UNIT 18 ALTERNATIVE AGRICULTURE

Structure

18.1 Introduction
Objectives
18.2 Components of Alternative Agriculture
Livestock
Bee-keeping
Sericulture
Lac Cultivation
Aquaculture
Poultry
18.3 Agro Forestry
18.4 Social Forestry
18.5 Plantation Crops
Coconut
Areca nut or Betel nut
Cashew nut
Cocoa
Rubber
Tea
18.6 Herbal and Medicinal Plants
18.7 Agri-Processing
Food Preservation Methods
Technology Development in Agro-processing
18.8 Summary
18.9 Terminal Questions

18.1 INTRODUCTION

It has been realized that income through arable farming alone is insufficient for marginal farmers. Activities such as livestock management, poultry, aquaculture, beekeeping, sericulture, agro forestry etc. assume significant importance in supplementing their farm income. The concept of 'Alternative agriculture' is a broad range of agricultural systems that are alternatives to present common practices and provides an opportunity to increase economic gains per unit area per unit time by virtue of intensification and allied enterprises. Alternative agriculture fits well with farm level infrastructure and ensures judicious utilisation of available resources and the by-products and will reduce the drawback of present day agriculture. Its main objective is to make agriculture ecologically and economically sustainable. The emphasis is on two dimensions i.e. time and space. This minimizes the risk and increases the production with better utilisation of resources like waste and residues. In this unit we will discuss the various components of alternate agriculture and how their integrated use can enhance the income of the marginal farmer and contribute towards sustaining agricultural production.

Objectives

After studying this unit, you should be able to:

- define alternative agriculture;
- list the various components of alternative agriculture;
- explain the importance of livestock rearing, bee keeping, poultry, aquaculture, sericulture and lac cultivation;
- describe agro forestry and social forestry;
- understand the importance of various plantation crops; and
- gain knowledge about herbal and medicinal plants.

18.2 COMPONENTS OF ALTERNATIVE AGRICULTURE

Alternative agriculture is being practiced now to improve the economy of Indian agriculture and standard of living of the farmers of the region. Farmers and land holders need information about alternative agricultural practices which may provide them with a profitable alternative to what they are currently practicing. Some may wish to diversify their crop or livestock to deal with the risks inherent in agriculture yet others may look for some alternative for supplementing their family income. The different components of alternative agriculture can be: agro forestry, sericulture, apiculture, plantation of cash crops and medicinal crops, livestock, poultry, aquaculture etc., but all depend upon the requirement and available resources of the farmers and their ability to judicially incorporate the alternative components. Let us discuss these components briefly.

18.2.1 Livestock

The interdependency of crop enterprise and livestock production systems is an age old practice. The productivity of livestock is controlled by 3 principal factors, *viz.*, (i) genetic make-up, (ii) environment including nutrition and diseases, and (iii) their interactions. If livestock production is to be made sustainable, it should have 4 major qualities, *viz.*, economic viability, technical feasibility, social acceptability and relevant resource base.

Breeding, **weeding**, **feeding** and **heeding** are universally recognized essential aspects for livestock management. Management of animals involves a certain degree of control of these parameters. The present trend is to give greater emphasis to the study of their behaviour and apply control through intelligent manipulation of their behaviour rather than through the application of brute force or through inflicting pain. Domestication is the process whereby man has structurally, physiologically and behaviourally modified certain species of animals by maintaining them in or near human habitation and by breeding them for various human objectives like docility, efficient maternal care, high fertility, longevity, production and ornamentation. In breeding, animals both the male and female selected for breeding should be of superior genetic merit, of known potentialities and possess desirable qualities.

The entire edifice of dairying rests on four pillars — breeding, weeding, feeding and heeding. By breeding the farmer needs to ensure that the stock has high genetic potential and the herd is genitally disease free. Weeding ensures the timely disposal of animals suffering from incurable diseases like tuberculosis so that time money and labour spent on their management and feeding is saved. Feeding a well balanced and nutritious diet is of utmost importance for improving the performance and health of the dairy animals. Heeding involves the protection against contagious diseases and parasitic infestation-both internal as well as external to ensure health and efficiency of the dairy animals.

The production characteristics of livestock are not entirely because of heredity, but it is influenced by environment also. Heredity provides the ability to exhibit certain characters and environment provides the opportunity to express them. The capacity of animals to cope with the climate and disease environment of a region and to maintain a healthy status is of profound importance to livestock production systems. Healthy stock makes use of genetic potential under good nutrition. Although indigenous livestock are equipped with better climatic adaptation, ability to withstand stress, disease resistance and ability to thrive on poor feeding regimen, they are also poor producers. Major reasons for poor performance may be poor genetic constitution, inadequate availability of nutrients and large number of unproductive animals. The genetic superiority of the indigenous stock for the ability to adapt to thermally adverse environments may result in better survivability of these animals in these environments, but need not necessarily result in better productivity.

Land use pattern for livestock: The status of land use pattern for livestock production (total reported area is 395 million ha) is almost constant since 1950-51 onwards. Out of the total geographical area, 22.26% comes under forest area, 3.87% under pasture-cum-grazing lands, 1.21 % under miscellaneous tree crops and groves, 4.92% under cultivable wastelands, 7.67% under fallow lands and 6.96% under barren-cum-uncultivable land. The wastelands constituting about 33% (129.76 million ha) of the total area and the development of the wastelands into land for feed and fodder resources can solve the most critical constraint that stands in the way of livestock improvement.

Feed and fodder resources: According to "National Wasteland Development Board" the deficiency of dry and green fodder for livestock has been estimated recently to be 43.46 and 73.18 per cent respectively. The deficiency is likely to increase in coming years if no efforts are made to meet the supply of fodder. Various approaches to enhance feed and fodder productivity on existing land need to be taken.

Areas of integration: The integrated approach becomes more acceptable to the people if it is well designed on need based principles, for which, a systematic analysis of the various inputs like conservation methods, selection of suitable biomass species, use of quality planting stocks, along with available adequate waste land and its suitability for growing fodder is needed to make them available for livestock development programme. This will enhance the extra income for the rural masses. It is evident that both livestock rearing and wasteland development programme should be taken up in an integrated manner. The agencies concerned with the wasteland development and livestock development must act in close co-ordination by ensuring active involvement of financial institutions.

Livestock Management

Livestock management involves the integrated application of the principles of breeding, feeding, housing, organization of disease control in a manner suitable for a particular situation. These principles are often modified based on different trends in livestock management. Renewable rural energy utilization, draught animal power, animal waste management and use of non-conventional animal resources are now receiving greater attention in the livestock field. Greater stress is given to the sustainability so that the farming system may not destabilize or contaminate the environment; or degrade natural ecosystems. Emphasis is also given to the social aspects in that it should provide optimum employment opportunity and promote self reliance.

All the managerial systems should be designed and executed in such a way that livestock remains healthy and attains optimum production. In modern livestock production systems where large numbers of animals are concentrated in limited space, ventilation, prompt and efficient removal of excreta like urine and dung assumes great significance in hygiene, and prompt cleaning and disinfections of sheds, premises and surroundings are of paramount importance.

South Asian Countries have vast livestock resource, which includes cattle, buffalo, sheep and goat. Livestock rearing provides employment and supplementary income to majority of rural households, particularly landless and marginal farmers**. On an average, 100 ha of cropped area sustain 151 bovine stock comprising 111 cattle and 40 buffaloes.** It is a well-accepted fact that the productivity of livestock in these countries is very poor. Typically, the milk yield per animal per day in case of crossbred cows ranges from about 3 litres to 9 litres. In comparison, the milk yield from cows in Western countries ranges from 15 to 20 litres and that of murrah buffaloes is 8 litres per day per animal.

India had approximately 204 million cattle and 84 million buffalos and the gross value of output from livestock sector alone at current price is Rs. 1.114 billion which is above 25% of the value of output of Rs. 4,495 billion from agriculture sector (1997-98). There are about 70.6 million drought animals comprising mainly cattle and buffalo, contributing 20% of energy input into crop farming.

The reason for such low productivity can be attributed to poor health coverage and insufficient capital for rearing livestock on scientific lines. Besides these factors, the most critical factor is inadequate supply of feed and fodders, which depends on availability of the land resources. However the situation regarding the availability of milk changed after "Operation flood" which covers 9 million farmer families in 170 milk-sheds in 22 states and union territories under the cooperative umbrella. Operation flood provides animal health, marketing facilities and new technologies for improved cattle and buffalo productivity.

