BLOCK 4
ALLIED SECTORS

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UNIVERSITY

BLOCK 4 INTRODUCTION

It comprises three units.

Unit 14 covers the details of **'Livestock Enterprises'**. It discusses the importance of livestock in the Indian economy and the principles and pillars of livestock management. It discusses the management of different livestock species. A brief information is provided about poultry and fish farming. The complete information on the Indian livestock industry is added in this unit. It includes detailed information on breeds, nutrition, housing and health care of livestock.

Unit 15 is on **'Fisheries'** covering different aspects of inland fisheries, marine fisheries, brackish water, ornamental, and aquaculture. This unit includes the overall scenario of the Indian fisheries sector and its contribution to the Indian economy. The different types of fishery resources are classified. Major characteristics of the inland, marine, brackish water, cold water, ornamental fisheries and aquaculture are described in this unit.

Unit 16 discusses the **'Subsidiary Enterprises'** including the apiculture, sericulture, mushroom production and agro-forestry. It details the importance and scope of apiculture and describes the hive products and strategies for honey marketing. It describes different components of the sericulture industry and explains the various types of silkworms and their rearing technology. The scope, benefits, and types of agroforestry-based industries are also described. The information on the importance and different types of mushrooms under cultivation is also included.

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 a 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.

UNIT 14 LIVESTOCK ENTERPRISES

Structure

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14.0 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.

14.1 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 practised by much 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 practised by small and marginal farmers having landholding of 1 to 2 acres maintaining 2 to 3 animals. Livestock acts as a continuous source of income for farmers, reduces seasonality in livelihood patterns of the rural mass and 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 eggs. 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.

14.2 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 for 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 or bullocks, male buffaloes, camel, horses, and donkeys. Animal dung/faeces act as fuel for cooking as well as nourishing the soil. For cooking it is used in the form of Dung cake and *Gobar* gas. Further, for crop production dung/ faeces is added to soil in the form of manure or fertilizer to supply nutrients to the plants.
- ***Fiber and Hide:*** The livestock also contribute 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 dead or slaughtered animals in the form of bones, horns, hoof, animal fat (tallow from cattle, lard from pig) and several products for pharmaceutical and industrial use.
- ***Land Management:*** Livestock are used as biological control of bushes 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 is considered as 'moving banks' because of their potential to be disposed of 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).

14.2.1 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 20thLivestock 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 the National Statistical Office (NSO), MoSPI data (2021), the Gross Value Added (GVA) of the livestock sector was about Rs. 9,62,682 crores during 2019-20, being about 28.36% of the 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 is 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 Exercise 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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14.3 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 management 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.

14.3.1 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 Hariana, 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, Kilakarisal, Madras Red, Mandya (Bannur, Bandur), Mecheri (Maiylambadi, Thuvaramchambali), Nellore, Ramnad White, Tiruchi Black, and Vembur (Karandhai). Some popular wooly 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 breedsare Black Bengal, Kannaiadu, Kutchi, Ganjam (Dalua), and Tellicherry.

- ***Pig Breeds:*** Most of the pigs you see on the roadside are small and non-descript or indigenous animals that do not have specific characteristics. Important exotic pig breeds of commercial importance are Large White Yorkshire, Landrace, Hampshire, Berkshire, and Duroc, etc.
- ***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.

14.3.2 Nutrition

Livestock feed provides 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 costs constitute 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 fibre 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 fibre content (more than 18%), *e.g.,* 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, for 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 of 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”.

14.3.3 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 to provide 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 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 practised in Cattle and Buffaloes, *viz.* loose houses and conventional barns. In loose

housing, animals are kept loose in an open paddock throughout the 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 conventional 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 suitable for the temperate Himalayan region and cooler parts of the country. A house in which sheep are maintained is called a 'Pen' or 'shed'. Normally, sheep do not require elaborate housing facilities, but minimum provisions will increase productivity, especially protection against extreme weather conditions and predators. A house in which goats are maintained is called a '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'.

14.3.4 Health Care

As we suffer from many health ailments, animals are also get affected by various diseases. These diseases are caused by micro-organisms/microbes and parasites that 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, *etc*.

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, *etc*. 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 that 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, and Finrot, *etc*.

Check Your Progress Exercise 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 _____.

14.4 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 buffaloes or water spraying on their bodies will keep the buffaloes comfortable, especially during the 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) Newborn 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' bodies.
- The navel cord of the calf should be tied 2.5 cm away from its body and cut about one centimetre 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 as they can eat.
- The size rather than the age of a dairy heifer at the breeding time is important. Breeding under-sized animals is 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 the 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 exercise.
- 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 mating a day is optimum.

Check Your Progress Exercise 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 …….. keeps them comfortable, especially during summer.

   iv) …….. should receive plenty of exercise.

2) Briefly describe the care and management of a newborn calf.

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14.5 SHEEP, GOAT AND PIG FARMING

Sheep are mostly reared by small and marginal farmers having landholding of 0.5 to 2 acres. They are easily manageable and require low initial investment and working capital as they require minimal housing and can be maintained through grazing. The goat is considered a "poor man's cow" since it provides livelihood and nutritional security to small and marginal farmers with minimum investment and management. Goats can be managed only by browsing and can yield 0.5 to 1 litre 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.

14.5.1 Care and Management of Sheep and Goat

The management procedure varies at each stage in the life of sheep and goats. The different management 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 ensures 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. Rams worry about the ewes and interfere in their grazing.
- Do not handle the pregnant ewes or do it too frequently.
- Separate the advanced pregnant ewes or does from the main flock and take effective care of 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 to ensure 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 centimetre 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 gastro-intestinal 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.

14.5.2 Care and Management of Pigs

The management 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 the 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 they 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 Exercise 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) The gestation period of Sheep and Goats ranges 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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14.6 POULTRY FARMING

'Poultry' refers to domesticated birds which are reared for their flesh (meat), eggs, and feathers and it includes several 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 practised 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 management techniques followed to increase the net profit. Poultry is also best suited for the mixed farming system by integrating different components like 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 to provide water and some feed. The "Intensive" system is the most

common housing system practised by commercial poultry farmers where the birds are indoors. Deep litter and cage systems are the most prevalent intensive systems of rearing chickens. In the Deep litter system, which is mostly practised in broiler farming, birds are left free on the floor. Whereas layers are reared mostly 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.
- Chicks cannot maintain body temperature soon after they are hatched. Hence, brooding (providing 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 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 a "Brood-grow house" (BGH) and later on shifted to a "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.

14.7 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*. *e.g.,* 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. *e.g.,* Mullets; Milkfish, sea bass, Tilapia, pearl spot, *etc*.
- Marine fishes: Marine cultivable fishes thrive/ spend all their life cycle in high saline seawater. *e.g.,* 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 a culture system; ii) Biculture: wherein a carnivorous fish is grown along with another species; iii) Polyculture: Farming of more than one species together on 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*** 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 a unit area. This varies with regard to species and the type of grow-out system. The stocking rate depends on many factors such as the fertility of water, rate of water exchange, and availability of natural food, *etc*. When the farmed fish reach marketable size, they must be harvested. The marketable size of farmed fish also depends on the local needs /tastes 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, fish 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 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 Exercise 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 the start of lay in _____ and later shifted to _____.

   iii) _____ is farming 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.

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3) Explain the harvesting of fish.

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14.8 LET US SUM UP

Livestock acts as a continuous source of income to farmers, reduces the seasonality in livelihood patterns of the rural mass and helps in counteracting the income loss due to crop failure. Livestock produces several useful commodities and services, *viz*. nutritious food, energy, power, fuel, fibre/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 practised for 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 the 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.

14.9 KEYWORDS

Ad libitum: 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 is rich in antibodies that confer passive immunity to the newborn.

Concentrate: A feed that is rich in energy, low in fibre 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 returning 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 who 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 and 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

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14.11 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercises 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, fibre and raw materials.

Check Your Progress Exercises 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 Exercises 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 centimetre 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 Exercises 4

1) i) Ewes
   ii) 3 to 3½
   iii) 142 to 150
   iv) guard rails

2) A 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 Exercises 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 chickens. In the Deep litter system, which is mostly practised in broiler farming, birds are left free on the floor. Whereas layers are mostly reared in a cage system in which birds are restricted to meshwork compartments (cages).

