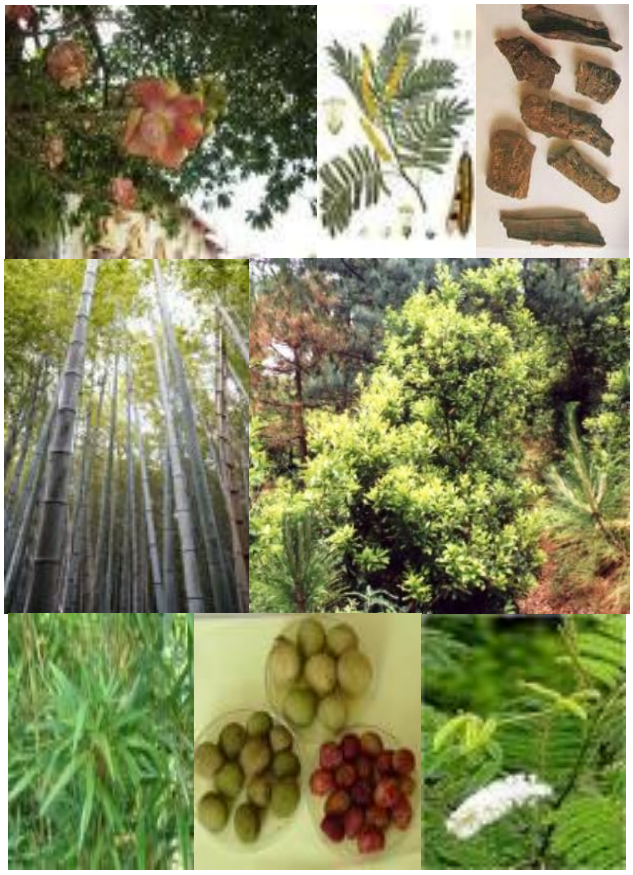
Diploma in
Management of Non-Wood Forest Products

(DMNWFP-16)

Course Title: NWFP Basics (NWFP 01)



Department of Forestry and Environmental Science
School of Earth and Environmental Science

UTTARAKHAND OPEN UNIVERSITY
Haldwani, Nainital, Uttarakhand

Expert Committee

Dr. V.K. Pathak
Vice Chancellor
Uttarakhand Open University

Prof . S.P. Singh. Ex- Vice Chancellor
HNB Garhwal University
Srinagar

Mr. I.D. Pande
Ex-Principal Chief Conservator of Forest,
Uttarakhand

Prof. Uma Melkania
G.B. Pant University of Agri. & Tech.
Pantnagar

Dr. G.C.S. Negi
G.B. Pant Institute of Himalayan Environment & Development
Kosi Almora

Dr. Jeet Ram
Department of Forestry
Kumaun University
Nainital

Dr. Ashish Tewari
Department of Forestry
Kumaun University
Nainital

Mr. Mukund Kumaiyan
Central Himalayan Environmental Association(CHEA)
Nainital

Course Writing and Compilation Team

Prof. Uma Melkania
Depaertment of Environmental Science
G.B. Pant University of Agriculture & Technology
Pantnagar

Dr. Jeet Ram
Department of Forestry
Kumaun University
Nainital

Dr. N.P. Melkania
Department of Envioronmental Sciences
APEX Institute of Technology
Rudrapur, Uttarakhand

Dr. G.C.S. Negi
G.B. Pant Institute of Himalayan Environment & Development
Kosi Almora

Dr. Ashish Tewari
Department of Forestry
Kumaun University
Nainital

Mr. Mukund Kumaiyan
Central Himalayan Environmental Association(CHEA)
Nainital

Dr. Beena Joshi
Department of Forestry, School of Sciences
Uttarakhand Open University
Haldwani

Dr. H.C. Joshi
Department of Forestry, School of Sciences
Uttarakhand Open University
Haldwani

CONTENTS

Unit 1: Status of Non Wood Forest Products

Unit Structure

1.1 Learning Objectives

After you have studied this unit you should be able to:

- To understand the importance of Non–wood forest products (NWFPs) in India and World.
- To develop knowledge about policy and institutional challenges of NWFPs.
- To assess the regeneration status of various Non-wood forest products.
- To develop basic understanding on status of NWFPs in our forest policies.