The advances in animal husbandry have greatly helped in improving the economic status of rural masses of the country. To obtain maximum profit it is advisable to rear Jersey crossbred cows (F1 crosses) since they come up very well in all climatic

conditions, consume less feed and fodder, give more milk with high fat content and possess comparatively better disease resistance. However, Holstein Friesian crosses could be reared for higher milk yield in places of cooler climate as they lack heat tolerance. Buffaloe breeds like Murrah crosses and even non-descript types could be reared for milk production. Buffaloes can digest more percentage of roughage than cows and thrive well on dry fodder. Buffaloes contribute nearly 60% of milk to the national milk grid. More profit could be accomplished through utilisation of improved breeds.

Box 18.1: The important breeds of livestock in India

Cattle: Kankrej, kangwariya, Kherigarh,Malvi, Tharparkar,, Bachaur, Gaolao, Hariana, Krishna velley, Mewati, Nagauri, Ongole, Rathi,Dangi,Deoni, Gir, Nimari, Red Sindhi, Sahiwal, Hallikar, Amritmahal, Khillari, Kangayam, Alambadi, Ponwar, Siri,

Buffalo: Murrah,Bhadawari, Jaffarabadi, Surti, Mehsana, Nagpuri, Nili Ravi, Godavari, Toda, Parlakhemundi, Tarai, Sambalpuri

Sheep: Nilgiri, Hissardale, Kasmir merino,Pugal,Patanwadi, Tibetia, Bonpala, Gaddi, Rampur Bushir, Poochi, Karnah, Gurez,Ramboullet, Suffolk,Corriedale, Karakul etc.

Goat: Jamunapuri, Beetle, Sirohi, Surti, Kutchi, Barbari, Ganjam, Changthangi, Gaddi, Marwari,, Bakharwal, Mehsana, Osmanabadi, Malabari, Zalawadi,Gohilwadi, Sangamneri, Kannaiadu etc.

18.2.2 Bee-keeping

Honeybee and the fruits of its toils have been familiar to man since pre-historic times. It is one of the few insects that are directly beneficial to man. One comes across a number of folk-lore's praising the honeybee's diligence, usefulness and sacrifice. These winged creatures and the honey they produce find mention in many religious epics. Figures and carvings of the honeybee, its combs and hives are found in tombs, coffins, crowns, maces of kings and coins of ancient and modem empires. Honey is prized as food and medicine and the uses of beeswax are many and varied. Bee keeping is an important art which provides additional income with little effort (Fig. 18.1).

Fig.18.1: Bee keeping in orchards

Social life and division of labour

The honeybees live in a colony and adopt highly organized system for their own protection and production of honey and also provide a unique example of social life showing a division of labour similar to human communities. A normal honeybee colony contains one queen, 10000- 80000 workers and 100 to 400 drones.

Queen: Queen is the mother of the colony and all others work under her stewardship. The main function of the queen is to lay eggs which she does in large numbers.

Worker bees: These are females; unable to reproduce. Each worker bee is assigned a definite amount of work. The main functions of worker bees are:

- nest building for the queen for laying egg,
- preparing feed by mixing pollen and honey for the young larvae,
- maintaining the temperature inside colony,
- guarding the nest against the attack of enemies
- collect nectar and pollen from different species of flowers and
- synthesizing honey in their body and confining honey in the cells.

The worker bee starts her work by doing comb cleaning during first 3 days after birth and provides feed to the developing larvae for the next 4 days. In the meantime, royal jelly is formed in the head region of the worker-bees, which is fed for 2 days to the small worker larvae and for 6 days to the queen larvae. The jelly formation continues for 10-13 days. After about 12 days, wax glands are formed on the lower side of the bee's stomach and produce wax which is used for the formation of combs/cells. The bee starts taking flight after 7 days of her emergence but starts collecting water and feed after attaining the age of 21 days.

Drones: are male bees and the bee species can not multiply without them.

Honeybee as Universal Pollinator

Honey bees are excellent pollinators particularly in grain or vegetables crops having separate male and female flower/plants owing to their adaptation for carrying the pollen such as:

- dense cover of hairs on its body,
- habit of visiting flowers frequently to collect nectar and pollen,
- consistent visit on the same flora for many days,
- ability to cover a large area up to 2 km radius,

Products of Honeybee

Honey: also known as"Liquid Gold of Nature" has its immense use on account of nourishment and its healing properties. It contains large amount of glucose and fructose and is readily absorbed into the blood stream. The raw use is preferred because cooking removes the special aromatic compound and causes the sugar to caramelize. It has a long keeping quality and requires no refrigeration. Honey is supposed to work in the treatment of aliments, gastric and intestinal disorder, respiratory troubles etc. and has germicidal properties and used in surgical dressing. Its nutritional value per 100g is described as, calories (319K cal), moisture (20g), protein (0.3g), carbohydrate (79.5g), calcium (5g), phosphorous (16mg), iron (0.9mg), vitamin C (4mg).

Bee-wax: It is a complex substance containing complex esters of monatomic alcohols and fatty acids constituting 70.4 to 74.7% of wax. The other components are, free acids 13.5 to 15.0% and saturated hydrocarbons 12.5 to 15.5%. It is rich in vitamin A and 100g of wax contain 4096 I.U of vit A. it is mainly consumed by candle industry and bee industry for preparing comb foundation sheets. Wax is also an important

constituent of cosmetics like cold creams, lipsticks and rouges because it adheres better to skin. Pharmaceutical and perfume industries are also major users of wax. It is also used in ointments, capsules, pill coatings and deodorants. Bee wax is used in preparation of shoe polish, furniture etc.

Bee venom: A bee, when two weeks old has maximum venom in her poison sac and there is no more addition to this quality. Composition of bee venom is complex and it consists of many active substances such as stamina, apamine, calcium etc., Bee venom has been reported to be useful for curing many diseases and disorders. It has also given positive results in curing neurosis, endoarteriosis, endoarthritis and neuralgia.

Propolis: It is gathered by bees from resinous exudes of trees. In the bee colony bees for sticking frames, sealing cracks and crevices, use propolis. It has the quality of healing wounds effectively and is commonly used in preparing ointments for treating cuts: wounds and abscesses in cattle.

Economics of bee-keeping

The beekeeping is the only enterprise, which requires less initial investment and can be started from a small to large unit according to the capacity of the farmers. From ten colonies one can earn a net profit of Rs. 8500 (Table 18.1).

Table 18.1: Economics of bee-keeping

Particulars	Rate (Rs.)	Quantity (No.)	Total Expenditure (Rs.)
(A) Non Recurring	1000	10	10, 000
Double chamber bee Hives (Kailwood)			
Nucleus colonies (4 bees in each frame)	480	10	4, 800
Iron stands	50	10	500
Honey extractor	1000	1	1, 000
Bee-veil, bee gloves, Hive tool, smoker, bee brush, uncapping knife, etc.	500	1 set	500
Queen excluder	60	10	600
Honey tins	25	6	150
Sub-total			17, 550
(B) Recurring			
Comb foundation sheets	7/sheet	160	1,120
Sugar (2kg/colony)	16/kg	20	320
Winter packing	10/colony	10	100
Sulphur (100g/box)	30/kg	1	30
Sub-total			1,570
Grand total			19,120
(C) Gross income			
Honey (15kg/colony)	50/kg	150	7,500
Sale of multiplied colonies	480	5 (No)	2,400
Wax (300g/colony)	60/kg	3 kg	180
Total Gross Income			10,080
D) Net Profit			
Gross income			10,080
Less recurring Expenditure			1,570
Net profit			8,510

SAQ 1

What are the main products of bee keeping?

Activity 1

If possible visit a bee keeping unit and make out a report on its working.

18.2.3 Sericulture

Agriculture and agro-based industries play a vital role in the improvement of rural economy. The limited availability of land, the limited cash returns, and agriculture being confined to one or two seasons in the year, have made villagers to look for supporting rural industries, such as sericulture. Agriculture and sericulture are adopted simultaneously by the agriculturists in regions where the ecological conditions are favourable.

Sericulture, with a high annual turnover of three to four crops in rain fed conditions and five to six crops under irrigated conditions, provides a means of regular and stable income. Division of the garden into plots with alternate harvest timings could enable a household to carry on rearing silk worm throughout the year on a continuous basis.

A regular and relatively steady income from sericulture provides a very strong ground for improving the living conditions of the poor.

Cocoon: The silken shell spun by the silkworm larva that serves as a protective covering during its pupal stage of existence. The cocoon needs to be processed through reeling for taking out the silk fibre in the form of silk yarn.

