normally, the spring season (February-April) and post-monsoon (September-November) are the best periods to start beekeeping.
5. **Purchase of nucleus colonies:** For starting beekeeping, nucleus colonies should be purchased at the beginning of the suitable season.

6. **Time of shifting honey bee colonies:** The purchased colonies should be shifted only when bees are not active (i.e. at dusk or dawn) and all the foragers are back inside the hive.
7. **Transportation of the colonies:** Before shifting, the colonies should be properly packed to make them properly ventilated but bee leakproof. Jerks to the honey bee colonies are to be avoided during their transport.
8. **Placement of colonies at the chosen apiary site:** After reaching the destination, the hives should be placed in at least 10 feet apart rows with 6-8 feet distance between two adjacent hives. The hive entrance should preferably face south-east direction and be placed preferably away from a common passage.

14.2.3 Honey Bee Species

Under superfamily Apoidea, under Apinae family, four species of honey bees belonging to genus *Apis* viz. *Apis dorsata* Fab. (Rock bee/ Dammer bee); *Apis florea* Fab. (Small bee/ Little bee); *Apis cerana* Fab. (= *A. indica*, *A. cerana indica*) (Asiatic bee/ Indian bee/ Hill bee/ Pahadi bee); and *Apis mellifera* Linn. (European bee/ Western bee) are the traditional honey bees from which surplus honey is extracted and all these four are presently found in India. The first two species, namely *A. dorsata* and *A. florea* are wild ones (cannot be hived) while the latter two (*A. cerana* and *A. mellifera*) are hive ones (can be domesticated).

A few distinguishing morphological and behavioural attributes for the above traditional honey bee species have been tabulated (Fig. 14.1, Table 14.1).



(i) *Apis dorsata*



(ii) *Apis mellifera*



(iii) *Apis cerana*



(iv) *Apis florea*

Fig. 14.1: Different species of honey bees

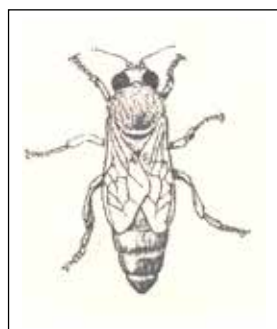
Table 14.1: Identification/differentiation among different honey bee species

Characteristics	<i>A. dorsata</i> (Giant honey bee) (i)	<i>A. mellifera</i> (European honey bee) (ii)	<i>A. cerana</i> (Asiatic honey bee) (iii)	<i>A. florea</i> (Small/ little honey bee) (iv)
1. Body size	Largest	Medium	Medium	Smallest

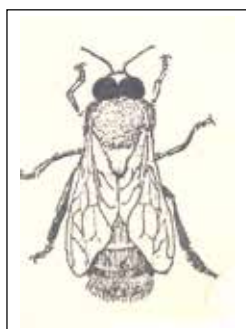
2.	Body colour	Head blackish, abdomen reddish yellow anteriorly and blackish at the tip	Body golden yellow, profusely hairy with faint black and yellowish stripes posteriorly	Body colour blackish, abdomen with white & black stripes	Abdomen reddish anteriorly with black & white stripes posteriorly
3.	Wings	Smoky	Transparent	Transparent	Transparent
4.	Proboscis size	Largest	Medium	Medium	Smallest
5.	No. of worker cells/4 linear inches	18.75	19.3	21.25 to 25.0	32.8 to 36.0
6.	Nature and temperament	Wild bee, hostile	Can be hived, docile	Can be hived, docile	Wild bee, relatively less hostile
7.	Comb construction	Single, large (5-7' x 2-4') combs, constructed under the roof projections, water reservoirs, and on trunks of tall trees	Many parallel combs inside enclosure/ cavities or in beehives	Many parallel combs inside the enclosure/ cavities or in beehives	Single, small (Palm to quarter plate size) combs, constructed in bushes/ hedges, cotton sticks, etc.

14.2.4 Colony Organization and Division of Labour

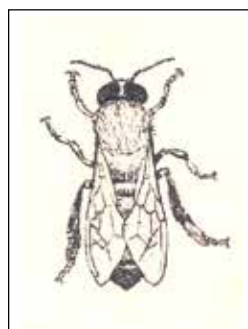
In any honey bee colony, there are three castes, namely queen bee (fertile female), drone bee (male bee), and worker bee (sterile female). These castes in the case of hive honey bees can very easily be differentiated based on their morphological characteristics; the distinguishing features among the three castes for the commonest bee species, i.e. *A. mellifera* are given below (Fig. 14.2).



Queen bee



Drone bee



Worker bee

Fig. 14.2: Different castes of *A. mellifera*

Horticulture And Allied Sectors **Queen Bee:** It is a sexually functional female which is developed from a fertilized egg, and is bigger in size than a worker bee. It has a long abdomen extending well beyond the apical margins of wings. It is mainly concerned with reproduction and maintaining a populous colony. She gets mated by drone(s) during nuptial flight and later remains confined to the hive to lay eggs throughout her life. There is only one queen bee in a colony in normal conditions. At the height of brood rearing season, the queen would lay up to 2000 eggs per day.

Drone Bee: It is a functional male which is developed from an unfertilized egg and is larger and darker than the worker bee. Its compound eyes are holoptic i.e. very large and are united at the vertex. It has no sting or wax glands and neither its hind legs are modified for any pollen collection. These are found in the colonies only in a few hundred and that too during breeding (active brood rearing) seasons.