3) Harvesting can be partial or complete. In partial harvest, only those fishes which have attained marketable size are 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 used in developed countries.

ignou THE PEOPLE'S UNIVERSITY

UNIT 15 FISHERIES

Structure

15.0 Objectives

15.1 Introduction

15.2 Inland Fisheries

15.3 Marine Fisheries

15.4 Brackish Water and Saline Fisheries

15.5 Cold Water Fisheries

15.6 Ornamental Fisheries

15.7 Aquaculture

15.8 Let Us Sum Up

15.9 Keywords

15.10 Suggested Readings/ References

15.11 Answers to Check Your Progress Exercises

15.0 OBJECTIVES

After reading this unit, you will be able to:

- describe the overall scenario of the Indian fisheries sector and its contribution to the Indian economy;
- classify different types of fishery resources;
- differentiate between different types of fisheries; and
- explain the salient features of inland, marine, brackish water, cold water, ornamental fisheries and aquaculture.

15.1 INTRODUCTION

Indian fisheries and aquaculture are important sectors of food production, providing nutritional security to the food basket, contributing to agricultural exports, and engaging more than 14 million people in different activities. With diverse resources ranging from deep seas to lakes in the mountains, the country has shown continuous and sustained increments in fish production since independence. Constituting around 8% of the global fish production, the sector contributes 1.24% to the country's Gross Value Added (GVA) and over 7.28% to the agricultural GVA. The total fish production of 16.25 million metric tonnes during 2022-23 has nearly 75% contribution from the inland sector (12.12 MMT) including culture fisheries (DoF, 2023).

Do you know about the activities involved in the fisheries sector? Fisheries is an economic activity that involves harvesting fish or any aquatic organism from the wild (Capture Fisheries) or raising them in confinement (Culture Fisheries/ Aquaculture). It may be Traditional/ Small Scale Fisheries (SSF) for sustenance, or Large-Scale/ Commercial Fisheries for profit. Fish (in

general) a cold-blooded aquatic organism that breathes with gills and swim with fins; they are categorized as Finfish and Shellfish. Finfish are cold-blooded aquatic vertebrates that have gills, fins with rays, and scales covering the body. Shellfish are cold-blooded aquatic invertebrates that have gills, various types of locomotor organs, and a shell/ exoskeleton covering the body. They include crustaceans and molluscs.

India is the 3rd largest fish producing and 2nd largest aquaculture nation in the world after China. The country is also home to more than 10% of the global fish biodiversity in terms of fish and shellfish species and is one of the 17 mega biodiversity-rich countries. Andhra Pradesh is the largest fish producer in the country, followed by West Bengal and Gujarat. More than 50 different types of fish and shellfish products are being exported to 75 countries around the world. With high growth rates, the different facets of marine fisheries, coastal aquaculture, mariculture, inland fisheries, freshwater aquaculture, and cold water fisheries are increasingly being diversified, contributing to food, health, economy, exports, employment, and tourism of the country. The country has 429 Fish Farmers Development Agencies (FFDAs) and 39 Brackish Water Fish Farmers Development Agencies (BFDAs) for promoting freshwater and coastal aquaculture. Along with food fish culture, ornamental fish culture, and high-value fish farming are gaining importance in the recent past.

During 2021-22, the export of marine products stood at 1.37 MMT (million metric tonnes) and was valued at Rs. 57,586.48 Crores (USD: 7.76 billion) with an impressive average annual growth rate of about 10% in recent years. USA continued to be the major importer of Indian seafood with an import worth USD 3371.66 Million, accounting for a share of 43.45% (DoF, 2023). Paradigm shifts in terms of increasing contributions from the inland sector and further from aquaculture are significant over the years.

India has a large number of finfish species. As per the database of the National Bureau of Fish Genetic Resources (NBFGR), Lucknow, a total of 2,508 species of native finfish have been recorded, of which 1,518 species are from the marine environment, 113 from brackish water and 877 from freshwater habitat. In addition, 291 exotic fish species also occur. The Indian fishery resources (both inland and marine) are presented in Table 15.1:

Table 15.1: Marine and Inland fishery resources of India

1.	Length of the coastline (km)	8118
2.	Exclusive Economic Zone (million sq. km)	2.02
3.	Continental Shelf Area (‘000 km)	506
4.	Length of Rivers, Canals (km)	1,91,024
5.	Brackish Water Area (million ha)	1.23
6.	Reservoirs Area (million ha)	3.15
7.	Tanks and Ponds (million ha)	2.25
8.	Beels, Oxbow, and Derelict Waters (million ha)	0.82
9.	Marine Fish Potential (million tonnes)	4.41

10.	Inland Fish Potential (million tonnes)for the next five years - 2028	20.0
11.	Estimated Fish Production (million tonnes) 2022-23- **Marine** **- Inland**	4.13 12.12
	TOTAL(million tonnes)	16.25

15.2 INLAND FISHERIES

The fisheries sector is considered a sunrise sector and is poised to play a significant role in the Indian economy shortly. In the recent past, Indian fisheries have witnessed a paradigm shift from marine-dominated fisheries to inland fisheries, with the latter emerging as a major contributor of fish production from 36% in the mid-1980s to 70% in the recent past. Within inland fisheries, a shift from capture to culture-based fisheries has paved the way for a sustained blue economy.

Having learnt about the fisheries sector and its contribution, can you identify the inland fishery resources? Yes. The inland capture fishery resources comprise rivers and canals, estuaries, floodplains, wetlands, lagoons, and reservoirs and this sector holds enormous production potential to meet the inland fish requirements of the country. The river system of the country comprises 14 major rivers (catchments >20,000 km), 44 medium rivers (catchments 2,000 to 20,000 km), and innumerable small rivers and desert streams. Different river systems of the country having a combined length of 29,000 km provide one of the richest fish genetic resources in the world.

Riverine fisheries: India is bestowed with 14 major, 44 medium, and numerous minor rivers. For optimally harnessing the potential of riverine fisheries, the focus is on the conservation of indigenous fisheries resources and restoration of natural productivity by the practice of river ranching and the Conservation and Awareness in Riverine Fisheries program sanctioned under the Blue Revolution flag. Production of native species in the rivers by seed ranching of native stock, upgradation of riverine landing centres and instruments to provide financial assistance for fishermen's wellbeing are being targeted.

Reservoirs constitute the single largest inland open-water fishery resource both in terms of resource size and productive potential. Reservoirs are large areas of water bodies contributing significantly to total inland fish production. The area under reservoirs is expected to reach 6.0 million ha in another two decades from the current 3.15 million ha. The present fish production from reservoirs is estimated at 0.94 lakh tonnes with over 79% contributed by small reservoirs followed by large (14%) and medium (7%) reservoirs. At the present level of management and utilization, reservoirs yield an average of 20 kg/ ha/year which is far below the potential.

In recent years, the implementation of cage culture technology has contributed around ~3.81% of the total inland fish production. Many measures have been taken for the promotion of cage culture in reservoirs in a

sustainable manner for optimizing production through culture-based fisheries in small and medium reservoirs. To harness the full potential of all the reservoirs, the government has focused on increasing current fish production through cage culture of 2.44 lakh MT to 6.29 lakh MT by 2024-25 by tapping a minimum of 60% of the reservoirs and boosting the productivity of all types of cages (small/medium and large).

The floodplain lakes are primarily a continuum of rivers Ganga and Brahmaputra. These are in the form of oxbow-lakes (Mauns, Chaurs, Jheels, and Beels as they are called locally), especially in the states of Assam, Manipur, West Bengal, Bihar, and eastern Uttar Pradesh. These are mainly located in the States of Assam, West Bengal, Bihar and Uttar Pradesh. These water bodies are extremely rich in nutrients. The floodplain wetlands are lying uncared for and are in the process of swampification. These can yield more than one tonne of fish per ha on average if subjected to scientific management. Therefore, a vast untapped production potential is yet to be harnessed in floodplain wetlands. The estuarine systems (2.7 million ha) are identified as an important source of fish and shrimp seed. These are vital for fisheries of both riverine and marine sectors.