Sericulture, being a cottage industry, provides the maximum opportunity for the participation of women. In fact, it is estimated that more than 60% of work in sericulture is carried out by women. Thus sericulture provides a unique scope for the direct participation of women in the process of production and decision making, for improving their economic conditions, and for giving them a greater recognition and status in the family and society.

Sericulture is the sector where nothing goes waste. There is a hundred percent utilization and recycling of all that goes into or comes out of the production system, be it rearing or reeling. While the left-over mulberry stems along with the worm droppings form an excellent cattle fodder on the one side, there are reelers to reel the worst of the cocoons, the dirtiest flimsy and jelly cocoons rejected at the cottage basins. Finally, even the stifled and much maligned pupae are used up for preparation of dog biscuits, oil etc.

Sericulture, the technique of silk production, is an agro-industry that can play an eminent role in the rural economy of the SAARC region. Silk-fibre is a protein produced from the silk-glands of silkworms. Mulberry silk constitutes nearly 95% of **total silk production.**

Uni,Bi,and Multi Voltine: Silkworms are classified based on the number of generations (life cycles) per year under natural conditions. If it is one it is Univoltine, if it is two then it is called Bivoltine, and for more than two it is called Multivoltine. In the rest of the period they undergo diapause during the egg stage.

Silk in popular terms may refer only to mulberry silk and sericulture only to the rearing of mulberry silk worm, *Bombyx mori*. Although there are several commercial species of silkworms but, *Bombyx mori* is the most widely used and intensively studied, and techniques for its rearing are the most improved Figure 18.2 shows the life cycle of *Bombyx mori.*

The life cycle of the silk worm ranges from 25 to 30 days through which the eggs reach the stage of cocoons. In betw een, the worms, being voracious eaters, expand more than 10,000 times consuming a lot of mulberry leaves, labour and care. Silk worm has **univoltine, bivoltine** and **multivoltine** species. Multivoltines produce many generations without any rest period throughout the year.

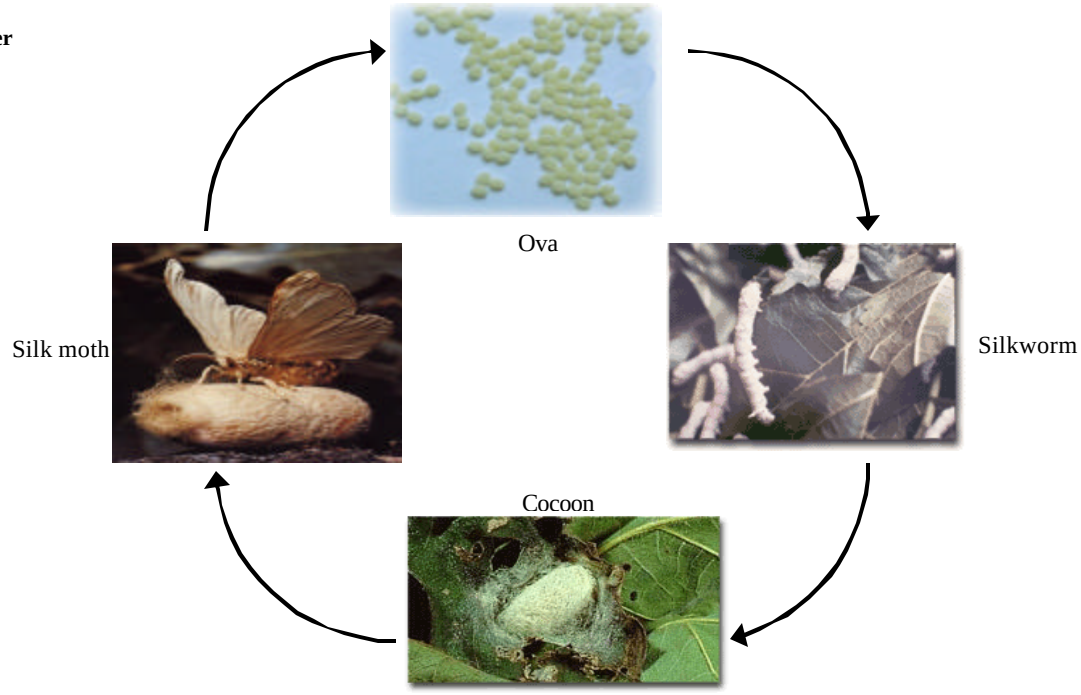

Fig.18.2: Life cycle of *Bombyx mori*

Sericulture in India – A Case Study

Among the developing countries, India enjoys a very favourable position for doubling the present status of silk production of 2,969 tonnes owing to the low cost of labour. Sericulture is ideally suited for improving the rural economy of the country, as it is practised as a subsidiary industry to agriculture.

Five varieties of silk worms are reared in India for producing this natural fibre. *Bombyx mori*, the silk worm, feeds on the leaves of Morus to produce the best quality of fibre among the different varieties of silk produced in the country. *Antherea assama* is confined only to the Brahmaputra Valley of India. It produces the famous mugasilk.Tasar silk is a product *of Antherea mylitta*, which feeds on *Terminalia tomentosa* grown in the thick jungles of Bihar, Madhya Pradesh and Orissa. The recent introduction of *Antherea royeli* and *Antherea perniyi* has enabled the country to produce the oak tasar silk. *Phylosamia ricini*, the eri silkworm, which feeds on *Ricinus communis*, is raised in Assam and Orissa commercially.
Of the total production of 2,969 tonnes of silk in India, as much as 2,445 tonnes is produced by the mulberry silkworms, *Bombyx mori.*

DFL (Disease Free Laying): A silkworm laying which is produced under controlled breeding conditions in a grainage (silk worm seed production centre). Each laying contains about 250 to 500 eggs depending on the silkworm race and breed. Usually, the eggs are allowed to be laid on sheets of paper called 'egg sheets' — each sheet having a place for 20 layings.

The mulberry yield of half an acre of irrigated land could be used to rear about 100DFLs per batch with the family labour of a small household of five members. Mulberry silk is produced extensively in the states of Karnataka, West Bengal and Jammu and Kashmir. About 85 per cent of the country's production is contributed by the Karnataka state by rearing multivoltine hybrids of silkworm and this activity enables the sericulturists to harvest five to six crops a year. Jammu and Kashmir, owing to its salubrious climate during autumn and spring, is producing silk by rearing univoltine silkworms. Other states, namely, Andhra pradesh, Assam, Tamil Nadu, Uttar Pradesh,Himachal Pradesh and Punjab, contribute roughly 1.8 percent to the total production of mulberry silk in India.

Sericulture has progressed under the leadership of Central silk Board which is popularising the new technology of silkworm rearing which gives specific attention to Chowki rearing, quality of mulberry to be used as food, proper spacing and bed cleaning method to reduce the mortality of silkworm. This technology has increased the harvest from 15-20 kg/100 DFLs to 40 kg/100DFLs.The development of hybrids

like "Nandi" and "Chamundi" has opened up new frontiers in increased production in silk.

Sericulture plays a vital role in transferring wealth from richer sections of the society silk is consumed mostly by the affluent and money so spent by them on purchase of silk is distributed among the seri culturists, reelers, weavers and traders. Summary of percentage distribution of money from sale of soft silk fabric of 40.5 to 60 g/m is given in Fig. 18.3.

From the figure we can see that contrary to the traditionalfarmer the primary seri culturist who grows the food plant and raises the silkworm cocoon gets the maximum share.

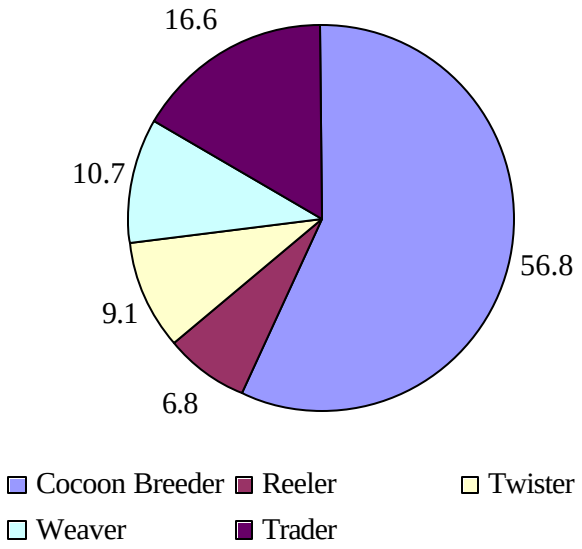

Fig.18.3: Distribution of gross income from sale of soft silk fabrics of 60g/m

Indian farmers are now increasingly prone to take up mulberry cultivation, as the returns from it are more than the other crops besides getting an additional income from silk worm rearing (Table 18.2).