Worker Bee: It is a sexually sterile female caste produced from a fertilized egg and is the smallest in size as compared to those of the above discussed two castes. The worker bees are imperfectly developed females unable to reproduce. Worker bees perform all important functions such as nest building, food gathering, brood care, defense of the colony, attending the queen, keeping the hive warm and hygienic, secreting wax from the abdominal glands, and also gathering resins (made into propolis) for nest building.

The three castes of honey bees depend upon one another for their existence. A lonely worker may not live for more than 2-3 days under the best environmental conditions. The queen bee cannot even start a colony because she is physically incapable of secreting wax, building comb, collecting food, and rearing brood; the drone would not be able to last for an hour without food. Thus, the honey bee colony is a unit of life of which the different castes are inseparable or integral parts.

14.2.5 Hive Products

Honey, pollen, beeswax, royal jelly, propolis, and bee venom are important products of beekeeping.

1. **Honey extraction:** Honey is extracted through a machine known as Honey Extractor. Only sealed (ripe) honey has to be extracted from brood-free combs only.
2. **Pollen:** Pollen is the male germplasm of floral plants and collected by bees on corbiculae of pollen collecting legs (hind legs). Bees collect pollen from bee forage as food for the nurse bees. Pollen is the source of proteins, enzymes, vitamins, minerals, and fat for bees for brood rearing or tissue building.
3. **Bees Wax:** Beeswax is the secretion of paired epidermal glands situated on the underside of 4th to 7th abdominal segments of bees of generally 14-18 days of age and is used for comb construction. Normal recovery of beeswax is 2 percent of the honey produced. Sources of beeswax include cut cappings of sealed honeycombs, broken bits of combs that fall into the honey extractor, brace and bur combs, old damaged combs, and deserted wild honey bee combs.

4. **Royal Jelly:** Royal Jelly is a mixture of clear watery secretion of hypopharyngeal glands and milky secretion of mandibular glands of nurse bees (6-13 days age) in the ratio of 1:1. It is highly nutritive food that is fed to the royal caste (queen bee) during the larval period and even during the whole of its adult stage. The jelly is extracted either with the help of an aspirator or using some water-vacuum pump or motorized suction pump.
5. **Propolis:** Propolis is produced only by *Apis mellifera* bees. Even in *A. mellifera*, some races collect more propolis than others. Propolis is sticky and resinous material, collected by foraging bees as exudates of buds, bark, and wounds of plants/trees. Propolis is used by bees to plug the cracks and crevices in the hive, varnishing the comb surface and as a repellent against ants at the hive entrance.
6. **Bee Venom:** Bee venom is synthesized in venom glands of worker bees (150-300 µg) and queen bees (700 µg), however, only the worker bees are exploited for venom production. Normal recovery of dry venom per bee is 0.5 – 1.0 µg. Bee venom is a clear watery material having a somewhat sharp and bitter taste, a hydrolytic blend of proteins with basic pH, and is used by the bees for their defense. For the venom collection, the electro-shock method is used and the device used for the venom collection is known as Venom Extractor.

14.2.6 Strategies for Honey Marketing

The important strategies, such as maintenance of quality, labeling, selection of channels that may be followed in the marketing of honey, are discussed below:

1. Maintaining Honey Quality

For honey marketing, it is highly essential to maintain its quality, both for domestic selling as well as for its export. Following pre-harvest as well as post-harvest measures help ensure better honey quality:

- i) Minimize the use of chemicals in beekeeping
- ii) Maintain colonies on super and use queen excluder between the brood chamber and super
- iii) Extract only ripe honey
- iv) Extract honey only from brood free supers
- v) Filter out the honey just at the time of extraction or immediately after extraction
- vi) Store honey in containers made of food-grade material
- vii) Keep honey in air-tight condition and at a cool place

2. Attractive Packing and Informative Labeling

For earning higher profits, it is highly advisable to undertake self-marketing of the produce in retail packing. For such marketing, the following points will be helpful in easier and more profitable selling of honey:

- i) Give an attractive brand name for your honey
- ii) Always use new/ clean bottles for honey packing
- iii) Honey should always be filled-up in wide-mouthed bottles
- iv) The packing must bear an attractive label, giving various information about the product including the brand name, address of packer, his phone number, lot number, the source bee flora, date of packing, quantity, price, specific instructions about the particular honey, a few of its important uses, etc.
- v) Try to obtain ISI or AGMARK for your honey as this will ensure the consumer's confidence in your produce

3. Avenues for Honey Sale

Beekeepers may follow any of the following ways for selling their produce:

- i) Direct selling by self
- ii) Door-to-door/ direct selling on a commission basis by employing salespersons
- iii) Supply to the wholesale distributors
- iv) Supply at the retail shops
- v) Opening of sale booths on roadsides or near/ at various tourist places
- vi) Putting up sale stalls at various festivals, farmers markets, agricultural fairs, beekeeping workshops/ conferences, exhibitions, etc.
- vii) Supply to various agricultural marketing societies/ cooperatives

Check Your Progress 14.2

- Note:** a) Use the spaces given below for your answers.
b) Check your answer with those given at the end of the unit.

1) What is propolis?

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2) What is royal jelly?

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3) What is bee venom? What are its uses?