Scientific management of these water bodies through a selection of the right species and stocking, stock manipulation, fishery regulations, harvesting schedules, adoption of pen and cage culture technologies, and development of the package of practices for different categories of reservoirs would help in increasing fish production. Indian upland fishery waters include rivers, natural lakes, and reservoirs. The capture fisheries of these waters are poorly developed. These are characterized by low primary productivity of resources, slow growth rate of fish, inefficient fishing practices, and inaccessibility of fishing sites.

Although inland fisheries and aquaculture have grown in absolute terms, the development in terms of its potential is yet to be realized. The unutilized and underutilized vast and varied resources, in the form of rivers and canals, floodplain lakes, ponds and tanks, reservoirs and brackish water resources offer great opportunities for enhanced production along with livelihood development and accompanying economic prosperity. Recognizing the importance and potential of the fisheries sector, the Government of India approved the flagship scheme, Pradhan Mantri Matsya SampadaYojana (PMMSY), in May 2020 under the Aatmanirbhar Bharat COVID-19 relief package with a vision to bring about 'Blue Revolution' through the sustainable and responsible development of fisheries sector.

Wetlands: Wetlands are regions where water plays a major role in regulating the surrounding ecosystem, along with the plant and animal life that it supports. Where the water table is at or close to the surface of the land, or where the land is submerged in water, they develop. Wetlands are characterized as "lands bridging terrestrial and aquatic ecosystems when the water table is typically at or near the surface or the land is covered by shallow water". There are several types of Wetlands in India:

- **Coastal wetlands:** They are found in places like shorelines, beaches, mangroves, and coral reefs that are between the land and the ocean but

are not affected by rivers, *e.g.,* Mangrove wetlands of Sundarbans (Fig. 15.1).

Fig. 15.1: Sundarban wetland

- **Shallow lakes and ponds:** They are regions with little flow and persistent or semi-permanent water, *e.g.,* vernal ponds, spring pools, and salt lakes.
- **Marshes:** These are characterized by herbaceous (non-woody) flora that is acclimated to moist soil conditions and are occasionally saturated, flooded, or ponded by water.
- **Swamps:** Trees and shrubs predominate above them, which are mostly nourished by surface water sources. Swamps can be found in saltwater or freshwater floodplains.
- **Estuaries:** A very diverse range of biodiversity can be found in the region where rivers meet the sea and the water transitions from fresh to salt.

The natural wetlands of the country are being developed by keeping the ecological integrity of important natural wetlands through the promotion of sustainable fishing practices.

Some of the common major cultivable fishes are presented below (Fig. 15.2):

Fig. 15.2: Major cultivable fishes

Activity 15.1:

Collect comprehensive information from different sources regarding the fisheries sector of India, particularly the inland fisheries sector which contributes significantly to the development of the socio-economic conditions of the country as well as the fishing industry.

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Check Your Progress Exercise 1

Note: a) Use the space below for your answer.

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

1) What is the contribution of the fisheries sector to the Indian economy?

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2) Differentiate between the reservoirs and floodplain lakes.

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3) List any two Indian and two exotic cultivable fishes.

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15.3 MARINE FISHERIES

Marine fisheries play a pivotal role in ensuring the food and nutritional security of the growing population, employment generation, enhanced income, and foreign exchange earnings. It was only after the establishment of the Central Marine Fisheries Research Institute (CMFRI), Kochi, Kerala in

1947, that marine fisheries development was put on sound footing. In earlier years, the emphasis on the marine fishery sector was on the mechanization of indigenous crafts, the introduction of mechanized fishing boats, improvements in fishing gears, and the establishment of infrastructure facilities such as processing plants, ice plants, cold storage, and landing and berthing facilities. These programs, backed by the discovery of rich fishing grounds in inshore waters paved the way for the establishment of Sea Food Exports Industries. In the recent past, the above programs were continued with greater emphasis on the introduction of mechanized fishing boats and the adoption of synthetic materials for fishing gear.

With the declaration of an Exclusive Economic Zone of 200 miles in 1976, the programs relating to deep-sea fishing were intensified. While in the fifties and sixties, mechanized boats with trawl nets and motorized indigenous crafts were introduced for efficient harvests from the inshore region, in the seventies, purse-seines were introduced along the southwest coast. These developments resulted in the expansion of fishing areas and an increase in production. Improved harvesting technologies coupled with the increasing demand for fish for domestic and export markets have resulted in a significant increase in production over the last fifty years. However, the intense exploitation of resources in coastal areas up to 50 meters by the artisanal and small-mechanized fishing sector resulted in the annual catch plateauing, with a decrease in catch per unit effort. While the contribution of the artisanal sector to the total production was significant in the sixties, their contribution at present is low (only 13%) and the mechanized and motorized sector contribute 87% of total production. Technological research in the fisheries did not receive much attention in India until the establishment of the Central Institute of Fisheries Technology (CIFT), Kochi, Kerala; which gave a foundation for research in the design of various fishing crafts, gears, fishing techniques, methods of handlings, and post-harvest processing and utilization.

Initially, the motorization of indigenous crafts was taken up as a first step of mechanized fishing. Subsequently, several designs of small, medium, and larger-sized mechanized boats were introduced into the fishing industry. Fish detection facilities were introduced in large boats with facilities for proper gear handling to enhance their efficiencies. Various designs and sizes of mechanized crafts were introduced besides specialized fishing vessels like trawling cum-fish carrying, trawler-cum-purse-seiner boats for long-line fishing and trolling. Gear designing was given greater emphasis for enhancing the production from the mechanized vessels and diversification of fishing activities. The introduction of gears like, purseine trawl and bulged-belly trawl could increase the catching efficiency by about 30%. The use of non-rotting synthetic fibre in fishing gear was another significant development. Of late, the use of mechanical fishing accessories, ancillary fishing equipment, and electronic testing devices of practical value in fishing operations have also added a new dimension for enhancing the catch per unit effort of specific gear and craft.

An increase in the fishing intensity, declining stocks, conflict between the fishing sectors, decreasing catch rate, decreasing recruitment, inappropriate

exploitation patterns, habitat degradation, and resource degradation have been identified to be the major problems of coastal fisheries, presently. Several regulatory measures like, regulation of mesh size, regulation of fishing areas, seasonal closure of fishing, ban of the destructive gears, promotion of marine sanctuaries, promotion of artificial reefs and sea ranching, effecting code of conduct for responsible fishing have to be implemented to ensure sustainable growth in this sector. Contributed by major fish species like Oil Sardine, Mackerel, Bombay duck, Pomfrets, and shrimp (Fig. 15.3), the total catches from the wild have gone up from 0.53 million tonnes in 1951 to about 4.13 million tonnes in 2022-23.

Anchovies

Bombay duck

Indian Mackerel

Indian Tuna fish

Oil sardine fish

Fig. 15.3: Marine fishes of India

Fish production from the open seas has been stagnating since the last more than a decade and marine fisheries are still restricted to the nearshore areas. Marine capture fisheries play a vital role in India's economy. The sector provides employment and income to nearly four million people. During the last decade, marine fish production has reached a plateau. The present scenario suggests that the current level of marine fish production from the exploited zone has to be sustained by closely monitoring the landings and the fishing efforts and by strictly implementing scientific management measures to fish those resources to increase fish production from the marine sector, the industry needs ocean-going vessels and sophisticated onboard facilities that are capital-intensive. The major marine fish resources of India are given below:

ANCHOVIES	**EPEOIDS**	**MULLETS**
BARRACUDAS	**FLAT FISHES**	**LONG TAIL TUNA**
BOMBAY DUCK	**SEER FISHES**	**CATFISHES**
LIZARD FISHES	**INDIAN MACKEREL**	**SHRIMPS**
CARANGIDS	**SHARK**	**YELLOWFIN TUNA**
CROAKERS	**INDIAN OILSARDINE**	**RAYS**

Mariculture: Mariculture involves the cultivation of marine organisms in seawater for food and other products either in the open ocean, an enclosed section of the ocean, or in tanks, ponds, or raceways. Examples of mariculture include the farming of marine finfish, and shellfish, *e.g.,* shrimps, lobsters or oysters, mussels, and seaweeds, *etc*. Non-edible products produced by mariculture include fishmeal, nutrient agar, ornaments and jewellery (*e.g.* cultured pearls), and cosmetics. In the world scenario, the contribution of India to mariculture production is very negligible.