Table 18.2: Annual revenue per hectare from different crops

Irrigated conditions		Rain-fed conditions	
Crop	**Net income per ha/year**	**Crop**	**Net income per ha/year**
Mulberry	15,000	Mulberry	5,000
Sugarcane	12,700	Jowar	550
Paddy	4,500	Ragi	750

SAQ 2

a) How many varieties of silk are produced in India?
b) How does sericulture help to supplement the income of marginal farmers?

18.2.4 Lac Cultivation

Lac is the hardened resin, secreted by the tiny lac insect found in the south eastern region. The Indian lac insect is *Kerria lac* Kerr (Tachardiidae : Homoptera) and the lac insect of Thailand is *Kerria chinensis*. Lac insects settle closely on the twigs of certain host trees, suck the plant sap and grow, all the while secreting lac resin from their bodies. Since the insects are closely spaced on twigs, the resin forms continuous encrustations over the twigs of the host trees.

Lac cultivation can be achieved by planting host plants of lac insect as a component of agroforestry system, on waste and marginal lands; degraded forest areas, panchayat lands, field bunds, etc.

Sticks of lac encrustations (broodlac) which contain mature female (gravid) insects, about to give birth to young larvae, are placed on suitably prepared specific host plants. After emergence from the mother cells, the young larvae settle on the fresh twigs of the host plants, suck the plant sap and grow forming encrustations. The twigs containing these encrustations are harvested after they are fully grown to extract the lac resin.

Lac cultivation is simple, does not need any large investment and requires only part – time attention. Sustained production and steady returns can be achieved by adopting improved methods of cultivation. Thus, lac cultivation can be an extremely attractive In Lac cultivation poor people of tribal areas get employment. Pit digging, planting, watering of seedlings, proper rearing of lac insects, collection of stick lac and brood lac and their processing provides job to the people of weaker section in these areas. There are two maturity periods of kusumi strain: JETHWI (January- February to June-July) and AGHANI (June-July to January –February). (ii) Rangini strain (grows well on palas and ber). There are two maturity periods of rangini strain: one is KATKI (June-July to October-November) and another is BAISAKHI (October-November to June-July).

Fig.18.4: Encrustation of Lac on twigs of host tree. This forms sticklac

Selection of brood lac for further inoculation is done when a tiny yellowish spot appears at one end of encrustation indicating maturity of the brood lac and for collection of lac from host plant, harvesting is done when lac becomes mature. The encrusted shoots are cut and by scraping of the shoots lac is collected.
The raw lac thus obtained is known as **scraped lac** or simply **sticklac** (Fig.18.4). Sticklac is crushed into small grains, sieved, washed with mild alkaline water and dried. This semi-refined product, called **seedlac,** is further refined by a system of hot melting, filtration and stretching into thin sheets which are subsequently broken into brittle flakes called **shellac.** Alternatively the purified lac resin can be in the form of circular discs called **button lac.** If a solvent process is used to purify the raw lac, *dewaxed, decolourised lac* can be obtained as the end product. The normally amber coloured resin can also be bleached with sodium hypochlorite to obtain *bleached lac*, which is white in colour. Bleached lac has specialised demand for coating medicinal tablets, confectioneries etc.

India is the principal lac producing country of the world producing approximately 18,000 metric tonnes of unrefined (raw) lac annually. About 85% of the country's production is exported to various countries. The USA, Germany and Egypt are some of the major lac importing countries of the world.

Lac products are shellac and shellac based varnishes and insulating varnishes.
The various applications of lac are as follows:

Lac Resin

- Food processing industry
- Cosmetics and toiletries industry
- Varnish and printing industry
- Coating of fruits and vegetables
- Electrical industry
- Leather industry
- Adhesive industry
- Pharmaceutical industry
- Perfumery industry
- Miscellaneous applications

Lac Dye

- Food and beverages industry
- Textile industry

Lac Wax

- Polishes (shoe, floor, car polishes etc.)
- Food confectionery and tablet finishing
- Lipsticks
- Crayons etc.

With increasing environment awareness, the importance of lac has assumed special relevance, being an echo friendly, biodegradable and self-sustaining natural material. Since lac insects are cultured on host trees which are growing primarily in wasteland areas, promotion of lac and its culture can help in eco-system development as well as give reasonably high economic returns. Many tribal men and women are already engaged in this trade. They earn Rs.25 to 40 per day and without being displaced from their village.

18.2.5 Aquaculture

Aquaculture constitutes an important ingredient of integrated rural development. It provides opportunities for self employment and income generation to the unemployed and under-employed people in rural areas. Aquaculture has provided protein rich aqua-food basket, which is more diversified, and consumers are getting both fresh water and seafood products.

In addition, the wasteland, unutilised water bodies, and animal, agricultural and agro-industrial wastes can be utilized extensively as environment-friendly tools in aquaculture. Aquaculture has a great role in human resource development by providing protein rich food to the people for good health and combat malnutrition among rural masses in the region. Blue revolution through aquaculture is possible and can largely be based on a two pronged approach: one is to extend the benefit of technology to rural poor by promoting low cost technology, and secondly to achieve the envisaged quantum jump in fish production for domestic supply as well as export earnings. Fish farming has established itself as a profitable venture as compared to traditional agriculture and animal husbandry because of high return per unit area, easy cultural practices, few risks and no marketing problems.

Aquaculture in India

The fisheries sector with an annual growth of 4-6% is contributing 1.28 % to the total gross domestic product of the country and its share in agriculture sector is increasing. The innovation and adoption of technologies like polyculture, integrated fish farming, cage culture and pen culture of carps, cat fishes, mahasher, snow trouts, murrels, live fishes, fresh water prawns, mullets, milk fish, sea bass, shrimps, oysters, mussels, clams, lobster, crabs, sea cucumber and sea weeds have added new dimensions to the life of poor people by bringing prosperity. India's total fish production is 5.35 million tons out of which 1.6 million tons is contributed by aquaculture.

SAQ 3

How can aquaculture prove to be more profitable than traditional farming?

India is the fifth largest producer of eggs in the world and only next to China, USA, Japan and Russia. The per capita availability of eggs and poultry meat was 33 eggs and 1,100 gm respectively.

Indian Council of Agricultural Research has played a vital role for poultry improvement by establishing two poultry institutes, *viz*., Central Avian Research Institute, Izatnagar, U.P. and Project Directorate on Poultry, Hyderabad, (A.P.) These institutes provide necessary research, training and extension support to the growing poultry industry.

18.2.6 Poultry

"Poultry" includes a number of avian species such as chicken, turkey, geese, guineafowl, pea fowl, etc. domesticated for economic purposes. These species perform well under a variety of agro-climatic conditions, which help in raising them successfully almost anywhere provided certain minimum management, and nutritional requirements are met with. These birds are efficient converters of feed into animal protein of high biological value compared to other livestock species. While chicken and ducks are raised for commercial egg and meat production, turkeys, guineafowl, geese, etc. are maintained only for meat production.

Box 18.2: Some poultry breeds

Common poultry breeds are:

American breeds: Plymouth Rock, Rhode Island Red, New Hampshire.
Asiatic breed: Brahma, Cochin, Langshan
Mediterranean breeds: Leghorn, Minorca, English breeds: Cornish, Australorp
Indigenous breeds: Aseel, Busra, Chittagong, Karaknath,

In India poultry keeping is as old as its civilization. Poultry farming remained a disorganized "backyard venture" only to be patronised by poor and weaker sections of the society. Our poultry industry is primarily chicken oriented which accounts for more than 90% of the total poultry available in the country. Ducks are next to chicken in the order of preference and account for about 6% of poultry production. The quail egg and meat have recently become popular and commercial quail farms are being set up throughout the country, both in the government and private sectors.

Indigenous poultry breeds, which are hardy but poor in productivity, continue to dominate Indian poultry scenario. There were strong prejudices against raising of poultry and consumption of poultry egg and meat by higher stratum of the society. Low productivity of indigenous birds, low prices for egg and meat, inadequate knowledge of poultry raising and lack of appreciation of poultry's special role in alleviating poverty and improving malnutrition through protein were the major drawbacks in development of poultry. However, during the last four decades, the entire scenario of poultry farming has changed. Poultry is recognized as an organized and agro based industry with tremendous employment potential. Both large and small farmers have come up all over the country with highly specialised hybrid layers and broilers. At present 500 hatcheries have been established throughout the length and breath of the country to produce and supply commercial hybrid chicks.