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14.3 SERICULTURE

Sericulture is an agro-based industry related to silk production. The industry is comprised of Host plant cultivation, Silkworm rearing, Silkworm Seed production, Silk reeling, Twisting, and Weaving. Raw silk production in the country was 18,370 MT in 2008-09 which has increased to 35,468 MT in 2018-19, registering a CAGR of 6.16%. Mulberry silk production in the country continues to dominate the sector with a share of 71% followed by Eri (20%), Tasar (8%), and Muga (1%). The employment generation in sericulture enterprise grew at 3.5% per annum from 6.30 million persons in 2008-09 to 9.2 million persons in 2018-19 (Source: THE NATIONAL SILK POLICY – 2020, pp 4-5)

14.3.1 Meaning and Importance of Sericulture

What is Silk?

How many of you know that Silk is a protein fiber secreted by silkworms? The silk fabrics worn by us are thus, nothing but pure animal protein. The plant protein available in the leaves fed to silkworms gets converted to animal protein in the form of silk and accumulates in the silk glands of the mature silkworm. This is then emitted out in the form of tender silk thread and wrapped by the silkworm around its body. Thus, the shell called cocoon is spun by the silkworm as its home to live in and overcome unfavorable weather conditions. With the contact of air, the cocoon becomes hard. The thread from the shell is un-winded through the reeling process to obtain silk.

Origin of Silk

Do you know that silk has its origin in China and it managed to keep the secret of silk production for thousands of years, exporting the rare textile to Europe over trade routes? Eventually, silkworm eggs were smuggled out and in the 13th century, Western production of silk began in Italy and eventually spread to other countries, today India becoming the second largest producer of silk after China.

Why Sericulture?

When We enter a new venture, it is necessary to know its pros and cons. Until it provides us ample opportunities to our favor, it shall not be of our use. Since sericulture is basically a rural industry; it needs to be assessed in relation to other cash crops. The following factors make sericulture a highly favorable rural industry:

- Rural activity
- No interference with cash crops
- Minimum gestation period
- Less investment
- Quick turnover
- Maximum employment
- Primarily ladies/children involvement
- Additional income

Sericulture, being the rural industry, offers excellent opportunities for self-employment, particularly to rural youths. The women and children are also actively engaged with this wonderful industry. The industry offers a chain of activities to earn a decent income. The first field relates to Silk cocoon generation through the rearing of silkworms in the capacity of *Silkworm Rearer*. Second in the chain is the reeling of cocoons for obtaining raw silk by procuring silk cocoons from rearers. This class is known as *Reelers*. Followed closely are the *Twisters* who twist silk yarn produced by reelers. This is to strengthen tender silk filament. The next in line are the *Weavers* who procure twisted yarn and weave the ultimate silk fabric. The other important opening is that of a licensed *Silkworm egg producer* to meet the demand for silkworm seed. Last but not least there are nursery growers popularly known as *Kisan Nursery Farmers* to raise saplings of host plants on a commercial scale to make these available to silk cocoon producers to enable them to develop their plantation for rearing silkworms. Then there are *ancillary units* manufacturing various disinfectants, rearing, and other appliances used in silkworm rearing and egg production.

14.3.2 Types of Silk

The type of silk is related to the silkworm that produces it. Many of you may have learned in school a bit about silkworms and their life cycle but how many of you are aware that there are four distinct varieties of silk, namely *Mulberry*, *Tasar*, *Muga*, and *Eri*? Further, there are two sub-varieties of tasar – the tropical tasar and the temperate tasar. All these varieties are produced by different silkworms. India with the advantage of varying agro-climatic conditions has the monopoly of producing all four varieties of silk. Muga – the golden yellow silk with its fancy the world over is produced in India only in Assam. *Tasar*, *Muga*, and *Eri* constitute the group of non-mulberry silks.

Mulberry Silk: The bulk of the commercial silk produced in the world comes from this variety and often silk generally refers to mulberry silk. Mulberry silk comes from the silkworm, *Bombyx mori L.* which solely feeds on the leaves of the mulberry plant.

Tasar Silk (Tropical Tasar): *Tasar* (Tussah) is copperish colour, coarse silk is mainly used for furnishings and interiors. It is less lustrous than mulberry silk but has its own feel and appeal. *Tasar* silk is generated by the silkworm, *Antheraea mylitta*, which mainly thrives on the food plants *Asan*, *Arjun*, and *Sal*.

Oak Tasar Silk (Temperate Tasar): This is a finer variety of tasar generated by the silkworm, *Antheraea proylei J.* which feeds on natural food plants of oak, found in abundance in the sub-Himalayan belt of India. This is a hybrid evolved in India by crossing Indian sp. *Antheraea royeli* with Chinese counterpart *Antheraea pernyi*. The advantage of this hybrid is that it yields a single shell cocoon, unlike *royeli*, thus, reelable. China is the major producer of oak tasar in the world.

Muga Silk: This golden yellow colour silk is the prerogative of India and the pride of Assam state. It is obtained from the semi-domesticated multi-

voltine silkworm, *Antheraea assamensis*. These silkworms feed on the aromatic leaves of Som and Soalu plants and are reared on trees similar to that of tasar. Muga culture is specific to the state of Assam and an integral part of the tradition and culture of that state. The muga silk, a high-value product is used in products like sarees, mekhalas, chaddars, etc

Eri Silk: Also known as Endi or Errandi, Eri is multivoltine silk spun from open-ended cocoons. Eri silk is the product of the domesticated silkworm, *Philosamia ricini* that feeds mainly on castor leaves. Eri culture is a household activity practiced mainly for protein rich pupae, a delicacy for the tribals. The eri cocoons are open-mouthed and are spun. The silk is used indigenously for the preparation of chaddars (wraps) for own use by these tribals. The silkworm being domesticated is reared indoors on the pattern of mulberry silkworms.