Mariculture is expected to be a major activity in the coastal areas in the years to come. Given the wide spectrum of cultivable species and technologies available, the long coastline, and the favourable climate, mariculture is likely to generate considerable interest amongst the coastal population. At a time when we speak of over-exploitation in the near-shore waters, limited access to capture fisheries, and the need for diversification, mariculture can be one of the most appropriate alternatives. Technologies for a couple of species are presently available in the country and there is an urgent need for developing a package of practices for many more commercially important species.

The Central Marine Fisheries Research Institute (CMFRI), Kochi, Kerala is the pioneer in mariculture research in India, and many technologies have been developed by the Institute during the last five decades. Though efforts to popularize these technologies were undertaken in the States of Kerala, Karnataka, Goa, Maharashtra, and Tamil Nadu, a quantum leap in mussel production was observed only in the state of Kerala mainly due to the preference for mussel meat in Kerala. Edible oyster farming (Fig. 15.4) practised on a very small scale at certain locations in Kerala also requires to be expanded.

Fig. 15.4: Oyster farming in the open sea

Among the crustaceans, shrimp (Fig. 15.5) has been produced in the coastal ponds in the country and about 100,000 tonnes of American White Shrimp (*Penaeusvannamei)* is produced in the country outpacing the Tiger Shrimp (*P. monodon)*. However, the two promising marine crustacean species are the Blue Swimmer Crab (*Portunuspelagicus)* and the Sand Lobster (*Thenusorientalis*). Though seed production of these species has been developed by CMFRI, commercial-level seed production technology for both species is yet to be achieved. The marine ornamental fish industry has been expanding globally in recent years and about 20 to 25 million marine ornamental fishes are traded annually.

Fig. 15.5: Shrimp Aquaculture Farming

Nearly 98% of the marine ornamental species marketed are wild, collected mainly from the coral reefs of tropical developing countries. This has been demonstrated as a viable enterprise in India threatening the long-term sustainability of the trade due mainly to indiscriminate exploitation of coral reef areas, leading to the degradation of coral reef habitat and overexploitation of desired species. CMFRI has also pioneered open sea cage culture (Fig. 15.6) during the last decade and has standardized cage design and mooring for Indian waters.

Fig. 15.6: Cage culture for raising fish in open seas

Many species of finfish like, Asian sea bass, cobia, mullets, and pearl spots were successfully reared in cages in different maritime states of the country. Among shellfish, capture-based aquaculture of spiny lobsters is found to be highly profitable. An object-oriented development approach, coupled with appropriate policy formulations can lead to the emergence of mariculture as a substantial contributor to the seafood production of the country.

Check Your Progress Exercise 2

Note: a) Use the space below for your answer.

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

1) Give the importance of marine capture fisheries in the Indian economy.

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2) Define mariculture with examples.

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3) Name any two marine fishes of India.

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15.4 BRACKISH WATER AND SALINE FISHERIES

Coastal Aquaculture production in the country is largely on account of shrimp farming. It is estimated that, out of about 1.23 million ha identified as potential areas for brackish water fish farming in the country, about 10% area is being farmed at present. Of this area, about 80% is under a traditional farming system and the remaining is under extensive and semi-extensive shrimp farming. At present, about 300 shrimp hatcheries are operational with a total production capacity of 12 billion post-larvae (PL 20)/year, mostly in the private sector. The coastal aquaculture-farmed shrimp production has increased from 40,000 tonnes in 1991 to 8.0 lakh tonnes in 2021. This contributes to the bulk of the Indian shrimp exports.

The Brackish water resources comprise estuaries (deltaic river mouths), coastal lagoons, lakes, backwaters, tidal creeks, canals, mudflats, mangrove

plants, *etc*. These water bodies lying between the freshwater and marine regimes have certain characteristics, fluctuating water levels synchronizing with the tides, a wide salinity range of 0-35 ppt (parts per trillion), higher nutrient content, and productivity, and serve as nursery grounds for numerous marine organisms, harbour a rich diversity of flora and fauna, and support artisanal capture fisheries and provide a livelihood to the coastal fishers.

The tidal currents carrying with them the juvenile fish and shrimp, and the rising and falling water level formed the basis of traditional brackish water fish and shrimp farming practices in the Bheries of West Bengal and Pokalli paddy fields of Kerala. Scientific brackish water aquaculture started around the 1980s, wherein shrimp were cultured in well-designed and managed ponds as there was high demand for them in the export market. At present around 0.16 million ha are under shrimp culture. Andhra Pradesh and West Bengal States are the chief producers of shrimp, accounting for about 80% of the total country's production. However, of late, the culture of high-value euryhaline marine fish species is being undertaken in brackish water ponds and cages to meet the demand in the domestic market. The most commonly cultured fishes are Mullets, Milkfish, Sea bass (Fig. 15.7), Pompano, Grouper (Fig. 15.8), *etc*.

Fig. 15.7: Asian sea bass fish

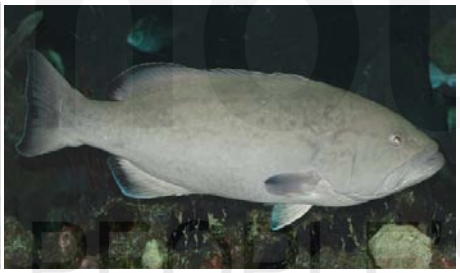

Fig. 15.8: Grouper fish

15.5 COLD WATER FISHERIES

India is bestowed with vast and varied cold water resources with valuable indigenous fish germplasm and pristine water with a range of thermal regimes. Hence the Himalayan states offer a unique value proposition in Cold Water Fisheries. India has significant resources in terms of upland rivers/streams, high and low altitudes of natural lakes in addition to man-made reservoirs existing both in Himalayan regions and the Western Ghats. Coldwater fishes occupy an important place amongst the freshwater fishes of India. The Coldwater fisheries deal with the activity in water where the temperature of water ranges from 5 to 20 degrees centigrade. The gills of the cold water fish are greatly reduced and the gill openings are smaller in size for adaptation to cold temperatures.

Important Coldwater fishes of India are Mahseer (Fig. 15.9)- Deep Bodied Mahseer, Golden Mahseer, Deccan Mahseer), Snow Trout (Fig. 15.10)- Common Snow Trout and Chirruh Snow Ttrout, Mountain Trout - Vagrabaril, Indian Hill Troutand other fish such as Catfish, Red-tailed Garra, Mountain Labeo, Assamese Kingfish, Gangetic Latia/Stone roller, *etc*. There are 16 big and small rivers in the Himalayan and peninsular regions having an area of about 3,885 km. Apart from these rivers, the area of natural lakes

is 20,500 hectares. The man-made reservoirs are spread over an area of 2,65,000 hectares. Fish culture has been successfully carried on in certain lakes and reservoirs of J&K, Himachal Pradesh, Uttarakhand, Nagaland, Meghalaya, Arunachal Pradesh, Tamil Nadu, and Kerala. The Government of India established the National Research Centre on Cold Water Fisheries (NRCCWF), Bhimtal, Uttarakhand. It has played a significant role in the improvement and conservation of indigenous as well as in the establishment of exotic species in this region. The biological functions of fishes at high altitudes depend upon several factors resulting in different adaptations. The torrential streams of water in mountains contain rich oxygen (7.8 to 10.2 ppm) and low carbon dioxide, the parameters of which are most important for the growth of fish.

Fig. 15.9: Mahseer fish

Fig. 15.10: Trout

To harness its potential, the government has focused on increasing current cold-water fish production to 90 thousand MT by FY 2024-25. Cold water fisheries have also been instrumental in creating employment opportunities and targets at doubling the engagement across the focus States/UTs. Additionally, cold water fisheries are being promoted as a *niche* market by promotion of omega-packed trout in all Himalayan States/UTs by targeting 10 thousand MT of Trout production.