The policy of government to achieve self reliance has favoured the establishment of pure line breeding programmes both in public and private sectors for development of genetically improved layers and broilers. Our country has also achieved a respectable measure of self-sufficiency in manufacture of compounded poultry feeds, equipment and machines, pharmaceuticals etc. There is now greater emphasis on poultry related research and human resource development. Major emphasis is being given on processing of poultry egg and meat and manufacture of value added egg and meat products. In India the traditional system of poultry keeping although loosing its importance from day to day under the impact of modernisation and industrialisation, is still prevalent in rural and tribal areas of country. Near about one lakh poultry farms with flock size ranging from 25-250 birds exist in rural areas most of which follow backyard open range system of poultry keeping.

Now that you have a brief idea about some of the alternatives to traditional forms of agriculture, we discuss agro forestry in the next section.

18.3 AGRO FORESTRY

Taungya is a scheme in which small scale farmers are given agricultural land and subsidies on state forest in return for planting and maintaining trees on the plot of land given to them.

Agro forestry is a collective name for land management systems involving positive interactions between trees, crops and/or animals on the same unit of land. It actually involves cycling of nutrients and flow of energy through various trophic levels interacting positively at higher ecological efficiency. Conservation of natural resources and optimisation of productivity could be considered vital to its functioning. Agro forestry has been an age old practice in India, since modern agriculture evolved in forests. From the early *taungya* systems to scattered trees on farm lands, agri-silviculture, silvipasture, agri-horticulture, hortipasture, energy farms, farm boundary planting, aquaforestry, home garden, slash and burn agriculture etc. are various forms of agro forestry practised throughout India. All these systems are the result of human need and support to their livelihood. Of course, variations are there according to the necessity and resources available with the farmers. Most of these practices are seen in small farm holding where there is a need of diverse requirements for the farm family.

Agro forestry is a holistic concept that involves various organisms sharing a habitat and its abiotic and biotic components. It is acknowledged as a potential technology for arresting land degradation, restoring production waste and improving the environment besides enriching the wood products for rural use and industry. Agro forestry reduces the farmers' dependency on forests even as it provides them economic benefits.

Trees can provide many products such as timber, fodder, fuel wood, medicines, and oils. They also help to conserve soil, enhance soil fertility, and provide shelter belts for crops and fruit trees. Queries have been raised on the efficiency of this type of agriculture, especially regarding soil nutrients, which are required by both the groups, i.e. trees and crops, and how they help each other. All plants compete with their neighbours to some degree for these vital resources. But they can also be helpful to each other. For instance, some trees have a light, thin canopy, which allows adequate light to filter through to crops below. Crops growing under them save soil moisture as the protection of the tree cover reduces their rate of evaporation. Many leguminous trees can fix nitrogen, enriching the soil. This benefits subsequent non-leguminous crops, which do not have this capability. Trees also improve the soil in other ways. Leaf litter decomposes and adds nutrients. Even the root systems release nutrients and improve soil structure when they decompose. Some trees capture nutrients lying too deep in the soil, and bring them to the surface and later return them to the soil as litter, which the crops utilize when it decomposes. Trees use nutrients and regain them through their recycling system. However, if leaves and branches are left on the ground to decompose and their nutrients are lost, the tree will have to be nourished with external nutrients added as fertilizer or organic manure.

Strategic Options

Viable agro forestry options for different agro-ecozones have been identified and specific technology packages as strategic options are now available, *viz.* silvipastoral systems on dry degraded lands, agrihorticultural systems on rain fed marginal agricultural lands, agrisilvicultural practices involving different tree species in different areas. Highly adapted tree species have been identified for each agro-ecozone to encourage high productivity and diversify the products for use. Most important multipurpose trees for meeting these demands have been identified, *viz.* *Eucalyptus* hybrid, *Populus delfodes, Acacia* sp., *Dalbergia* sp. *Morus alba*, *Anthocephalus cadamba, Casuarina equisefifolia, Prosopis* sp., bamboos, *Grevillea robusfa, Leucaena leucocephala* etc. The popular agro forestry systems are as follows:

1. **Agri-silviculture system**: Under this system agricultural crops are intercropped with tree crops in the inter-space between the trees and can be grown profitably up to two years in "protective irrigated conditions while in rain fed up to 4 years.

Fodder crops can be grown up to longer duration. The aim of this system is to increase the overall yield of the land and solve the problem of shortage of food, fodder, fuel wood and timber. Agri-silviculture includes home gardens, boundary plantation with Tad palm, trees, shrubs; scattered trees like Babul, Khejri etc. and allay cropping shrubs or trees alternated with crops with fixed width.

2. **Silvipasture system** : This system includes growing of improved pasture species along with tree species. Tree species would be either for timber or fuel cum fodder. Grasses or grass-legume mixtures are grown along with tree species simultaneously on same unit of land. The typical example of this system is Kangayam tract of Tamil Nadu where *Acacia leucopholea* is being raised as intercrop. The tree canopy gives a better shade to the cattle and the pods become palatable feed to the cattle and sheep.

3. **Agri Horticulture system** : This system refers to growing of agricultural crops along with fruit trees, which can be continued up to 5 to 6 years or till the canopy of fruit trees become fully enclosed. If fruit trees are planted at a wider spacing agriculture can continue simultaneously.

4. **Silvi Horticultural system**: This system is like agrisilviculture system and is based on the sustained yield. Tree species are managed to get timber, fuel wood etc. and horticulture crops are grown in between the inter-space. Horticulture crops provide additional benefit in the form of fruits and vegetables. Thus dual benefit is available to the farmers. Silvi horticulture system may vary with the nature of horticultural crops like silvihorti pome (with apple, peas), silvihorti other fruits (orange, lime and other citrus), silvihorti vegetables (with vegetables), silvihorti garden (with ornamental plants) etc.

5. **Silvi-horti-pastural system**: Under this system trees are grown along with fruit trees while grass and legume mixtures are raised in inter-space between trees. The three combinations are based on the principle that each of its components draws nutrients from different layers of soil. For instance in the state of Karnataka, *Casuarina* was intercropped with fruit tree like Mandarin orange and the performance of orange was excellent compared to other trees like *Eucalyptus* and *Leucaena*. The incidence of pest and disease was also negligible on orange when grown with *Casuarina*. Likewise when *Leucaena* was intercropped with fruit tree Sapota *(Archrus sapota)* encouraging results were achieved. Thus there is a need to identify profitable agro-forestry system. This system can solve the problem of wood, food, fodder and restoration of ecological balance. Further by adopting this system the unemployment problem can be reduced to some extent and the socio economic conditions of the farming community will improve.

6. **Silvi-agri-sericulture system**: This is a very complex system where crops or vegetables are grown along with tree species (basically host plants of silk worm). If the tree species is *Terminalia arjuna,* tasar silk worms are reared and the larval excreta acts as a good manure for the crops and silk is obtained as the end product. The pruned branches of tree species are used as fuel.

7. **Silvi-agri-lac culture system**: Under this system crops or vegetables are grown along with host plants of lac insect. On maturity of host plants lac insets are reared. Woody shrubs *Moghania macrophylla* is ideal host for lac insect and is suitable for incorporation in this system. This is very popular in Chotanagpur plateau of Bihar where farmers also grow fodder along with lac host plant.

8. **Silvi-agri-apiculture/Horti-silvi-agri-apiculture system**: This is a complex system and the idea is to manage the land in such a way that the production of flowers, crops and honey is concurrent. The trees and crops are judiciously selected so that the worker bees in the course of ramblings never miss to collect

nectar and pollen. There should not be any shortage of flowers in the system. Farmers in this system collect fuel wood, timber, honey and agricultural crops from the same unit of land. In several parts of the North-East, citrus trees are grown and citrus honey is a priced commodity.

Along with agro forestry, social forestry is also very important for the upliftment of living standard of rural masses. In the next section we will discuss the primary objectives of social forestry

SAQ 4

Distinguish between agri-silvicultural and silvi pasture systems.