14.3.3 Silk Producing States

India is a country gifted with varying agro-climatic regions. Different types of silkworms require different climatic conditions to survive. So is the case with their host plants. Evidently, one or the other type of silks can be produced in one or the other part of the country. Major silk producing Indian states are listed below:

MULBERRY:

- **Traditional States** – Karnataka, Andhra Pradesh, Tamilnadu, West Bengal, J&K
- **Non-Traditional States** – Uttar Pradesh, Uttarakhand, Haryana, Punjab, Himachal Pradesh, Bihar, Jharkhand, Chattisgarh, Orissa, Gujarat, Rajasthan, Madhya Pradesh.

TASAR: Bihar, Jharkhand, Orissa, Chattisgarh, Madhya Pradesh, A.P.

OAK TASAR: Manipur, Jammu & Kashmir, Uttarakhand

MUGA: Assam, Nagaland, South Tripura

ERI: Bihar, Jharkhand, Orissa, Chattisgarh, Manipur, Tripura, Assam

Check Your Progress 14.3

Note: a) Use the spaces given below for your answers

b) Check your answer with those given at the end of unit

1) Explain the chain of Sericulture activities. How does it offer avenues of self-employment?

.....

2) Name different types of silk. Which variety is the monopoly of India?

.....

- 3) Name traditional States producing mulberry silk.

14.4 AGROFORESTRY

Agroforestry has been practiced traditionally by farmers across the world in some form or the other since time immemorial (Nair and Muschler 1993). The sustainability of agroforestry systems in providing livelihood, employment, poverty reduction, and environmental services is being rediscovered due to rapid industrialization (Samra and Solanki 2005). Thus, the introduction of fast growing species suitable to yield industrial raw materials on agricultural holding is a must to meet industrial wood demand on a sustainable basis, and agroforestry helps a lot in this direction.

Definition

Agroforestry is not a new system or concept. The practice is very old, but the term is definitely new. Agroforestry means the practice of agriculture and forestry on the same piece of land. **Bene et al. (1977)** defined agroforestry as a sustainable management system for land that increases overall production, combines agricultural crops and animals simultaneously. **Nair (1983)** defines agroforestry as a land-use system that integrates trees, crops, and animals in a way that is scientifically sound, ecologically desirable, practically feasible, and socially acceptable to the farmers. Another widely used definition given by the International Center for Research in Agroforestry (ICRAF) Nairobi, Kenya, that, “agroforestry is a collective name for all land use systems and practices where woody perennials are deliberately grown on the same land management unit as agricultural crops or animals in some form of spatial arrangement or temporal sequence” (**Nair, 1983**).

Source: <http://www.fao.org/docrep/ARTICLE/WFC/XII/0931-B5.HTM>

14.4.1 Scope and Importance of Agroforestry

Forests play an important role in shaping a nation’s economy and environment. In a developing country like India, policymakers regularly face difficulty in making a tradeoff between economic growth and forest conservation. According to the State of Forest Report by Forest Survey of India (FSI), Dehradun, forest and tree cover of India accounts for 758546 sq km (comprises of 712249 sq km total forests (21.67 %) and 46297 sq km scrub (1.41%)) in 2019 which is 23.08 % of the total geographical area. The forest policy of 1952 emphasized that 33% of the total geographical area of the country should be covered with forest which means that there is still a gap of more than 10 % towards the national target. Nevertheless, the pressure on India’s forest continues to be very high due to the large segment of the population being dependent on forests for livelihood, and also demand for

wood for various uses are increasing with the growing population. Therefore, measures such as protecting existing forests and bringing more areas under tree cover need to be encouraged. In this regard agroforestry, i.e., deliberate use of woody perennials (trees, shrubs, bamboos, palms, etc.) on agricultural lands and/or livestock production, can be a viable land use option.

14.4.2 Benefits from Agroforestry

Higher yields of crops have been observed in forest-influenced soils than in ordinary soils. Approximately, 20% higher yields of grains and wood have been reported in agroforestry areas of Haryana and western Uttar Pradesh than from pure agriculture (**Dwivedi and Sharma, 1989**).

Nitrogen-fixing trees grown in the agroforestry systems are capable of fixing about 50 -100 Kg N/ha/year (**Tewari, 1995**).

Experience in Punjab, Haryana, Uttar Pradesh, Gujarat, and some parts of the southern states indicate that a tree and agriculture crop production system is more productive. The total production and value of fuel, fodder, and small timber in degraded lands are reported to be many times more than the coarse grains usually produced on them (**Gupta and Mohan, 1982**).

Sanchez (1987) stated that “appropriate agroforestry systems improve soils physical properties, maintain soil organic matter and promote nutrient cycling”. Nitrogen fixing trees are mentioned as one of the most promising components of agroforestry system. The leaf litter after decomposition forms humus releases nutrients and improves various soil properties, it also reduces the fertilizer needs.

Growing trees and fodder crops (including fodder trees) is more economical, particularly on marginal lands. Observations taken in hot arid and semi-arid areas of Rajasthan indicate that marginal lands are incapable of sustaining stable and dynamic cultivation of agricultural crops.

Silvipasture consisting of growing trees such as *Prosopis*, *Albizia*, *Zizyphus*, and *Acacia* species may provide many times more returns per unit of land than agriculture under such conditions (**Gupta and Mohan, 1982**). Eucalyptus in agroforestry has been found to be more profitable than pure agriculture in Haryana. *Populus deltoides* increase the farm return by 50% in Tarai region of Uttar Pradesh (**Chaturvedi, 1981**).