- **Coldwater fishery resources** encompass high and mid-altitude lakes, rivers, streams, and manmade reservoirs. According to conservative estimates, the riverine stream length holding Coldwater fisheries in the two mountainous zones trained by the Indus and its tributaries (Jhelum, Chenab, Ravi, Beas, Sutlej, Bhagirathi, and Alaknanda) is about 7,000 km. The fishable streams length of hill streams in the North-West and eastern Himalayas has been estimated as 3,200 km. Further, there are a large number of natural lakes located in the uplands of Jammu and Kashmir, Himachal Pradesh, Uttrakhand, Arunachal Pradesh, and Sikkim. These natural eco-tops are virtually dotted all over the hilly terrain of these states and they hold rich ichthyofauna of both commercial and sport fishes. While there exists a vast scope for the development of cold water fisheries both on grounds of logistics and economics, these resources have largely remained untapped mainly due to a lack of development and scientific efforts.

The current fishing activities in the hills are limited to fishing/ angling by individual fishermen in the rivers and streams and are hardly of any commercial importance. The successful evolvement of technology of commercial Rainbow Trout Farming in Jammu & Kashmir and Himachal Pradesh has opened tremendous potential in exploiting various hilly rivers and streams flowing in the foothills of the Himalayas. Similarly, the successful Running Water Fish Culture Programme being carried out by monoculture of mirror carp in the hill states has given a new impetus to the aquaculture promotion programme in the uplands. The expansion of both

these programs could go a long way not only in boosting fish production in the Himalayan states but also in the generation of large-scale employment for hill inhabitants.

India has around 2.25 million ha of Tanks and ponds area where culture-based fishery is predominant and contributes to the maximum share of total fish production. The current production from tanks and ponds is 8.5 million MT. As a major contributor towards production, the government now has prioritized expanding the horizontal area under tanks and ponds to achieve a target production of 13.5 million MT.

Check Your Progress Exercise 3

Note: a) Use the space below for your answer.

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

1) Name any three brackish water resources.

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2) Define cold water fisheries. Give its importance.

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3) Name any two fishes commonly (each) cultured under brackish water and cold water fisheries in India.

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15.6 ORNAMENTAL FISHERIES

Ornamental fish culture is the culture of attractive, colourful fishes of various characteristics, which are reared in a confined aquatic system. Farmers and hobbyists mainly grow them. Ornamental fishes are also known as "living jewels". Ornamental fishes of India contribute about 1% of the total ornamental fish trade. India has great potential in ornamental fish production due to the presence of a rich biodiversity of species, favourable climatic conditions, and the availability of cheap labour. Kerala, Tamil Nadu, and West Bengal mainly practice ornamental fish farming in India.

The ornamental species are categorized into indigenous and exotic. The availability of a vast number of native species has contributed significantly to the development of the ornamental fish industry in the country. North-eastern states, West Bengal, Kerala, and Tamil Nadu are blessed with potential indigenous species. The north-eastern states contribute around 85% of the total market and the rest comes from the southern states of India. The ornamental fish exports from India showed an increasing trend and exponential growth over the years. The share of India in world ornamental fish exports fluctuated and remained at less than one per cent for most of the years. About 90% of native species are collected and reared to meet export demand. Presently, nearly 100 native species are reared as aquarium fish. There is also a great demand for exotic species due to their colour, shape, and appearance.

More than 300 exotic species are covered in the ornamental fish trade. About 200 species are bred in India. And 90% of India exports go from Kolkata followed by 8% from Mumbai and 2% from Chennai. There are more than 30,000 fish species reported around the world, of this about 800 belong to ornamental fishes which come under eight closely related families. Most of the ornamental fishes survive in the freshwater. The northeast region is known as a repository (74%) of the ornamental fishes. Some of the important species are Ornamental Goldfish, Rosy Barb, Golden Barb, Silver Barb, Goldfish, Zebra Fish, Blue Perch, *etc*.

Aquarium fishes are mainly categorized into two groups, *viz.* oviparous (egg layers) and ovoviviparous (livebearers). The majority of aquarium species are egg layers and normally external fertilization occurs. Based on this, it is again categorized into the following types:

1. Egg scatter laying non-adhesive eggs
2. Egg scatter laying adhesive eggs
3. Egg buriers
4. Mouth incubators
5. Nest-builders and
6. Egg-carriers

The potential of streams and rivers of the Western Ghats as a rich source of ornamental fish is yet to be recognized. About 80% of ornamental fishes are from freshwaters and the rest are from brackish and marine waters. Most of the ornamental species are warm water tropical, except some eurythermal carps like, goldfish, and koi, which are cold temperate in origin and now have a worldwide distribution. Ninety per cent of the freshwater ornamental species are farmed and wild species through capture are only 10%. In the case of marine and brackish water species reverse is the case.

In contrast to freshwater ornamental fishes, marine ornamental fishes are the most popular attractions worldwide due to their adaptability to live in confinement. The variety of shapes, sizes, colours, behaviour, and ecology exhibited by reef fishes is amazing. In the Gulf of Mannar, a total of 113 marine ornamental finfish species have been recorded under 24 families.

Potential marine ornamental fish species resources are Clown Fish, Lion Fish, Parrot Fishes, Trunk Fishes, Marine Angels, Butterfly Fish, Cardinal Fishes, Unicorn Fish, Rabbit Fish, Squirrel Fish, Scorpion Fish, Sand-smelt Fish and Seahorse.

Ornamental fisheries have immense export potential; it is a multi-billion industry spread across more than 125 countries with trade at a retail level worth US $10 billion. To put India at the forefront of ornamental fisheries (Fig. 15.11), the Government is making efforts for holistic development of the sector through the creation of ornamental fish clusters in selected inland and marine areas. Focus is also being given to promoting public-private partnerships for the establishment of various fish production units to make the sector vibrant and remunerative. The scheme has already started demonstrating tangible benefits by adopting a participatory approach.

Fig. 15.11: Ornamental fishery in India

15.7 AQUACULTURE

Indian fisheries and aquaculture is an important sector of food production, providing nutritional security to the food basket, contributing to agricultural exports, and engaging about 14 million people in different activities. The total fish production of 16.24 million metric tonnes presently has nearly 65% contribution from the inland sector and culture fisheries constituting about 6.3% of the global fish production. Aquaculture production has been broadly classified into mariculture, brackish water culture, and freshwater culture.

Aquaculture in coastal areas is normally considered part of brackish water aquaculture while aquaculture activities in cages or pens set in bays and lagoons are considered part of mariculture activity. In terms of aquaculture production in quantity during the year 2021, China ranks first followed by India with the production of 12.11 million tonnes.

Brackish water aquaculture in India is concentrated around the Giant tiger prawn and White-leg shrimps the most important species (Fig. 15.12). In the recent past culture of exotic, white-leg shrimp, however, has attracted the farmers' attention because of its fast growth, low incidence of native diseases, availability of Specific Pathogen Free (SPF) domesticated strains, and culture feasibility in wide salinity range (Fig. 15.13). With the production levels of 10–12 tonnes/ha/crop of 3-4 months' duration, the production of this species has reached a level of 800,000 tonnes during 2021-22.

Fig. 15.12: Brackish water aquaculture farms

Fig. 15.13: Harvested Shrimp from the aquaculture ponds/farms

Freshwater Aquaculture: Freshwater aquaculture (Fig. 15.14) resources of the country have been estimated to be of the order of 6.23 million ha, of which 2.25 million ha are in the form of ponds/tanks, 0.827 million ha in the form of Beels, Jheels/ derelict water bodies, and 3.15 million ha of reservoirs. The present contributions of 8.0 million tonnes from these resources are hardly commensurate with their vastness and offer the scope for realizing more production with the available technologies in the country. There is a

wide scope for increasing fish production through aquaculture and by utilizing the available reservoir areas.