18.4 SOCIAL FORESTRY

Social forestry has often been described as forestry of the people, by the people and for the people. It is an answer to the unprecedented pressure on our traditional forest reserves, which have been steadily depleted due to the removal of large quantities of fuel, fodder, small timber, fruit and other forest produce. In practical social forestry, trees are grown along road sides, rail tracks, canals, banks, sides of drainage channel, compounds and around the buildings, cremation grounds etc. around or near the society or people's habitation for producing fuel, fodder, forage, food, fibre, medicines, raw materials of cottage industries. This creates, develops and maintains a favourable microclimate around inhabitation of people; provides shelter for livestock; and shelterbelt for condensation of hot wind as well as for windbreak.
Much forestry related integrated programmes are being sponsored by government agencies and non-government organisations. Various integrated projects based on forestry, aim to maintain the balance between man and nature. They strive for an overall development of the area without causing a strain on nature and natural resources.

The primary objectives of these projects are:

- to maintain the delicate balance between man, nature and natural resources;
- to provide a renewable resource of fuel, fodder, timber and fruit for meeting the needs of the local population; and
- to uplift the living standards of the rural masses by energy saving devices, and animal health services.

In India the various social forestry and integrated forestry programmes undertaken in Jammu and Kashmir, Madhya Pradesh, Himachal Pradesh Uttar Pradesh include plantation of fuel wood and fodder species in forest lands lying in the vicinity of the villages; plantation of fuel wood, fodder and fruit trees on Panchayat /Community lands and degraded lands; distribution of seedlings to local farmers at highly subsidised rates; encouraging school children to plant trees, motivating local organisations such as Panchayats and Mahila mandals to actively participate in social forestry programmes.

Strengthening village institutions holds the key for successful promotion, management and utilization of social-forestry applications. Creating rural opportunities for value-addition of products and establishing mechanisms for efficient marketing is yet another activity that is vital to social-forestry adoption. It is also important to link the farmers and industry through development of village-level institutions. Value-addition facilities, *viz.*, seasoning, grading, conversion and product diversification like, bamboo mat boards, panels, medicinal plant products etc. need to be created at village level to provide employment opportunities and attract higher prices for the products. To give more impetus to this activity, it may be required to stop subsidy on government supply of raw materials to industry and impose duty on the import of pulp. It will also be

important to continuously strive to up- grade planting material and identify newer species of trees for higher production. When social-forestry is viewed in its totality it is realized that certain legal and procedural frameworks require improvement to encourage its adoption.

SAQ 5

What is the need of social forestry?

18.5 PLANTATION CROPS

The SAARC region is rich in plantation crops and with proper scientific management it can provide extra income to the rural masses that are still following traditional technologies. With new technologies available to utilize by-products of plantation crops, progress of rural masses is not far off. Various plantation crops are discussed in following sub-sections.

18.5.1 Coconut

Major share of coconut production in India is contributedby millions of small and marginal farmers mostly in the coastal areas. The important coconut growing states in India are Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, Maharashtra, Goa, Assam, Pondicherry, Lakshadweep, Andaman and Nicobar Islands.

The coconut crop has considerable significance in national economy in view of its vast opportunities for employment and income generation. Every part of the crop is useful in one way or the other (Fig. 18.5).

Fig.18.5: Products from the Coconut Tree

Coconut is mainly cultivated for the nuts from which two important products 'copra' and fibre are obtained. Copra yields oil and oil cake. The trunk of the mature palm is used as timber for houses and the leaves are used for thatching houses, fencing etc. The unopened spathe is tapped for toddy called 'neera'. Sweet toddy can be converted

into jaggery and sugar. Fermented toddy is a mild alcoholic drink and vinegar can be made from it. Water from tender coconut is a refreshing drink. In Kerala, the extraction of coir from the husk of nuts and the manufacture of coir products provides employment for thousands of people. The coconut shell is largely used for fuel and for the production of charcoal. The shell flour is used as filler for plastics.

18.5.2 Areca nut or Betelnut

This is an extensively cultivated tropical palm and the nuts of which form a popular masticatory in India, Middle East, and Far East. India produces annually 150,000 tonnes of areca nut from an area of 18, 34,000ha. It is a tall-stemmed erect palm, reaching varied heights, depending upon the environmental conditions (Fig. 18.6). Palms attaining a height of 30 metres are not uncommon. Areca nut is consumed both as a raw/ripe nut (adaka or Kacha tamul), as dried ripe nut (chali supari) and as semi-mature cut and processed varieties 'Batoldike'' or 'Kalipak'. There are over 150 trade types, differing in maturity, processing conditions and varying in their taste characteristics as per market conditions prevailing at different centres of the country. The drying of the whole fruits for making chali supari requires up to 40 to 45 days of good sunshine, so as to get a moisture level of about 10 per cent. Drying ripe nuts on cement floors reduces fungal infection of the nuts to a minimum level of about 5%. A drier designed recently has been found to be most suitable to produce good quality chali supari. The cup shaped nuts are prepared by boiling tender areca nuts after husking and cutting into halves. An important by-product is the husk of the nuts which can be utilized for making boards, paper etc. The spathe covering the inflorescence and the leaf sheath can be used for making caps and for packing. The palm trunk is a useful building material.

Fig.18.6: Areca nut plantation

18.5.3 Cashew nut

India is the largest producer and exporter of cashew nut It occupies a premier position contributing about 43% of the cashew nut production. The maximum production of raw cashew nut was 5.2 lakh tonnes, obtained from an area of 6.86 lakh ha during

1999-2000. This production is hardly sufficient to meet 50% of the demand of about 825 cashew-processing units in the country. The average demand growth rate for kernels for export and internal consumption is around 13% per annum. Cashew nut is grown over 0.635 million ha today with an average productivity of 658 kg/ha while the demand of the industry is about one million tonnes of raw cashew nut.

18.5.4 Cocoa

Fig.18.7: Cocoa pods

The cocoa plant is a perennial dicotyledonous plant which has been under cultivation since pre-historic times. The centre of origin has been placed in the tropical forests of the Amazon Valley in South America. It is now extensively grown in the continents of Africa, Asia, and South America and in parts of North America. The annual export earnings from cocoa are to the tune Rs. 9 crores. (Compared to the global production of 29 lakh MT, the Indian contribution is insignificant.) To fill the gap between the production and requirement, intensive programmes for production need to be initiated. The fruit is a berry containing 20 to 40 seeds each surrounded by a pulp, which is a transformation of the outer integument of the ovule (Fig. 18.7). The outer cells release a highly mucilaginous substance at full growth and are one reason for preventing fermentation of beans after harvesting.

In coconut plantations spaced at about 7.5 metres, cocoa may be planted either in a single row alternating with coconut or in double rows in triangular positions between the rows of coconut. This crop combination of cocoa and coconut has synergistic effect on the yield of both the crops.

18.5.5 Rubber

Natural rubber is found in the latex of as many as 895 species of plants belonging to 311 genera of 79 families. Of these *Hevea brasiliensis* (Euphorbiacaeae), the para rubber tree is the most important source of rubber. The tree is now grown in the tropical regions of Asia, Africa, and America. It is a hardy, quick growing tree with a straight trunk producing branches 3-5 m above the ground and forming a spreading canopy. The optimum ecological requirements consist of a fairly distributed rainfall not less than 200 cm, a warm humid climate (21 to 35^{o}C) and a well-drained deep loamy soil. It flourishes from the sea level up to altitudes of 450-600 m. Others are *Glaziovi*i (Euphorbiacaeae), *Ficus elastica* (Moracaeae), *Parthenium argentatum* and *taraxacum kok-saghyz* (Compositae). Many other species such as *Euphorbia intisy* (Euphorbiacaeae), *Cryptostegia grandiflora*, and *Landolphia* sp. have been tried as possible minor sources of natural rubber. *Hevea brasiliensis* is a native of Brazil and was introduced in tropical Asia in 1876 through the Kew Gardens (England).

18.5.6 Tea

Tea (*Camellia* spp.) is made from the tender or young leaves and unopened buds of the evergreen tea-plant, popular as a 'healthful herb'. The important tea growing countries are: India, Sri Lanka, East Africa, Japan, Indonesia, Bangladesh, China, Georgia and Argentina. The leading tea growing states of India are: Assam, West Bengal, Kerala, Karnataka and Tamil Nadu, and to some extent in Tripura and Himachal Pradesh. In India tea is grown in about 3, 58,000 hectares and over 468 million kilograms of product is obtained annually. Over one million workers are employed by the tea industries (Fig. 18.9). Two distinct varieties of tea-plant are generally recognised, the small-leaved China (sinensis) and the large-leaved Assam (assamica).