1.2 Introduction

The forest is a plant community composed of trees and other vegetation which contains not only a great quantity of timber reserves, but also abundant non-wood plant and animal

resources. In China the development of non- wood forest products (NWFPs) resources has been given high priority over a decade. NWFPs constitute a large proportion of total exports of forest products in China and several other countries of the world and they have become essential means of livelihood for the people. It is estimated that 60 percent of the total production of NWFP is consumed locally. The contribution of some of the NWFP, through sales comes to nearly 50 percent of the total revenue from the forestry sector in India. Nearly 400 million people living in and around forests depend on non-wood forest products for their sustenance and supplemental income. NWFPs provide as much as 50 percent of the income to about 30 percent of rural people. The high potential of NWFPs in India should be rationally used through scientific approaches aided by research, acquisition of technology and people's participation. Intellectual property rights over knowledge about the uses and properties of NWFPs need to be suitably protected.

1.3 Status of Non-Wood Forest Products

Non-wood forest products (NWFPs) deserve special mention because of their grant potential to support an economic development consistent with the principles of Sustainable Forest Management (SFM). Non-wood forest products (NWFPs) cover a wide range of products (goods & services) from thatching materials to medicinal plants. These products are essential needs of local communities. Some NWFPs, such as latex, gums, resins, essential oils, flavours, fragrances and aroma chemicals help to promote value added processing, niche marketing and export trade. Non-wood forest products (NWFPs) can provide increased employment opportunities and income earning capabilities. Deriving the full benefits of some of the high value NWFPs, requires specialized/ sophisticated skills ranging from bio prospecting, at the resource end to quality control, storage and packaging at the market end. Management of NWFPs will decide the sustainability of forestry in future.

Nearly 400 million people living in and around forests depend on NWFPs for their sustenance and supplemental income. Non-wood forest products (NWFPs) provide as much as 50 percent of the income to about 30 percent of rural people.

It is heartening to note that, in this context, there is a growing realization now that NWFP have a tremendous potential in meeting the subsistence needs of local people on the one hand while alleviating their abysmal poverty on the other. Another striking feature of minor forest products (MFPs) and non-wood forest products (NWFPSs) is that they can be used

on a sustainable basis under scientific manner without adversely affecting the resource base. In this respect they differ considerably from 'Major Forest Produce'.

Non- Wood Forest Products (NWFPs) is an umbrella term used for a vast array of goods of biological origin other than timber derived from the forests. However, considering many conservations, cultural and ethical issues related to wild animals and their derivatives, these have been excluded from being considered as NWFPs. These are a wealth of useful goods with significant potential to ensure livelihood security at community level. Based on origin, NWFPs may be arranged in different classes viz., plant fruits, seeds and nuts; plant exudes-latex, resin, and nectar; plant parts-stem, leaf, roots, bark, apical buds, flowers, mushrooms and orchids and non plant products such as lac and silk. Commonly collected NWFPs in the Himalaya include a variety of medicinal and aromatic plants (MAPs), pine resin, lichens, moss, wild mushrooms, berries and honey. The values of NWFPs in poverty alleviation of marginalized forest-dependent communities has for long been acknowledged. The focus of interest is now on whether sustainable harvest from wild, cultivation on private farmland and commercialization of NWFPs can support local people to achieve sustainable livelihood in changed socio-economic scenario.

The contribution of non- wood forest products (NWFPs) to the forestry sector in most countries is significant, and studies are showing that they have been undervalued in the past. A recent valuation undertaken by the Ministry of Environment and Forests in India estimates that 220 million tonnes of fuelwood, 250 million tonnes of grass and green fodder and 12 million m^3 of timber are removed from India's forests annually. These products are estimated to be worth US$ 10 billion (Mukherjee, 1994).

In India, NWFPs provide about 40 percent of total official forest revenues and 55 percent of forest-based employment. Nearly 500 million people living in and around forests in India rely on NWFPs as a critical component for their sustenance (World Resources Institute, 1990). In Madhya Pradesh, the NWFPs which are primarily collected by tribal (i.e. members of local indigenous groups) women are worth more than Rs 21 billion (US$ 700 million) annually (Worldwatch Institute, 1991). Based on a study of ten forest protection committees under the Joint Forest Management programme, it was found that the income from NWFPs ranges from Rs 234 to Rs 5569 (US $8-$186) per hectare per year with a mean of Rs 2299 (US $79) (Malhotra et al., 1991).