With only 40% of the available cultivable water area under aquaculture, the average productivity of tanks and ponds is 3 tonnes/ha/year in Fish Farmers Development Agency (FFDA) ponds. By increasing the coverage of the water area and the productivity of existing waters by 50%, the total production from the aquaculture sector could be doubled. Thus, the thrust has to be on bringing more and more water bodies under aquaculture practices and also to increase the productivity of water bodies through scientific management and inputs. Indian aquaculture is mainly dominated by major carp that account for around 80% of the total inland fish production.

There are many potential finfish and shellfish species, catfishes, prawns, ornamental fishes, *etc*. suitable for different agro-climatic conditions and can be brought under the aquaculture practices. There is scope for achieving production levels of 6 to 8 tonnes of fish per ha per year in several parts of the country. Such potentials need to be harnessed to increase the overall production from the aquaculture sector through the intensification of cultural practices.

Fig. 15.14: Freshwater Aquaculture farms

Check Your Progress Exercise 4

Note: a) Use the space below for your answer.

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

1) Define Ornamental Fisheries. Where is it practised in India?

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2) Brackish water aquaculture in India is concentrated around which species?

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3) Mention the freshwater aquaculture resources in India.

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15.8 LET US SUM UP

Indian fisheries including aquaculture an important sector of food production provide nutritional security, livelihood support, and gainful employment to more than 14 million people, and contribute handsomely to agricultural exports. With diverse resources ranging from the deep seas to lakes in the mountains and more than 10% of the global biodiversity in terms of fish and shellfish species, the country has shown continuous and sustained increments in fish production since independence. The total fish production during 2021-22 was around 16.24 million metric tonnes, of which nearly 70% were from the inland sector and about 30% from culture fisheries constituting about 8.0 % of the global fish production. With high growth rates, the different facets, *viz.*, marine fisheries, coastal aquaculture, inland fisheries, freshwater aquaculture, and cold-water fisheries are contributing to the food basket, health, economy, exports, employment, and tourism of the country. The development of aquaculture in the country has great potential for enhancing fish production, accelerating the fish and shrimp industry, and generating several opportunities for employment with substantial contributions to the Indian economy. Ornamental fisheries have immense export potential; it is a multi-billion industry spread across more than 125 countries with trade at a retail level worth US $10 billion. To put India at the forefront of ornamental fisheries, the government is making efforts for holistic development of the sector through the creation of ornamental fish clusters in selected inland and marine areas.

15.9 KEYWORDS

Angling : Angling is a fishing technique that uses a fish hook attached to a fishing line to tether individual fish in the mouth.

Berthing : Bringing a fishing vessel to her berth (a designated location in a port or harbour used) and anchored.

Biodiversity : A variety of plants and animals live in the world or a particular habitat.

Brackish water : Water occurs in a natural environment that has more salinity than freshwater, but not as much as seawater; *a mixture of fresh and saltwater*.

Cold-blooded : Animals whose body temperature varies with that of the environment (*e.g.* fish).

Eurythermal : Organisms are those that can tolerate a wide range of

temperatures.

Flood plain : Generally flat area of land next to a river or stream.

Ichthyofauna : The fish of a particular region; indigenous fish of a region.

Impetus : Something that makes a process or activity happen or happen more quickly.

Lagoon : A lagoon is a shallow body of water separated from a larger body of water by a narrow landform, such as reefs, barrier islands, *etc*.

MMT : Million Metric Tonne; equals 1000kg.

Monoculture : Cultivation of a single crop or organism in a given area.

Pristine : Clean and fresh as if new.

Purse-seines : A large fishing net which may be drawn into the shape of a bag, is used for catching fish.

Reservoir : A large natural or artificial lake or water body is used as a source of water supply.

River Ranching : A form of aquaculture in which a population of a fish species is held in captivity for the first stage of their lives, then released, and later harvested as adults when they return from the sea to their freshwater birthplace to spawn.

15.10 SUGGESTED FURTHER READINGS/ REFERENCES

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15.11 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1. India is the 3rdlargest fish producing and 2ndlargest aquaculture nation in the world. Constituting around 8% of the global fish production, the sector contributes 1.24% to the country's Gross Value Added (GVA) and over 7.28% to the agricultural GVA.

2. Reservoirs constitute the single largest inland open-water fishery resource both in terms of resource size and productive potential. They are large areas of water bodies contributing significantly to total inland fish production. Whereas the floodplain lakes are primarily a continuum of rivers Ganga and Brahmaputra. These are in the form of oxbow lakes.

3. Indian: Catla, Rohu, Mrigal; Exotic: Silver Carp; grass carp, common carp.

Check Your Progress Exercise 2

1. Marine capture fisheries play a vital role in India's economy and provide employment and income generation to nearly four million people.

2. Mariculture involves the cultivation of marine organisms in seawater for food and other products either in the open ocean, an enclosed section of the ocean, or in tanks, ponds, or raceways. Examples of mariculture include the farming of marine finfish, and shellfish, *e.g.,* shrimps, lobsters or oysters, mussels, and seaweeds.

3. Anchovies, Indian Mackerel, Indian Tuna, Oil Sardine, Bombay Duck.

Check Your Progress Exercise 3

1. The Brackish water resources comprise estuaries (deltaic river mouths), coastal lagoons, lakes, backwaters, tidal creeks, canals, mudflats, mangrove plants, *etc*.

2. The Coldwater fisheries deal with fisheries activity in water where the temperature of water ranges from 5 to 20 degrees centigrade. Cold water fisheries have also been instrumental in creating employment opportunities and targets at doubling the engagement across the focus States/UTs.

3. Most cultured brackish water fishes are Mullets, Milkfish, and Sea bass. Coldwater fishes of India are Mahseer, Snow Trout, Mountain Trout and other fish such as Catfish, Red-tailed Garra, Mountain Labeo, Assamese Kingfish, Gangetic Latia/Stone roller, *etc*.

Check Your Progress Exercise 4

1. Ornamental fish culture is the culture of attractive, colourful fishes of various characteristics, which are reared in a confined aquatic system. Farmers and hobbyists mainly grow it. Ornamental fishes are also known as "living jewels". It is commonly practised in Kerala, Tamil Nadu, West Bengal and North-eastern states.

2. Brackish water aquaculture in India is concentrated around the Giant tiger prawn and White-leg shrimp.

3. Freshwater aquaculture resources of the country have been estimated to be of the order of 6.23 million ha, of which 2.25 million ha are in the form of ponds/tanks, 0.827 million ha in the form of Beels, Jheels/ derelict water bodies, and 3.15 million ha of reservoirs.

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UNIT 16 SUBSIDIARY ENTERPRISES

Structure

16.0 Objectives

16.1 Introduction

16.2 Apiculture

- 16.2.1 Importance and Scenario of Apiculture
- 16.2.2 Beekeeping Enterprise
- 16.2.3 Honey Bee Species
- 16.2.4 Colony Organization and Division of Labour
- 16.2.5 Hive Products
- 16.2.6 Strategies for Honey Marketing

16.3 Sericulture

- 16.3.1 Meaning and Importance of Sericulture
- 16.3.2 Types of Silk
- 16.3.3 Silk Producing States

16.4 Agroforestry

- 16.4.1 Scope and Importance of Agroforestry
- 16.4.2 Benefits from Agroforestry
- 16.4.3 Agroforestry - Industry Linkages
- 16.4.4 Market Prospects of Agroforestry

16.5 Mushroom

- 16.5.1 Prospects of Mushroom Cultivation as an Agribusiness Vocation
- 16.5.2 Why Grow Mushrooms
- 16.5.3 Types Suitable for Cultivation

16.6 Let Us Sum Up

16.7 Keywords

16.8 Suggested Readings/ References

16.9 Answers to Check Your Progress Exercises

16.0 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.

16.1 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.

Beekeeping covers the entire scope of management of honey bee resources, beekeeping practices, bee products, pollination services, and their interface with the socio-economic, cultural, natural heritage and environmental integrity. India, being very rich in floral availability and diversity and diverse climatic conditions from north to south and east to west, offers 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. 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 along with crops have been described as agro-forestry.

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, agroforestry, and mushroom cultivation.

16.2 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.