<http://www.fao.org/docrep/ARTICLE/WFC/XII/0931-B5.HTM>

Check Your Progress 14.4

Note: a) Use the spaces given below for your answers.

b) Check your answer with those given at the end of the unit.

1) What is tree farming?

.....

2) Name any one important role of trees in farmlands.

.....

3) What are the functions of the Forest Survey of India?

.....

4) Expand the following abbreviation:

(a) ICRAF:

(b) ICFRE:

14.4.3 Agroforestry - Industry Linkages

Agroforestry development in India has received impetus after two important policy announcements by the central government. Firstly, National Forest Policy, 1988 directed the wood based industries to phase out and ultimately stop the collection of raw material supply from the forest and to become self-dependent in their demand by developing strong linkages with the farmers through the arrangement on some incentive provisions such as credit facilities, input subsidy and assured marketing for tree planting.

Before the 1980s, all wood based industries depended on State Forest Departments for raw material supply and also for which many industrial plantations have been established. But unfortunately, the forests managed by the state forest departments failed to meet the yield/growth predictions (Chandra 2003). Demand for wood also increased manifold and therefore, leaving no option for industries to approach the farmers for the production of raw material which paved the way for developing industry-farmer relations boosting agroforestry and farm forestry activities.

Agroforestry / Farm Forestry Based Industries

Unlike agricultural crops and livestock that have a short payback period, benefits from woody perennials can be accrued after a long rotation. Therefore, to achieve sustainability of any agroforestry programme, proper utilization of this principal component must be ensured through industrial linkages and developing an ensured marketing system. A large number of wood based industries across the country are supported by agroforestry/farm forestry based raw material (Table 14.2).

Table 14.2: Wood based industries using agroforestry/farm forestry based raw material

Wood based industries	Tree species used
Pulp and paper, rayon	Various bamboo species, Eucalyptus spp., <i>Leucaena leucocephala</i> , <i>Casuarina equisetifolia</i>

Plywood and composite wood	Poplar (<i>Populus deltoides</i>), <i>Anthocephalus chinensis</i> , <i>Albizia lebbeck</i> , <i>Dalbergia sissoo</i> , <i>Mangifera indicca</i> , <i>Ailanthus grandis</i> , <i>Gmelina arborea</i> , <i>Tectona grandis</i> , <i>terminalia bellerica</i> , <i>Grevellea robusta</i> , <i>Bombax ceiba</i> , Bamboo species (bamboo matply)
Matchbox and sticks	<i>Populus deltoides</i> , <i>Anthocephalus chinensis</i> , <i>Ailanthus excelsa</i> , <i>Mangifera indica</i> , <i>Alstonia scholaris</i> , <i>Bombax ceiba</i> , <i>Trewia nudiflora</i>
Packing cases and crates	All plywood species, bamboo (Woven baskets), <i>Populus ciliata</i> , <i>Eucalyptus spp.</i>
Sawmilling	Almost all woods with minimum branches and straight bole. Best species include: <i>Tectona grandis</i> , <i>Gmelina arborea</i> , <i>Dalbergia sissoo</i> , <i>Artocarpus heterophyllus</i> , <i>Tamarindus indica</i> , <i>Azadirachta indica</i>
Furniture and cabinet making	<i>Tectona grandis</i> , <i>Gmelina arborea</i> , <i>Toona ciliata</i> , <i>Michalia champaca</i> , <i>Morus laevigata</i> , <i>Sygygium cumini</i> , <i>dalbergia sissoo</i> , <i>mangifera indica</i> , <i>Ougenia dalbergioides</i> , <i>Albizia lebbeck</i>
Agarbatti sticks	Bamboo species, <i>Santalum album</i> , <i>Juniper in temperate regions</i>
Pencil industry	<i>Alnus nepalensis</i> , <i>Alstonia scholaris</i> , <i>Salix tetrasperma</i>
Sports good industry	<i>Morus spp.</i> , <i>Salix alba</i> , <i>Fraxinus xanthoxyloides in temperate region</i>
Tanning industry	<i>Acacia leucophloea</i> , <i>Artocarpus heterophyllus</i> , <i>Bauhinia purpurea</i> , <i>Callophyllum inophyllum</i> , <i>Zizyphus mauritiana</i> , <i>Cassia siamea</i> , <i>Tamarindus indica</i> , <i>Terminalia arjuna</i> , <i>Acacia decurens</i>
Cutch and Katha	<i>Acacia catechu</i>
Silk industry (Host for silkworm)	<i>Morus alba</i> , <i>Anogeissus latifolia</i> , <i>Terminalia arjuna</i> , <i>Ficus tsjakela</i> , <i>Ricinus communis</i> (Shrub)
Host for lac and shellac industry	<i>Acacia catechu</i> , <i>Schleichera oleosa</i> , <i>Butea monosperma</i> , <i>Zizyphus mauritiana</i> , <i>Acacia nilotica</i>
Essential and aromatic oil	<i>Eucalyptuscitridora</i> (Leaves), <i>Santalum album</i> (Heartwood) , <i>Aquilaria agallocha</i> (Fungus infected heartwood)

The wood based industries that are sustained through agroforestry/farm forestry activities can aptly be categorized into:

1. Village/cottage level industries run mostly by individual households with very little capital investment such as petty sawmilling, furniture and cabinet making, silk rearing, agarbati stick making, pencil industry, sports goods, ice cream stick making, etc.

- Horticulture And Allied Sectors**
2. Small scale industries with medium investment and semi-automation such as packing case industry, large sawmills, agarbatti stick making, pencil industry, canned bamboo shoots, etc.
 3. Large scale industries with large investments and a high level of automation such as Pulp and paper industry, plywood and other composite wood industry, large matchbox and match stick industry.