Furthermore, revenues from NWFPs have been growing faster than revenues from timber in the past. For example, compound growth rates in revenue from NWFPs in India during the 1968/69 to 1976/77 period were 40 percent higher than those for timber. Export earnings from NWFPs on average account for about 60 to 70 percent of total export earnings from forest products, and this proportion has been rising. Moreover, there is considerable scope for increasing exports further by exploiting untapped resources as the current production of most NWFPs is estimated to be about 60 percent of the potential production. In the case of non-edible fibres and flowers, production is only 7 and 12 percent, respectively, of the potential production (Gupta, Banerji and Guleria, 1982).

It is now felt increasingly that management and development of NWFP resources is essential for various reasons. First, forest management focused on the production of NWFPs may be ecologically and economically sustainable provided that extraction rates do not exceed the maximum sustainable yield. Tribal communities have been involved in NWFP utilization for centuries without destroying the resource base. Managing forests for production of NWFPs also implies maintaining biological diversity of both plant and animal species. Second, non-timber forest products are a vital source of livelihood for a large proportion of the poor living in or close to the forest in most tropical countries. In West Midnapore district in West Bengal, many village communities derive as much as 17 percent of their annual household incomes from NWFPs (Malhotra et al., 1991). Other estimates suggest that up to 35 percent of the income of tribal households in India comes from the collection of unprocessed NWFPs. Also, since NWFPs involve a large variety of seasonal products, returns are frequent and relatively continuous. Moreover, local processing of NWFPs can increase off-farm rural employment opportunities. Small-scale forest-based enterprises, many of them based on NWFPs, provide up to 50 percent of income for 20 to 30 percent of the rural labour force in India (Campbell, 1988).Third, in addition to subsistence and income-generating potential, NWFPs also provide food security to large low-income populations, their cattle and other domestic animals, particularly during droughts or famines (FAO, 1989).

A major challenge related to the further development of NWFPs is the limited availability of documentation related to sustainable harvesting levels. In the past, studies on timber have dominated the scientific forestry literature. There are ethnobotanical studies which list a wide variety of forest products, descriptions of economically useful plants and scattered regional profiles of NWFP trade. The difficulty stems from a singular lack of hard scientific data on

the economics of NWFP management, trade and marketing in different forest types; on biological production functions for most NWFP species; traditional harvesting and utilization patterns; and the impacts of commercialization and changing use patterns on the state of NWFPs and related activities.

Since 1921, when commercial exploitation of Medicinal and Aromatic plants(MAPs) in the hill areas of Uttarakhand, first began through auctions, collectors have been subjected to various government prescribed procedures and guidelines. In 1950, the Department of Cooperation (DOC) was awarded marketing rights. In 1962, this system was replaced by private contractors who paid a fixed amount in royalties. These contractors were appointed by the Forest Department. This system was scrapped after the complaints about exploitation of collectors and non remunerative wages and the DOC system was returned in 1979. In the mid 1980s, the Medicinal plants and Herbs Development Project (MPHDP) was initiated which entailed the establishment of gross roots level local cooperatives with a paid government employee from the Horticulture Department as secretary, affiliated to district level organization called Bhesaj Sanghs (Medicinal Plants Cooperative Unions).

In Uttarakhand and much of the Himalaya, the most profitable NWFPs are endangered and threatened medicinal plants whose extraction has been banned after India became a signatory to the Convention on International Trade in Endangered Species (CITES) on trafficking in endangered species of plants and animals. Hence for many of these NWFPs, there exist significant legal issues if any kind of collection is to be permitted. Yet, illegal extraction continues on a large scale with both local collectors and migrant labour (hired by traders) involved in this activity depending on the products and region. While much of the rural community is classified as agriculturists, the traditional lifestyle of the people living in Uttarakhand, like that of most highland communities across the World, had distinctive characteristics and cannot be as easily compartmentalized. Traditionally, the rural economy has consisted of a basket of activities, in which agriculture and animal husbandry provide the base to the subsistence economy. Trading across borders, handicraft and extraction and processing of NWFPs, provided the base for the market economy.

Essential to the survival of the agro pastoral- economy, which is still the mainstay of the majority of the rural people is the dependence on forests for all elements of life, e.g., firewood, fodder, fibre, medicines, supplementary foods, water and soil conservation and

fertility maintenance. Leaf fodder for cattle and leaf litter for cattle bedding provide energy and nutrient inputs that sustain agriculture in Uttarakhand.

Biomass products such as fuel wood, fodder and leaf litter while neglected in almost all accounting system need to be recognized as the most valuable NWFPs being extracted from the forests and a basis of the current rural economy of Uttarakhand. Theses biomass products are however often treated in a category of their own and for the purposes of the discussion below are not being included as NWFPs.