16.2.1 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. It suits well for landless, small and marginal farmers where traditional agriculture would not be economically viable. It is a good option among people with limited economic

resources as apiculture needs little land or meagre monetary resources.

Honey bees not only provide us with 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 crops and thereby augment the crop yields both quantitatively as well as qualitatively. Apiculture can help for rural upliftment and economic liberation of our villagers and generate employment opportunities. It helps in the maintenance of ecological biodiversity. It is an eco-friendly enterprise and may help in improving people's health.

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 a 57.58 % increase. The export of honey has increased from 28,378.42 MTs (2013-14) to 59536.74 MTs (2019-20), which is a 109.80 % increase during the period. Sixteen Integrated Beekeeping Development Centers (IBDCs) as role models 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/PressReleseDetailm.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 2020-21wereUSA, Saudi Arabia, United Arab Emirates, Bangladesh, Canada (http://apeda.gov.in/apedawebsite/SubHead_Products/Natural_Honey.htm, 24.09.2021)

Check Your Progress Exercise 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 meant by apiculture?

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

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3) Write down the full form of IBDCs.

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16.2.2 Beekeeping Enterprise

Beekeeping is considered 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. Beekeeping in the country, in general, and in the north-western states has been commercialized in recent times, particularly due to the mass-scale adoption of high-yielding exotic honey bee species, the European honey bee (*Apis mellifera* Linnaeus). This bee, however, cannot 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 into consideration for initiating a good beekeeping project.

1. **Training from a recognized institute:** A beginner must acquire critical knowledge and practical skills by undergoing beekeeping training from some recognized institution and 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, and greater potential for starting beekeeping.

4. **Suitable season for starting beekeeping**: A suitable season for starting beekeeping coincides with moderate climatic conditions and the 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.

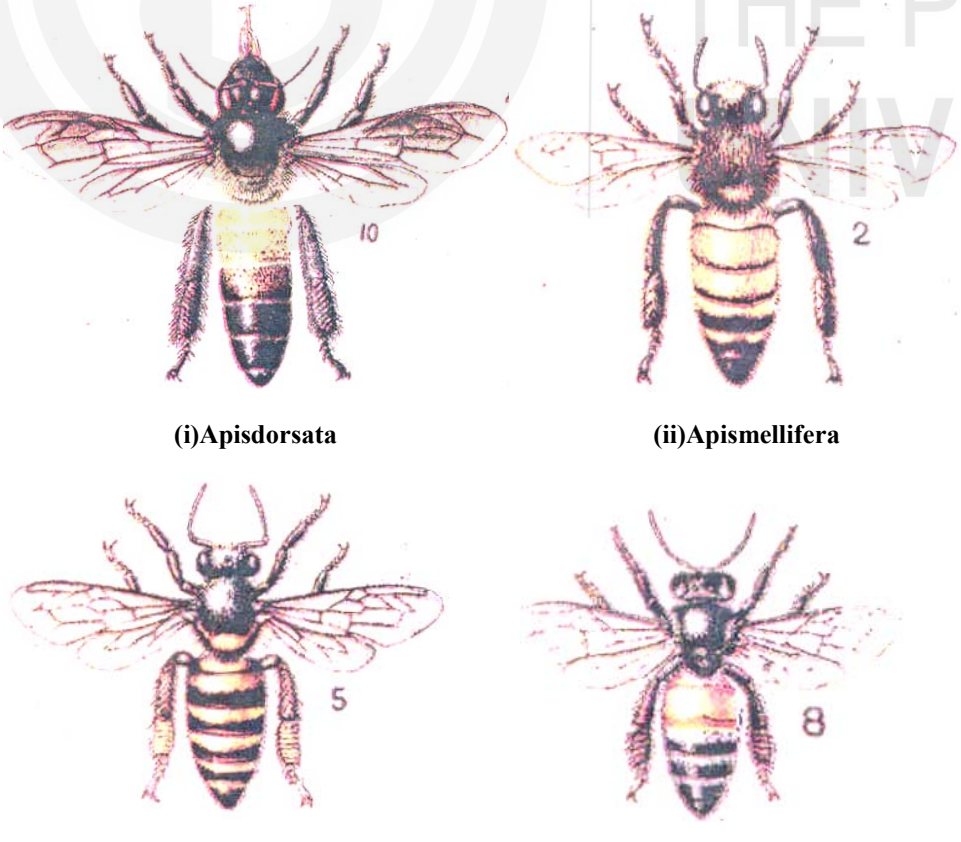
7. **Transportation of the colonies**: Before shifting, the colonies should be properly packed to make them properly ventilated but bee leakproof. Jerks to the honey bee colonies are avoided during their transport.

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 a 6-8 feet distance between two adjacent hives. The hive entrance should preferably face southeast direction and be placed preferably away from a common passage.

16.2.3 Honey Bee Species

Under superfamily Apoidea, under the 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. ceranaindica*) (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 presented (Fig. 16.1, Table 16.1).



(i)Apisdorsata **(ii)Apismellifera**

(iii) Apiscerana **(iv) Apisflorea**

Fig. 16.1: Different species of honey bees

Table 16.1: Identification/differentiation among different honey bee species

S. No.	Characteristics	*A. dorsata* (Giant honey bee) (i)	*A. mellifera* (European honey bee) (ii)	*A. cerana* (Asiatic honey bee) (iii)	*A. florea* (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 and black stripes	Abdomen reddish anteriorly with black and white stripes posteriorly
3.	Wings	Smoky	Transparent	Transparent	Transparent
4.	Probosci's 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 bees, 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 enclosures/ 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*.

16.2.4 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. 16.2).

Queen bee **Drone bee** **Worker bee**

Fig. 16.2: Different castes of *A. mellifera*

Queen Bee: It is a sexually functional female which is developed from a fertilized egg, and is bigger 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 the brood-rearing season, the queen would lay up to 2000 eggs per day.

Drone Bee: It is a functional male that 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 discussed above 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, defence of the colony, attending to the queen, keeping the hive warm and hygienic, secreting wax from the abdominal glands, and 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.

16.2.5 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 is 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 the 4^{th} to 7^{th} abdominal segments of bees generally 14-18 days of age and is used for comb construction. Normal recovery of beeswax is 2 per cent of the honey produced. Sources of beeswax include cut capping 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 a 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 a water-vacuum pump or a 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 a 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, varnish the comb surface and as a repellent against ants at the hive entrance.

6. **Bee Venom:** Bee venom is synthesized in the 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.

16.2.6 Strategies for Honey Marketing

The important strategies, such as maintenance of quality, labelling, and 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 a 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 conditions and in 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 the 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 to sell 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 Exercise 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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16.3 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 increased to 35,468 MT in 2018-19, registering a CAGR of 6.16% during the period. 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)

16.3.1 Meaning and Importance of Sericulture

What is Silk?

How many of you know that silk is a protein fibre 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 the cocoon is spun by the silkworm as its home to live in and overcome unfavourable 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. At present, India is 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 favour, it shall not be of use. Since sericulture is a rural industry, it thus needs to be assessed in relation to other cash crops. The following factors make sericulture a highly favourable rural industry:

- Rural activity
- No interference with cash crops
- Minimum gestation period
- Less investment
- Quick turnover
- Maximum employment

- Primarily ladies/children involvement
- Additional income

Job potential

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. Nursery growers, popularly known as *Kisan Nursery Farmers* raise saplings of host plants on a commercial scale to make these available to silk cocoon producers. Afterwards, the cocoon producers develop the host plantation for rearing the silkworms. Then there are *ancillary units* manufacturing various disinfectants, rearing, and other appliances used in silkworm rearing and egg production.

16.3.2 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, Bombyxmori L. which solely feeds on the leaves of the mulberry plant.

Tasarsilk (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, Antheraeamylitta, which mainly thrives on the food plants Asan, Arjun, and Sal.

Oak tasarsilk (Temperate tasar): This is a finer variety of tasar generated by the silkworm, *Antheraeaproyeli J*, which feeds on natural food plants of oak, found in abundance in the sub-Himalayan belt of India. This is a hybrid that evolved in India by crossing Indian sp. *Antheraearoyeli* with Chinese counterpart *Antheraeapernyi*. 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.