Among these, pulp and paper industry, plywood and composite wood industry, packing case and crates manufacturing industry, and sawmills consume wood in large quantities. With the scarcity of wood from conventional forest sources and emerging research findings on wood utilization, these industries are now shifting their focus on fast growing hardwood species that are suitably raised in farm landholdings.

14.4.4 Market Prospects of Agroforestry

It has become all the more important to integrate agroforestry services to market, particularly for the socio-economic upliftment of the rural poor (Mercer 2004). Hence, a few strategies have been worked out as below:

- *Promotion of small-scale agroforestry for community development* – Strategic models to be developed for income generation.
- *Improving marketing and processing of agroforestry products* - For such a strategy to be sustainable, the involvement of the private sector would have to be enhanced. New products that are in demand by rural and urban markets would have to be developed.
- *Diversification of agroforestry products and by-products* such as high-value trees, indigenous and exotic fruit trees, medicinal plants, fodder for livestock, organic vegetable production with green manure from trees will increase opportunities for small producers to develop their own processing and marketing channels (cottage industries) and add value to the raw products.
- *Development and promotion of substitutes and/or supplements for costly, imported external inputs* - Examples of such options include fodder trees, which can supplement or replace expensive dairy meal; and N-fixing trees together with their residues, which can supplement or serve as a substitute for inorganic nitrogen fertilizers.
- *Options for mitigating the continuing degradation of the environment and losses in biodiversity* - Agroforestry strategies that address environmental degradation and its consequences include replenishing soils in degraded lands and reducing risk due to climatic change through tree-crop integration; and promoting, protecting, and planting indigenous trees.
- *Options for mitigation of climate change impacts* – Although the international discussion on *global warming* offers opportunities for agroforestry research and development in the developing world including South Asia, this is linked to compensatory payments and clean development mechanisms designed to reward trees planting and management.

- *Development and implementation of strategies for large-scale dissemination of agroforestry technologies at the local level* - The current thrust towards decentralization policies, i.e., those leading to the devolution of power and control from the central state to lower levels, could provide an enabling environment and new avenues for agroforestry dissemination.
- *Training and capacity building in agroforestry among all major stakeholders.* Strategically, training (university, college, extension service, farmer-to-farmer) is the vehicle to achieve wide-scale dissemination of agroforestry technologies and services. Policy dialogue to raise the awareness of policymakers about the benefits of agroforestry and the constraints impeding its expanded adoption is essential.
- *Co-operation and partnerships with a broad range of actors* is a strategy that will enable the Regional Agroforestry Programme, despite limited resources, to succeed in the challenge of proactively seizing the opportunities for agroforestry arising in the future.

14.5 MUSHROOM

You must have seen that after rains many mushrooms appear from nowhere, especially in grassland, near manure heap, dung, or rotting straws/ wood. Firstly, let us try to understand what are these and from where they come. Mushrooms are fruit bodies of fungi. Fungi have been classified into a number of classes and mushrooms mainly belong to the class basidiomycetes and a few of the mushrooms belong to the class ascomycetes. At present, there is no simple method to differentiate an edible mushroom from a non-edible type. A few of these are poisonous. There have been attempts to cultivate different types of mushrooms. We have succeeded in cultivating more than 100 types of mushrooms, of which only 30 are cultivated on a commercial scale in one or another part of the world. Of these, 5-6 species are grown at an industrial scale. The major share of cultivated mushrooms is of button, shiitake, oyster, paddy straw, winter, and wood ear mushroom (Fig 14.3).



Fig 14.1 Some important cultivated mushrooms
(L to R, Top row: Button, Milky, Shiitake mushroom;
Bottom row: Oyster, Paddy straw, and winter mushroom)

Horticulture And Allied Sectors Mushrooms like wood ear, winter mushroom, and Shiitake were cultivated in China on wood logs more than a thousand years ago while button mushroom was cultivated in France about four centuries ago. But the scientific cultivation of mushrooms started at the beginning of the 20th century and in the initial years, button mushroom was the most important cultivated mushroom. Subsequently, a number of other mushrooms have been cultivated and today China cultivates around 60 different types of mushrooms and produces around 70% of the total mushrooms of the world. In India, we cultivate mainly four types of mushrooms viz., button, oyster, paddy straw, and milky mushroom.

The total estimated mushroom production in the country is around 4.36 lakh tonnes during 2015-16. Some of the mushrooms like truffles, morels, etc., are still collected from forests and we have not succeeded in cultivating these. People have been collecting and consuming mushrooms for centuries and their medicinal properties have also been recognized in some parts of the world particularly in China.

14.5.1 Prospects of Mushroom Cultivation as an Agribusiness Vocation

Mushroom growing requires proper knowledge of various steps of cultivation like spawn production, composting, cultivation, and processing. Due to their short shelf life, it is important to understand marketing aspects as well. World over mushroom cultivation has emerged as a major commercial activity that is undertaken on agricultural farms or commercial units established near such places. In India, mushroom cultivation in rural areas has emerged as an important activity for the educated, school dropouts, women, landless people, etc. Considering the demand for quality foods, mushroom cultivation has emerged as an important vocation. However, before taking up this venture a thorough knowledge of the subject and scientific aptitude towards agriculture is mandatory. Mushroom cultivation has all the potential of becoming an important rural industry in our country. The world mushroom industry can be classified into the trade of:

- edible mushrooms;
- medicinal mushrooms and products; and
- wild mushrooms.