The SFD (State Forest Department) is responsible for production and sustenance of NWFPs. However, it does not trade in NWFPs with the exception of resin. It mainly acts as a regulator in the total process of procurement and collection. It allots coups to registered agencies, such as Uttarakhand Forests Development Cooperation (UFDC), Bhesaj Sanghs, Garhwal Mandal Vikas Nigam (GMVN) and Kumaun Mandal Vikas Nigam (KMVN) for procurement and collection od NWFPs and charges royalty on such collection.

Resin is procured and traded by the forest department through the three main depots in the state to different units inside and outside the state. At present the trade process of the NWFPs other than resin is controlled by UFDC. It is functions as a corporate body and is involved in the scientific management of forest resources. Until recently, it primarily deals with the trade of the timber and minor minerals from the forest area. Since 2004, it has also taken the responsibility of trade of MAPs.

Herbal Research and Development Institute (HRDI) set up as a research and development agency, HRDI has a good field establishment in Chamoli district of the state. The HRDI is helping in certification of farmers for MAP cultivation and training and developing of package of practices. The recent inclusion of the Bhesaj Sanghs as a partner to HRDI further strengthens the ability of this organization to deliver results in this sector.

Bhesaj Sangh is a cooperative mechanism for the regulation of medicinal plants collection and their trade in the state. They are district level collectors cooperatives, which were set up under the Horticulture Department. Bhesaj Sanghs were mandated with training on medicinal plants cultivation for growers. However, the functioning of the Bhesaj Sanghs is not very professional and the politicization of this body has been a major hindrance. Recently, there has been an attempt to professionalize this body through improving coordination and expertise provided through the HRDI. In theory, under the Bhesaj Sanghs,

members of village- based cooperative societies were to be trained in sustainable harvesting/collection techniques and then issued with license at the start of collection season for rights to harvest specific species that are not under the endangered or threatened categories.

Thus, there was an excellent institutional mechanism in place which was supposed to assist in minimizing exploitation of local collectors by middle-men while at the same time conserving endangered MAPs. However, the profit earned by the Bhesaj Sangh is low and it is estimated that a small fraction, well less than 5% of the total trade in NWFPs occurs through these institutions. Typically, once a member obtains a license to harvest MAPs from the Sangh, it acts as a contractor, hiring a group of cheap migrant labour to do the actual MAP collection totally unsupervised. Some time not only harvesting is carried out unsustainably, but in order to increase profitability a range of MAPs many of them endangered are collected and sold to private traders.

G.B.Pant Institute of Himalayan Environment and Development (GBPIHED) an autonomous institute of Ministry of Environment and Forests, High Altitude Plant Physiology Research Centre (HAPPRC) of Garhwal University, Srinagar, and various NGOs are involved in research and development programme on medicinal plant conservation and cultivation. These organizations are also engaged in capacity building of local communities and extension activities.

It is heartening to know that some of the traditional farmers inhabiting the buffer zone of Nanda Devi Biosphere Reserve have successfully domesticated a number of medicinal plants including Angelica glauca, Carum carvi, Megacarpea polyandra, Pleurospermum angelicoides, Saussurea costus and Allium spp etc., at small scale.

The under mentioned provisions of National Forest Policy, 1988 are very important in the context of Minor Forest Produce (M.F.P.):

Meeting the requirements of minor forest produce and small timber of the rural and tribal populations

Increasing the productivity of forests to meet essential national needs.

Minor forest produce provides sustenance to tribal population and to other communities residing in and around the forests. Such produce should be protected, improved and their production enhanced with due regard to generation of employment and income.

The life of tribal and other poor people living within and near forest revolves around forests. The rights and concession enjoyed by them should be fully protected. Their domestic requirements of minor forest produce should be the first charge on forest produce.

Having regards to the symbiotic relation between the tribal people and forests, a primary task of all agencies responsible for forest management, including forest development corporations should be to associate the tribal people closely in protection, regeneration and development of forests as well as to provide gainful employment to people living in and around the forests.

Non- wood Forest produce has been given an imporatnt place in the U.P. State Forest Policy of 1998. There is very close relationship between forests and tribal & rural people living inside and near forests. Success of any scheme of conservation of forests is not possible without their active co-operation. Non wood Forest Product viz. Tendu patta, resin, cane, herbs, and shrubs, mahua, chiraunji, anola, flowers and fruits etc. form an important part of the life of people living in and around forest and also provide profitable employment opportunities for them. All such non timber forest produce shall be identified and their protection, regeneration and optimum collection shall be done with their interest in view. With all this in mind people/ tribals living in and around forests shall be given facility of free collection of mahua, cheraunji, honey, wax, and fuel for self use without causing any damage to the forest wealth in any way.