Mugasilk: This golden yellow colour silk is the prerogative of India and the pride of Assam state. It is obtained from the semi-domesticated multivoltine silkworm, *Antheraeaassamensis*. 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*.

Erisilk: Also known as Endi or Errandi, Eri is multivoltine silk spun from open-ended cocoons. Eri silk is the product of the domesticated silkworm, *Philosamiaricini* that feeds mainly on castor leaves. Ericulture is a household activity practised 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 of these tribals. The silkworm being domesticated is reared indoors on the pattern of mulberry silkworms.

16.3.3 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. 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, Chhattisgarh, Orissa, Gujarat, Rajasthan, Madhya Pradesh.

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

OAK TASAR: Manipur, Jammu & Kashmir, Uttarakhand

MUGA: Assam, Nagaland, South Tripura

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

Check Your Progress Exercise 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) Explain the chain of Sericulture activities. How does it offer avenues of self-employment?

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

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3) Name traditional States producing mulberry silk.

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16.4 AGROFORESTRY

Agroforestry has been practised 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 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 and combines 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, is 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 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

16.4.1 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 for758546 sq. km (comprised of 712249 sq. km total forests (21.67 %) and 46297 sq. km of 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 forests continues to be very high due to the large segment of the population being dependent on forests for livelihood, and the demand for wood for various uses is 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, bamboo, palms, *etc*.) on agricultural lands and/or livestock production, can be a viable land use option.

16.4.2 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 indicates that a tree and agricultural 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 higher 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 the 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 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 is more profitable than pure agriculture in Haryana. *Populusdeltoides* 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 Exercise 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) Name any one important role of trees in farmlands.

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

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3) Expand the following abbreviation:

ICRAF: ……

16.4.3 Agroforestry - Industry Linkages

Agroforestry development in India has received impetus after two important policy announcements by the central government. Firstly, the National Forest Policy of 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 of 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 for which many industrial plantations have been established. Unfortunately, the forests managed by the state forest departments failed to meet the yield/growth predictions (Chandra 2003). Demand for wood also increased manifold, therefore, leaving no option for industries to approach the farmers to produce raw material which paved the way for developing industry-farmer relations boosting agroforestry and farm forestry activities.

Agroforestry / Farm Forestry Based Industries

Unlike 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. Many wood-based industries across the country are supported by agroforestry/farm forestry-based raw materials (**Table 16.2**).

Table 16.2: 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., *Leucaena leucocephala*, *Casuarina equisetifolia*
Plywood and composite wood	Poplar (*Populus deltoides*), *Anthocephalus chinensis, Albizzia lebbeck, Dalbergia sissoo, Mangifera indicca, Ailanthus grandis, Gmelina arborea, Tectona grandis, terminalia bellerica, Grevellea robusta, Bombax ceiba,* Bamboo species (bamboo matply)
Matchbox and sticks	*Populus deltoides, Anthocephalus chinensis, Ailanthus excelsa, Mangifera indica, Alstonia scholaris, Bombax ceiba, Trewia nudiflora*
Packing cases and crates	All plywood species, bamboo (Woven baskets),*Populus ciliata*, *Eucalyptus spp*.
Sawmilling	Almost all woods with minimum branches and straight bole. Best species include: *Tectona grandis, Gmelina arborea, Dalbergia sissoo, Artocarpus heterophyllus, Tamarindus indica, Azadirachta indica*
Furniture and cabinet-making	*Tectona grandis, Gmelina arborea, Toona ciliata, Michalia champaca, Morus laevigata, Sygygium cumini, Dalbergia sissoo, Mangifera indica, Ougenia dalbergioides, Albizzia lebbeck*
Agarbatti sticks	Bamboo species, *Santalum album, Juniper in temperate regions*
Pencil industry	*Alnus nepalensis, Alstonia scholaris, Salix tetrasperma*
Sports good industry	*Morus spp., Salix alba, Fraxinus xanthoxyloides in temperate region*
Tanning industry	*Acacia leucophloea, Artocarpus heterophyllus, Bauhinia purpurea, Callophyllum inophyllum, Zizyphus mauritiana, Cassia siamea, Tamarindus indica, Terminalia arjuna,Acacia decurens*
Cutch and Katha	*Acacia catechu*
Silk industry (Host for silkworm)	*Morus alba, Anogeissus latifolia, Terminalia arjuna, Ficus tsjakela, Ricinus communis(Shrub)*
Host for lac and shellac industry	*Acacia catechu, Schleichera oleosa, Butea monosperma, Zizyphus mauritiana, Acacia nilotica*
Essential and aromatic oil	*Eucalyptuscitridora* (Leaves), *Santalum album* (Heartwood), *Aquilaria agallocha* (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*.

2. Small-scale industries with medium investment and semi-automation: 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 the pulp and paper industry, plywood and other composite wood industry, and large matchbox and match stick industry.

Among these, the 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.

16.4.4 Market Prospects of Agroforestry

It has become even more important to integrate agroforestry services into the 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, and 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 tree 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.

16.5 MUSHROOM

You must have seen that after rains many mushrooms appear from nowhere, especially in grassland, near manure heaps, 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 several classes and mushrooms mainly belong to the class Basidiomycetes and a few of the mushrooms belong to the class Comycetes.

Fig. 16.3: (L to R, Top row: Button, Milky, Shiitake mushroom; Bottom row: Oyster, Paddy straw, and winter mushroom)

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 button, shiitake, oyster, paddy straw, winter, and wood ear mushrooms (Fig 16.3).

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 20thCentury and in the initial years, the button mushroom was the most important cultivated mushroom. Subsequently, several 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 mushrooms.

The total estimated mushroom production in the country was 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.

16.5.1 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 the potential to become 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 per cent of the world trade is related to edible mushrooms. About 20 per cent is related to medicinal mushrooms and their products and only less than 10 per cent is related to the trading of wild mushrooms.

16.5.2 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 waste and generating wealth from the waste. The material left after growing mushrooms, commonly referred to as a 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.

16.5.3 Types Suitable for Cultivation

India is a country of diverse climates. 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 kilometres, 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^{o}C (winter mushroom), between 16-20^{o}C (button, shiitake, king oyster, *etc*.), between 20-30^{o}C (oyster and wood ear mushroom), and above 30^{o}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 mushrooms (*Flammulina velutipes*), wood ear mushrooms (*Auricularia polytricha*), shiitake mushrooms (*Lentinula edodes*), *Agrocybe aegerita*, *Macrocybe giganteum, Hericium* spp., medicinal mushrooms like reishi mushroom (*Ganoderma lucidum*), and others.

Check Your Progress Exercise 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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16.6 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 provides hiring service for crops' pollination benefits, thus increasing crop yields. Beekeeping should be started after acquiring training from some recognized institution. Selection of a suitable site for apiary and season for starting beekeeping, besides the purchase of nucleus colonies, their transportation, and their placement, are some important points that 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.

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 & and twisting of yarn thus, offering vast potential 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 mushrooms. Mushroom cultivation is one of the most profitable methods of recycling crop waste 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.

16.7 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 the 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 of dry venom.

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 unfavourable weather conditions

Flush: Term used for the appearance of mushrooms 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.

Home gardens: Practices of growing trees in the home yard.

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

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 a 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 an 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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16.9 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 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) The IBDCs stand for Integrated Beekeeping Development Centers.

Check Your Progress Exercise 2

1) Propolis is a 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, varnish 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 a 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, a hydrolytic blend of proteins with basic pH, and is used by the bees for their defence.

Check Your Progress Exercise 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, twisters, weavers, and suppliers.

2) Mulberry, Tasar, Muga, and Eri are the 4 varieties of silk. Muga is the monopoly of India

3) Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal, and J&K are the traditional mulberry silk producing states in India

Check Your Progress Exercise 4

1) Soil and water conservation, soil binding, moisture retention, nitrogen fixation, and organic matter addition.

2) To survey the forest cover and assess its status from time to time using remote sensing, ground truthing, and other geospatial measures.

3) International Centre for Research in Agroforestry

Check Your Progress Exercise 5

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

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