More than 70 percent of the world trade is related to edible mushrooms. About 20 percent is related to medicinal mushrooms and their products and only less than 10 percent is related to the trading of wild mushrooms.

14.5.2 Why Grow Mushrooms

In the nineteenth century, we could produce food only for our survival. In the last century, we produced adequate food in many parts of the world and convenience was an important area. For example, the ready-to-cook, ready-to-eat foods were commonly available. The 21st century is going to be a century of functional foods, that is, the foods that not only meet our calorie needs but also have compounds beneficial for our health. Mushrooms are not only quality food but also a way of utilizing agricultural wastes and generating wealth from the waste. The material left after growing mushrooms, commonly referred to as spent mushroom substrate, can be processed into

manure. Thus, mushroom cultivation is an important method to promote sustainable manure based farming. The addition of spent mushroom substrate is also reported to improve soil health. The very fact that mushrooms can be cultivated on paddy straw and other agricultural wastes, many of which are just burnt, is sufficient reason to grow mushrooms. By growing mushrooms, we are not only creating quality food but are also generating a healthy environment. More importantly, it leads to employment generation and women empowerment. With increasing population, the land is shrinking and mushroom cultivation utilizes vertical space and requires minimal land making it possible to promote mushrooms in semi-urban and urban areas also. Mushrooms are considered to be the highest protein producers per unit area per unit time.

14.5.3 Types Suitable for Cultivation

India is a country of diverse climate. Temperatures vary over location and season. We have got temperate conditions in the hilly parts and the remaining part is mainly tropical/sub-tropical. There is seasonal variation in most of the areas and temperatures differ to a great extent in summers and winters. However, India has a large coastline of about 8,000 kilometers, and temperatures in areas adjoining this do not vary much. Similarly, the conditions are mainly tropical in the southernmost parts of the country. We have mushroom species that can grow below 15°C (winter mushroom), between 16-20°C (button, shiitake, king oyster, etc.), between 20-30°C (oyster and wood ear mushroom), and above 30°C (milky and paddy straw mushroom). This implies that we can grow different mushrooms in different seasons and we can also select mushrooms depending upon our location. At present the four commonly cultivated mushrooms in the country are:

- i) Button mushroom (*Agaricus bisporus*)
- ii) Oyster mushroom (*Pleurotus* spp.)
- iii) Paddy straw mushroom (*Volvariella volvacea*)
- iv) Milky mushroom (*Calocybe indica*)

The cultivation technology is available for other mushrooms like winter mushroom (*Flammulina velutipes*), wood ear mushroom (*Auricularia polytricha*), shiitake mushroom (*Lentinula edodes*), *Agrocybe aegerita*, *Macrocybe giganteum*, *Hericiium* spp., medicinal mushrooms like reishi mushroom (*Ganoderma lucidum*), and others. We will be discussing the cultivation methods of some of these.

Check Your Progress 14.5

Note: a) use the space given below for your answers.

b) Check your answer with those given at the end of the Unit.

1) What are the different types of mushrooms under cultivation in India?

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.....

14.6 LET US SUM UP

Beekeeping involves easier management practices, can be adopted by persons from all ages and walks of life irrespective of gender, is suitable also as a part-time occupation, produces no offensive smell, rather is fragrance disseminating, pollution-free, giving several valuable products, and providing hiring service for crops' pollination benefits, thus increasing crop yields. Beekeeping should be started after acquiring training from some recognized institution. Selection of suitable site for apiary and season for starting beekeeping, besides the purchase of nucleus colonies, their transportation, and their placement, are some important points which need due consideration. To make beekeeping more sustainable and to enhance its profitability, all the hive products *viz.* honey, pollen, propolis, royal jelly, beeswax, and bee venom should be planned to be harvested with their maximum yield following the product-specific technologies. The quality of these products during the production phase as well as during the post-harvest phase has to be maintained.

Sericulture is an agro-based industry related to the production of Silk. It is comprised of various activities like the cultivation of food plants, rearing silkworms, egg production, reeling & twisting of yarn thus, offering vast potentials for self-employment as a rearer, egg producer, reeler, twister, weaver, nursery grower, or supplier of articles needed by the industry. All four varieties of silk are produced in India, Muga silk being its monopoly.

Agroforestry research and development have made great strides during the 1990s in South Asian countries (**Garrity 2004**). The vision for scaling-up agroforestry in the region foresees enhanced agricultural productivity, profitability, and sustainability improving the livelihoods of rural people across the region.

Mushroom is quality food. There are large numbers of mushrooms in jungles, only a few are under commercial cultivation. Important mushrooms for commercial cultivation are the button, oyster, winter, paddy straw, and wood ear mushroom. Mushroom cultivation is one of the most profitable methods of recycling crop wastes as it not only helps in producing quality food but also helps in improving soil health by using material left after growing mushrooms. It is thus suitable both from an economic and ecological point of view. Mushroom cultivation is rapidly increasing across the world and these are going to be an important component of food in the 21st Century in all parts of the globe.

14.7 KEYWORDS

Agar: A polysaccharide derived from seaweed used for solidifying culture media.

Agroforestry: Practice of agriculture and forestry on the same piece of land

Ascomycetes: A major class of fungi having sac-like ascus in the fruit bodies

Bagasse: The crushed juiceless remains of sugarcane as it comes from the mill.

Basidiomycetes: A major class of fungi having basidia in their gills.