The governments of various states have given concessitions to various tribes for the collection of the some NWFPs without harming the forests in any manner- Aola, Gum, Honey, Wax etc.

These facilities will be admissible only to the residents of those villages who have been duly notified as right holders or concessionists or are proposed under the forest settlement operations and in case of hills for residents of village chaks situated within the reserved forest boundaries. Under the facilities mentioned above, free of cost collection will be allowed to bonafied villagers only & not to any outsider.

1.4 Regeneration Status and Production of Various Categories of NWFPs

We have tried to very briefly discuss the regeneration status of the various plant and tree species under the categories of leaves, bamboos, flosses, tannins and dyes etc. The section includes the local name, brief distribution, uses and regeneration potential.

1.4.1 Leaves

1. Diospyros melanoxylon

Commonly known as “tendu”, but also called “abnus” in Andhra Pradesh, “kendu” in Orissa and West Bengal, “tembru” in Gujarat, “kari” in Kerala, “tembhurni” in Maharashtra and “balitupra” in Tamil Nadu.

Uses: Leaves are used as wrappers of tobacco to produce bidi. Off – cuts of leaves are burned and the ash is used in tooth powder.

Distribution: The species is abundant in Madhya Pradesh, Orissa, Maharashtra, Andhra Pradesh, Bihar, Rajasthan, Uttar Pradesh, Gujarat, Tamil Nadu and West Bengal. It generally grows in dry mixed deciduous forests occurring alongside Shorea robusta and Tectona grandis.

Regeneration: Under natural conditions, seed germinates in the rainy season and seedling production is plentiful. Seedlings tolerate considerable shade but for optional development more light is required. Seedling resists frost and drought but are vulnerable to excessive dampness. The profusion and tenacity of root suckers ensure the survival and spread of the species without planting. About 40 percent of fresh seed germinates. Germination starts after 36 days and is complete in 80 days. It is the best raise seedling in long narrow baskets and transplant the seedlings with the second rains. Coppicing yields the best quality leaves and also facilitates easy collection.

Annual production and value: Around 300,000 tons of bidi leaves are produced annually in India, of which over 85 percent is collected from Madhya Pradesh, Orissa, Maharashtra and Andhra Pradesh. The values of these leaves is based on an average price of Rs. 15,000 per ton, but rates vary from state to state, according to demand, availability of leaves and location of *bidi* making industries.

2 Bauhinia vahlii

Local name of Bauhinia vahlii is “Mahul” in Uttar Pradesh and Madhya Pradesh, and “siali” in West Bengal and Orissa.

Uses: Leaves are used for making cups and plates and for wrapping foods.

Distribution: It is a giant climber and one of the most abundant Indian Bauhinia species. The species is distributed in the sub- Himalayan region up to 3,000 meters above sea

level in Assam, Central India, Bihar, Eastern and Western Ghats. Commercial collection of leaves is done in Madhya Pradesh, Orissa and Andhra Pradesh.

Regeneration: The species grows naturally in the forests. No efforts to regenerate it artificially are made. It is usually considered a weed because of the damage it does to healthy trees by climbing and spreading over them.

Annual production and value: In Madhya Pradesh, about 780 tons of leaves are collected, valued at approximately Rs. 2 million. In Orissa, over 160 tons of dried leaves and 86 million leaf plates are marketed annually. Collectors receive only about Rs. 1.50 per kg and earn only Rs. 8 to 10 per day. Therefore, collection of Bauhinia leaves is done only as a last resort during the low- income.

1.4.2. Bamboos

Over 100 species of bamboo occur naturally in India. *Bambusa arundinacea, B. tulda, B. polymorpha, Dendrocalamus strictus, D. hamil-tonii, Melocanna baccifera and Ochlandra travancorica* are the most important species because of their wide availability. Dendrocalamus strictus and Bambusa arundinacea are the two principal economic species.

Uses: Because of its fast growth, easy propagation, soil binding properties and early maturity, bamboo is an ideal species for afforestation, soil conservation and social forestry programs. Bamboo is strong, straight and light. It is hard and hollow and easy to work. It comes in many sizes and has long fibres. Such characteristics make bamboo highly versatile. Among bamboo's medicinal properties is banslochan, a secretion found in the culums used as a cooling tonic, aphrodisiac and as a treatment for asthma and coughing.

