
UNIT 14 ALLIED SECTORS

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14.0 OBJECTIVES

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

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

14.1 INTRODUCTION

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

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

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

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

14.2 APICULTURE

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

14.2.1 Importance and Scenario of Apiculture

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

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

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

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

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

Check Your Progress 14.1

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

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

1) What is the comprehensive definition of apiculture?

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

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 3) What do you understand by diversification of apiculture?

14.2.2 Beekeeping Enterprise

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

Important Considerations for Starting-up Beekeeping Project

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

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

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

14.2.3 Honey Bee Species

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

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

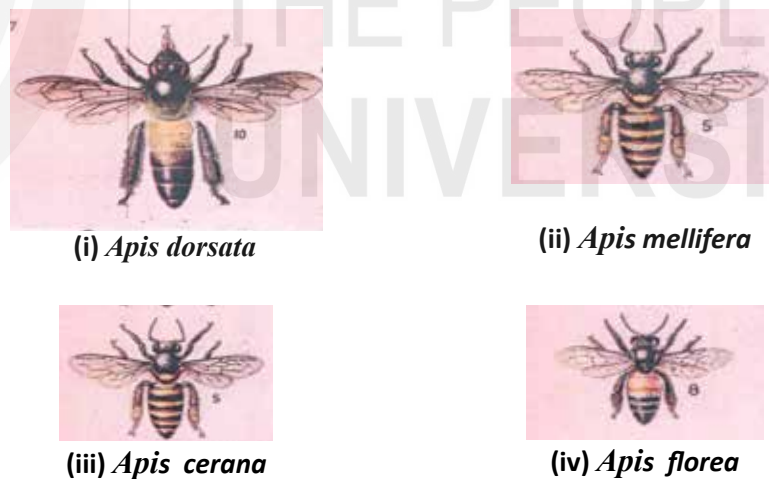


Fig. 14.1: Different species of honey bees

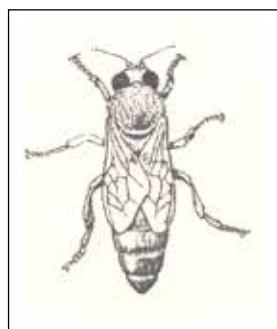
Table 14.1: Identification/differentiation among different honey bee species

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

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

14.2.4 Colony Organization and Division of Labour

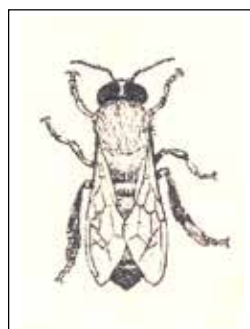
In any honey bee colony, there are three castes, namely queen bee (fertile female), drone bee (male bee), and worker bee (sterile female). These castes in the case of hive honey bees can very easily be differentiated based on their morphological characteristics; the distinguishing features among the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



Queen bee



Drone bee



Worker bee

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

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

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

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

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

14.2.5 Hive Products

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

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

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

14.2.6 Strategies for Honey Marketing

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

1. Maintaining Honey Quality

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

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

2. Attractive Packing and Informative Labeling

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

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

3. Avenues for Honey Sale

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

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

Check Your Progress 14.2

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

- 1) What is propolis?
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- 2) What is royal jelly?
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- 3) What is bee venom? What are its uses?
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14.3 SERICULTURE

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

14.3.1 Meaning and Importance of Sericulture

What is Silk?

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

Origin of Silk

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

Why Sericulture?

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

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

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

14.3.2 Types of Silk

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

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

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

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

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

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

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

14.3.3 Silk Producing States

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

MULBERRY:

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

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

OAK TASAR: Manipur, Jammu & Kashmir, Uttarakhand

MUGA: Assam, Nagaland, South Tripura

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

Check Your Progress 14.3

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

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

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

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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.

14.4 AGROFORESTRY

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

Definition

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

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

14.4.1 Scope and Importance of Agroforestry

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

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

14.4.2 Benefits from Agroforestry

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

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

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

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

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

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

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

Check Your Progress 14.4

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

- 1) What is tree farming?

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

.....

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

.....

4) Expand the following abbreviation:

(a) ICRAF:

(b) ICFRE:

14.4.3 Agroforestry - Industry Linkages

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

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

Agroforestry / Farm Forestry Based Industries

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

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

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

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

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

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

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

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

14.4.4 Market Prospects of Agroforestry

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

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

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

14.5 MUSHROOM

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



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

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

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

14.5.1 Prospects of Mushroom Cultivation as an Agribusiness Vocation

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

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

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

14.5.2 Why Grow Mushrooms

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

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

14.5.3 Types Suitable for Cultivation

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

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

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

Check Your Progress 14.5

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

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

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

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14.6 LET US SUM UP

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

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

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

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

14.7 KEYWORDS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Fruiting: The process of mushroom formation and development

Functional food: Foods for special health use.

Homegardens : Practices of growing trees in the home yard.

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

Incubation: Care of eggs at optimum conditions till hatching

Moult: Process of shedding body skin to grow further

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

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

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

Propagation: Multiplication of plants

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

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

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

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

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

Weeding: Removal of unwanted plants in a crop

14.8 SUGGESTED FURTHER READINGS/ REFERENCES

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14.9 CHECK YOUR PROGRESS: POSSIBLE ANSWERS

Check Your Progress 14.1

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

Check Your Progress 14.2

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

Check Your Progress 14.3

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

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

Check Your Progress 14.4

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

Check Your Progress 14.5

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



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