Bee Venom: Bee venom is the fluid synthesized in venom glands of worker bees (150-300 µg) and queen bees (700 µg), however, only the worker bees are exploited for venom production. Normal recovery of dry venom per bee is 0.5 – 1.0 µg. One million stings result in the production of 1 g dry venom.

Bioremediation: The process of correcting some harmful situations like polluted water, soils with harmful pesticides, dyes, etc. by using a biological method

Bran: The outer layer of cereal grains separated from the kernel.

Casing: The covering of compost by a thin layer of soil needed for the production of a button mushroom.

Chawki Rearing: Rearing of young silkworms up to 2nd moult.

Culture: The growing of mushroom tissue in a medium under sterile conditions.

Diapause: Stage of dormancy or reduced metabolism to avoid unfavorable weather conditions

Flush: Term used for the appearance of mushroom at intervals.

Fodder: Agricultural foodstuff used to feed domesticated livestock, such as cattle, goats, sheep, etc.

Fruit body: The sexual spore-bearing structure of fungi.

Fruiting: The process of mushroom formation and development

Functional food: Foods for special health use.

Homegardens : Practices of growing trees in the home yard.

Honey: It is a sweet viscous liquid that is elaborated by the honey bees from floral nectar and is stored in the comb cells. Generally, fructose is the dominating sugar in it. It is produced from nectar by conversion of its sucrose into fructose and glucose and concentrating it through evaporation of moisture.

Incubation: Care of eggs at optimum conditions till hatching

Moult: Process of shedding body skin to grow further

Multi-Purpose Trees: Trees that are grown for multi-purposes such as wood, fodder, soil conservation, soil reclamation, etc.

Mushroom: A macro fungus with a visible fruit body that may be formed above or below the ground.

Pollen: It is the male germplasm of floral plants and collected by bees on corbiculae of pollen-collecting legs (hind legs). Bees collect pollen from bee forage as food for the nurse bees.

Propagation: Multiplication of plants

Propolis: Propolis is sticky and resinous material, collected by foraging bees as exudates of buds, bark, and wounds of plants/trees. It is used by bees to plug the cracks and crevices in the hive, varnishing the comb surface and as a repellent against ants at the hive entrance. It is the only antimicrobial arsenal in the honey bee colony.

Horticulture And Allied Sectors Reeling: Process of unwinding silk filament from the cocoon

Royal Jelly: Royal Jelly is a mixture of clear watery secretion of hypopharyngeal glands and milky secretion of mandibular glands of nurse bees (6-13 days age) in the ratio of 1:1. It is highly nutritive food that is fed to the royal caste (queen bee) during the larval period and even during the whole of its adult stage.

Social Forestry: Growing trees to meet the livelihoods of the people

Swarming: It is a natural instinct in honey bee colonies for their multiplication. Here, the older queen bee with a large proportion of worker bees leaves the hive with a small proportion left behind with a few queen cells. Crowdedness in the colonies triggers the swarming.

Weeding: Removal of unwanted plants in a crop

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14.9 CHECK YOUR PROGRESS: POSSIBLE ANSWERS

Check Your Progress 14.1

- 1) Beekeeping covers the entire scope of management of honey bee resources, beekeeping practices, bee products, pollination services, and their interface with socio-economic, cultural, natural heritage, and environmental integrity.
- 2) Bees do a yeoman service to humanity by providing their services as efficient pollinators of the crops and thereby augment the crop yields both quantitatively as well as qualitatively.
- 3) Apiculture diversification implies enhancing the profitability of beekeeping by production and marketing of other hive products besides honey, mass rearing and breeding of queen bees for commercial purposes, and by renting out colonies for crop pollination services.

Check Your Progress 14.2

- 1) Propolis is sticky and resinous material, collected by foraging bees as exudates of buds, bark, and wounds of plants/trees. Propolis is used by bees to plug the cracks and crevices in the hive, varnishing the comb surface and as a repellent against ants at the hive entrance. It is the only antimicrobial arsenal in the honey bee colony.
- 2) Royal Jelly is a mixture of clear watery secretion of hypopharyngeal glands and milky secretion of mandibular glands of nurse bees (6-13 days age) in ratio of 1:1. It is highly nutritive food that is fed to the royal caste (queen bee) during the larval period and even during the whole of its adult stage.
- 3) Bee venom is a clear watery material having a somewhat sharp and bitter taste, hydrolytic blend of proteins with basic pH, and is used by the bees for their defense.

Check Your Progress 14.3

1. The chain of Sericulture activities includes host plant cultivation, silkworm rearing, silkworm egg production, silk reeling twisting, weaving, and ancillaries connected with manufacturing items required for various technical operations. The job avenues are in the form of rearers, seed producers, reelers, twistors, weavers, and suppliers.
2. Mulberry, Tasar, Muga, and Eri are the 4 varieties of silk. Muga is the monopoly of India

Horticulture And Allied Sectors 3. Karnataka, Tamilnadu, Andhra Pradesh, West Bengal, and J&K are the traditional mulberry silk producing states in India

Check Your Progress 14.4

- 1) The art of growing trees for production purposes is called tree farming.
- 2) Soil and water conservation, soil binding, moisture retention, nitrogen fixation, organic matter addition.
- 3) To survey the forest cover and assess its status from time to time using remote sensing, ground truthing, and other geospatial measures.
- 4) (a) International Centre for Research in Agroforestry
(b) Indian Council for Forestry Research & Education

Check Your Progress 14.5

- 1) There are four types of mushroom under cultivation in India. These are button mushroom, oyster mushroom, milky mushroom, and paddy straw mushroom.



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