The tea-plant, in the natural state grows into a small or medium-sized tree, but in commercial plantations it is pruned and trained to form a many-branched low bush and is encouraged to produce vigorous vegetative growth by adopting an appropriate schedule of fertilizer applications

Fig.18.9: Tea gardens in Assam

Coffee: India earns considerable foreign exchange by producing 85,000 to 100,000 tonnes of coffee. Arabica (*Coffee arabica*) and robusta (*Coffee canephora*) are the two principal species of coffee which are extensively cultivated in our country. The major coffee growing states in India are Karnataka, Tamil Nadu, Kerala and Andhra Pradesh. While on a limited scale it is also grown in some parts of Orissa, West Bengal, Assam and Madhya Pradesh.

The cultivation of coffee is mainly confined to the hilly areas of the Western and Eastern Ghats where annual rainfall ranges from 1250 to 3000mm.Coffee plant grows well at temperatures between 12 and 36 $^{\circ}$C and the elevation above the sea level influences the quality of the coffee.

In the next section we shall examine the need for cultivation of herbal and medicinal plants as a form of alternative agriculture.

18.6 HERBAL AND MEDICINAL PLANTS

There is a growing demand today for plant-based medicines, health products, pharmaceuticals, food supplements, cosmetics etc. in the international market. The international market of medicinal plants is over 60 billion US dollar per year, which is growing at the rate of 7 percent per annum. WHO has forecast that the global market for herbal products is expected to be US$ 5 Trillion by 2050. Herbal remedies would become increasingly important as people seek natural remedies and gentler, safer products to deal with the prevention of ill health and the promotion of good health. India, with its rich biodiversity has tremendous potential and a natural advantage in this emerging area.

Problems arising out of rapid genetic loss of medicinal plants forced the need for international co-operation and co-ordination to undertake programmes for conservation of medicinal plants to ensure that adequate quantities are available for future generations. Cultivation of medicinal and aromatic species gives scope to continue the supply of quality drugs for future generation. Commercial cultivation of medicinal and aromatic plants is the outcome of implementation of number of critical factors like location selection; good and genetically stable planting materials; good agro-technological practices; nutrient input; harvesting management and implementation of suitable post harvesting techniques to preserve the end product till smart and effective marketing arrangements are made.

The Indian Scenario

You have read in Unit 8 of this course that India is one of the world's 12 leading biodiversity centres, encompassing 16 different agro-climatic zones, 10 vegetation

zones, 25 biotic provinces and about 426 habitats of specific species. It has been estimated that about 45,000 plant species (nearly 20 per cent of the global species) occur in the Indian Sub-continent. About 3,500 species of both higher and lower plant groups are of medicinal values. More than 80 per cent of medicinal and aromatic plants are collected from 17 million hectares of Indian forest land. However, many of these, due to over-exploitation have become rare (*Rheum emodi, Aconitum deinorrhizum*), threatened (*Rauvolfia serpentina, Berberis artistata*), or endangered (*Sassurea lappa, Dioscorea deltoidea*).

The present export of herbal raw materials and medicines from India is approximately about 100-114 million US dollar per year. India is one of the major exporter of crude drugs mainly to six developed countries viz. USA, Germany, France, Switzerland, U.K. and Japan, who share amongst them 75-80 per cent of the total export market.

The scope of herbal industry in India is enormous, but the lack of sustainable harvesting methods is raising concerns for the future of many valuable medicinal plant species. The medicinal properties of most medicinal plants exist in the root, which means that when they are harvested in the wild, the whole plant, including its root, is pulled out the ground and it cannot grow again the following year. It is because of this, and the growing demand for these herbs from both domestic and foreign markets, that many medicinal plants are being over-harvested and threatened in their natural habitat.

The long-term availability of medicinal plants is of vital importance, not just for the herb-collectors who depend on it to earn a living, but also for the future of India's traditional system of medicine, ayurveda, which is rapidly growing in popularity both in India and abroad. Conservation of these plants is therefore of utmost importance.

Out of 45000 different plant species and 15000 medicinal plants, 7000 plants are used in Ayurveda, 700 in Unani medicine, 600 in Siddha medicine, 450 in Homoeopathy and 30 in modern medicine. The Indian Systems of Medicine have identified 1500 medicinal plants, of which 500 species are commonly used in the preparation of herbal drugs. More than 150 of these plant species have been categorised as endangered. The medicinal plants sector at present is not well organised and needs special attention. Though different Ministries and Departments in the Government sector, NGOs and individuals in the private sector are making efforts in different directions, yet there is a need to co-ordinate and systematise these efforts.

An appropriate mechanism for coordination and implementation of policies relating to medicinal plants both at the National and State levels is necessary to facilitate inter-ministry, inter-state and inter-institutional collaboration to avoid duplication of efforts. Therefore, a need for the establishment of a national level nodal body was felt to formulate policies for the medicinal plants sector and develop the potential of this sector through schemes and projects that encourage investment in this sector.

India is bestowed with a treasure of medicinal plants. The supply base of 90% herbal raw drugs used in the manufacture of Ayurveda, Siddha, Unani and Homoeopathy systems of medicine is largely from the wild. Besides this, plants are also used in various industries producing herbal items other than medicines (Table 3). This wild source is speedily shrinking day-by-day. Therefore, there is a need for conservation and sustainable use of medicinal plants. Cultivation is clearly a sustainable alternative to the present collection of medicinal plants from the wild. This can be a potential provider of returns to the farmers/cultivators

Table 18.3: List of important medicinal plants along with their utilization

S.No	Common name	Botanical name	Plant part and usage
1.	Amaltas	*Cassia fistula*	Fruit pulp- Purgative, laxative
2.	Amrita	*Tinospora cordifolia*	Stem- Dyspepsia, fever, urinary diseases, antipyretic
3.	Arni	*Premna latifolia*	Whole plant- Internally and externally dropsy, diuretic
4.	Ashwagandha	*Withania somnifera*	Roots- Cough, dropsy, rheumatism, tonic, astrigent, nerve sedative, gives glow to skin, removes excessive water from tissues, rejuvenating
5.	Ati bala	*Abutilon indicum*	All parts- Urinary trouble, lumbago, diuretic, nervous tonic, anti-pyretic
6.	Bala	*Sida cordifolia*	Seed & root- Diuretic and tonic
7.	Bel	*Aegle marmelous*	fruit and all- For digestive and stomach related disorders.
8.	Gangeran	*Grewia tenax*	All parts- Heart diseases, diuretic, nervous diseases, tonic
9.	Ghrit kumari	*Aloe vera*	Leaves- Cosmetics, glycosides anti-irritant, anti-aging, soothing
10.	Gokhru-big	*Pedatum murex*	Fruit- Diuretic and as a tonic; and other diseases of urino-genital systems
11.	Gokhru - small	*Tribulus terrestris*	Fruit and all parts- Tonic, diuretic
12.	Gugulu	*Commiphora wightii*	Resin- Perfumery, muscular rheumatism
13.	Hingota	*Balanites roxburghii*	Fruit and bark - Whooping cough and skin trouble, bark anthelmintic, family planning
14.	Indrayan	*Citrullus colocinthis*	Fruit & root- Purgative, used in ascites, jaundice, rheumatism & urinary troubles
15.	Isabgol	*Plantago ovata*	Seed & seed husk- Affections of kidney, bladder & urethra, ice-cream industries, substitute of Agar-Agar
16.	Jeevanti	*Leptidinea reticulata*	Whole plant- Tonic, increases milk yield
17.	Kasondhari	*Cassia occidentalis*	All parts- Purgative, for skin care
18.	Khari-Jal	*Salvadora persica*	Seed & root- Purgative, diuretic, cosmetic, dental care
19.	Kounch	*Mucuna pruriens*	Seeds- Disease of nervous system, sex power, dropsy
20.	Mehndi or Heena	*Lawsonia inermis*	Leaves & seeds- For colouring hands, antiseptic, sunscreen agent, astringent, improves skin hydration, hair conditioner
21.	Neel	*Indigofera tinctoria*	Leaves- Extract used in epilepsy and other nervous disorders
22.	Neem	*Azadirachta indica*	All parts- Skin trouble, antiseptic, laxative, insect killer, antiseptic
23.	Raasna	*Pluchea lanceolata*	Whole plant- Arthritis, constipation and respiratory diseases

24.	Safed-musli	*Chlorophytum borivillianum*	Roots - Tonic
25.	Sankhapushpi	*Evolvulus Asinoides*	Whole plant- Brain tonic, hair care
26.	Semul-musli	*Bombax malabaricum*	Roots- Tonic
27.	Senna or Sonamukhi	*Cassia angustifolia*	Leaves & pods - Laxative and purgative
28.	Sharpunkha	*Tephrosia purpurea*	Whole plant- Laxative, diuretic, bronchitis, liver diseases
29.	Shatavari	*Asparagus racæmosus*	Root- Herbal tonic, diuretic used in nervous and rheumatic complaints
30.	Solai gugul	*Boswellia serata*	Resin- Diuretic, stomach related disorders
31.	Utangan	*Blepharis edulis*	Seeds- Aphrodisiac, purgative, disorder of liver, asthma, diuretic

18.7 AGRI-PROCESSING

India is bestowed with a wide range of climate prevailing in its states, which enable the production of all sorts of fruits and vegetables. India stands second in vegetable and fruit production but consumers still feel its dearth because of inadequate availability throughout the year.

The total food production in India is likely to double in the next ten years and with the increase in agricultural produce in the region there is an opportunity for large investments in the areas of food processing. Specialty processing, packaging, frozen food/refrigeration and thermo-processing of fruits and vegetables, fish and fish products, milk and milk products, meat and poultry, alcoholic beverages and soft drinks, and grains are important sub-sectors of the food processing industry. Although there are a number of avenues in food processing sector, preservation of horticultural products like fruits and vegetables needs special attention.

In spite of abundant production the lack of infra-structural facilities results in the poor quality produce and heavy post-harvest losses and farmers are likely to get prices even lower than the production cost in glut season. So, the only way to make profit and make available the products round the year is through agri-processing that is, preserving the products with suitable methods. This will not only enable farmers to sweep in extra profit, but also provide the consumers their required quality products irrespective of the crop season.

Horticulture has been identified as a thrust area for development from agri-processing point of view. A sturdy infrastructure for post-harvest facilities designed to minimize post-harvest losses and ensuring a steady supply of quality harvest produce is on the way. Special incentives are envisaged for export-oriented production with an eye not only on foreign-exchange earnings but also on a growing quality consciousness. Modern knowledge in food processing has advanced enormously incorporating extrusion technology, membrane processes, aseptic packaging, microwave heating, supercritical fluid extraction, biotechnology and rapid techniques of monitoring food quality and safety.

18.7.1 Food Preservation Methods

Food preservation methods are employed to check microbial, chemical and enzymic spoilage of fruits, vegetables and other food products. Some of the common methods of preservation are:

- **Low temperature preservation**: Cooling, freezing, chilling slows down the microbial growth. Cooling below ambient temperatures slows the rate of all chemical and biological reactions and helps in retaining the nutritional value of food products.

Chilling Temperature in range of –1 to +8^{0}C is beneficial for preservation of various products. Some examples are: Fresh meat and fish are preserved at –1 to +1^{o}C; milk at 0-5^{o}C; butter, margarine and cheeses at 5-8^{o}C.

Freezing: in the range of – 18 to –35^{o}C is useful for food preservation. Temperature to be maintained in the domestic freezer is (–18^{o}C) so that water can freeze into ice crystals. Food can be stored for more than one year with minimal loss of nutrients.

- **High temperature preservation**: Various heating processes used to preserve food are blanching, pasteurisation and sterilisation.

  Blanching: inactivates enzymes in vegetables and fruits (prevents browning of peeled potatoes), reduces the level of surface micro-organism and leaching (loss) of water soluble vitamins (10-20% of Vit C), minerals and sugars.

  Pasteurisation: carried out by heating at 63-65^{o}C for 30 minutes or 73-80^{o}C for 5-16 seconds kills all the pathogens and more than 99% of other micro-organisms while food remains safe to consume. It also extend the shelf life of food to several days (milk), few weeks (fruit juices) or months (bottled fruit, canned beer) and nutrient losses are minimal (e.g. 25% vitamin C and 10% thiamine, vit B6, B12 and folacin losses in milk).

  Sterilisation: is carried out for canned food in temperature excess of 100^{o}C (usually 115^{o}C or above). It kills bacterial vegetative cells and spores including the most heat resistant spores of *Clostridium botulinum* and increases storage life for several years. However, under sterilisation hydrolysis of carbohydrates, lipids and proteins takes place. In addition losses of amino acids and 20-50% carotene in vegetables; thermal destruction of vitamins , (80% loss of vit C, 70% loss of thiamine, 100% loss of riboflavin); and 6-9% lowering of protein biological value also takes place. However, sterilisation improves keeping quality and the convenience outweighs the losses.

  Ultra High Temperature (135-140^{o}C for few seconds) is carried out to produce commercially sterile milk and milk products. It facilitates storage life to several months without refrigeration.

- **Preservation by drying** helps in removal of moisture from food and prevents the growth of microbes, prolongs storage life, and is easy to handle and use. Various drying techniques include: liquid drying (spray drying, roller/drum drying, and freeze drying) and solid drying (hot air drying, freeze drying, solar drying).

- **Preservation with salt, sugar, and other chemicals**: Salt, sugar, sucrose, and sodium metabisulphite create an environment unsuitable for microbial growth and other chemical changes such as browning. More than 70% sucrose is used in preserving fruits (jams, marmalade, sweetened condensed milk etc.). Different chemicals used in preserving food stuffs are given in Table 18.4. Chemical preservatives alone do not confer long storage, they usually employed in conjunction with other methods such as pasteurisation, drying etc.

- **Fermentation and pickling** checks the growth of bacteria, yeast and moulds, increases food diversity by changing product characteristics i.e. colour, nutrient content, composition, digestibility, taste and texture.

Table 18.4: Chemical Preservatives generally used for food products

Preservative	Food Product
Sulphite	Fruit juices; dried fruits and vegetables; raw prawns
Sorbic acid	Fruit juices
Benzoic acid	Fruit juices
Sodium nitrate	Cured or salted meat
Methylparaben	Food colours
Propionic acid	Cakes etc.

18.7.2 Technology Development in Agro-processing

In recent years some very important technologies have been developed in the field of agro-processing which are being exploited at the commercial level, for obtaining the following:

- Essential oils from citrus fruits
- Dehydrated products from grapes, pomegranate, mango, apricot etc.,
- Fruit wines
- Various products of indigenous fruits such as *jamun. phalsa,* bael, amla etc.
- Baby foods
- Extraction of Pectin from citrus and mango waste.
- Corrugated fibre board boxes for fruits and vegetables packaging
- Tamarind juice concentrate
- Fruit toffees
- Instant pickles
- Papain form papaya.
- Reduction of losses by pre-harvest spray of $CaCl_2$, fungicides and growth regulators
- Standardization of maturity of many fruits and vegetables for better shelf - life and quality
- Zero energy cool chamber for on-farm storage of fruits and vegetables
- Development of whole tomato concentrate for culinary purpose
- Storage of pulps in flexible pouches
- Use of apple juice concentrate for canning of peach halves
- Techniques for preservation of vegetables and raw mango slices by steeping techniques using food additives

18.8 SUMMARY

In this unit you have studied:

- 'Alternative agriculture' is a broad range of agricultural systems that are alternatives to present common practices and provide an opportunity to increase economic yield per unit area per unit time by virtue of intensification and allied enterprises.

- Alternative agriculture is being practiced now to improve the economy of agriculture and standard of living of the farmers of the SAAR region. But all depends upon the requirements and available resources of the farmer and his ability how judicially he incorporates and manages the mix of the different components.

- The different components for alternative agriculture can be: Social forestry and agro forestry, sericulture, apiculture, plantation, cash crops and medicinal crops, livestock and poultry, aquaculture and bee-keeping.

- Agric ulture and agro-based industries play a vital role in the improvement of rural economy in India and the other countries of South Asia. The limited availability of land, the limited cash returns, and agriculture being confined to one or two seasons in the year, have made villagers to look for supporting rural industries, such as sericulture, livestock rearing, beekeeping, lac cultivation, poultry, aquaculture, agro forestry, social forestry, agri-processing , growing of plantation crops and herbal and medicinal plants.

18.9 TERMINAL QUESTIONS

1. Define alternative agriculture. What are the important components of alternative agriculture?
2. What is bee keeping? Describe the economics of beekeeping.
3. What is sericulture? Mention different species of silk worm found in India along with their host plants.
4. How many strains of the lac crop are grown in India? Describe harvesting of lac. Mention any two uses of lac.
5. Write a note on aquaculture and poultry. How will you integrate these two enterprises in alternative agriculture?
6. Define agro forestry? Describe various systems of agro forestry.
7. What are the major areas for the development of sound social forestry system?
8. What are the important plantation crops of India?
9. What is the importance of agri-processing? Describe the various methods of preservation.