Distribution: It is found almost everywhere. Its distribution is governed largely by rainfall, temperature, altitude and soil conditions. Most bamboo requires a temperature of 8^0 to 36^0C, a minimum of 1,000 mm of rainfall annually and high humidity for good growth. Bamboo is an important constituent of many deciduous and evergreen forests and extends from tropical to mild temperate regions. It grows on flat alluvial plains up to altitudes of 3,050 m above mean sea level.

Regeneration: Between seedling periods, reproduction of bamboo is by asexual means. In bamboo clumps, rhizomes grow under-ground and produce new culms as annual shoots. This process continues until the plant produces flowers and seeds, then dies. The most common method of vegetative reproduction is by rhizomes or offset planting. Bamboo

flowers gregariously after long periods although sporadic flowering occurs almost every year. During the years of gregarious flowering, the forest floor is carpeted with seedlings and the areas are naturally regenerated.

Annual production and value: The price of bamboo varies with its end use. Most of the annual cut is used in making paper or rayon for which producers receive about Rs. 300 per ton. The value of the potential annual cut is Rs. 1,367 million.

1.4.3. Gums and Resins

Gums are translucent, amorphous substances which are degradation products of the cell wall of woody species. They exude spontaneously from trees and are soluble in water. Resins also are exudates but are soluble in alcohol not water. Resins often occur mixed with a high percentage of essential oils known as oleoresins. When oleoresins include some gum, as in the case of exudation from gums as in the case of exudation from *Boswellia serrata*, they are called oleoresins.

Uses: Commercial gums enter the market in the form of dried exudates. The varieties having the least color and highest adhesive power and viscosity are the most valuable. The finer grades are used in clarifying liquors, “finishing” silk, and in the preparation of quality water colors. In the cosmetics and pharmaceutical industry, gums serve to emulsify or bind mixtures in creams lotions and ointments. Resins are used in the manufacture of lacquers and varnishes. Resinous substances can be used for waterproof coatings. They are used in medicines for sizing paper, for incense and in the preparation of sealing wax and other products. Oleoresins are used in perfumery and medicines for making varnishes and lacquers as fixative and in scenting soaps.

Annual production and value: Madhya Pradesh has the potential to produce as much gum karaya as the rest of India combined. Approximately 1,400 tons of gum karaya are collected annually from other states valued at about Rs. 60 million. Production of other gums is about 1,900 tons fetching Rs. 12 million annually. About 46,000 tons of oleoresins are obtained from *Pinus roxburghii* each year, valued at approximately Rs. 2.8 million.

1.4.4. Oil seed

India has about 86 different oil seed is collected from Shorea robusta, Madhuca indica, Mangifera indica, Garcinia indica, Azardirachta indica, Pongamia globra, Schleichera trijuga, Salvadora oleoides,S.persica and Actinidaphne hookeri.

Uses: Sal (*Shorea robusta)* seed cotyledons yield the well known sal butter used for cooking and lighting. Mahua (*Madhuca indica)* seed is used in the production of washing soaps, refined oil can be utilized for cooking and also used in jute industry and in the manufacture of lubricating greases, candles, bathing oils, fatty alcohols and stearic acid. It is good laxative and is used in treating habitual constipations, piles and hemorrhoids. Karanj (*Pongamia globra)*, both the seed and oils are poisonous but they possess remarkable medicinal properties. The seed is carminative, purifies and enriches the blood and is used for inflammation, earache, lumbago and chest ailments. The oil is styptic, anti-helminthic and good for rheumatism and cutaneous infections and as a remedy for scabies and herpes. Kusum (*Schleichera trijuga*) oil produced is utilized by the soap industry. It is used in hair dressing and in medicines used in treating skin diseases, rheumatism and headaches. Neem (*Azardirachta indica*) oil is used in soap and local medicines. Mango (*Mangifera indica*) seed oil is used as a cocoa butter substitute. Khakan (*Salvadora oleoides*) and pisa (*Actinidaphne hookeri*) oils are used in making soap. The fruit of khakan is edible and is fed to cattle to increase milk yield.

Annual production and value: Sal seed is collected and marketed on a commercial scale. The potential production is estimated at 5.5 million tons but current collection is only 100,000 tons, valued at Rs. 200 million. Mahua has a potential kernel production of 1.1 million tons but the annual collection is around 25,000 tons, valued at about Rs. 17 million.

1.4.5. Essential oils

It is also called volatile oils, are liquids which possess a pleasant taste and strong aromatic odor. They occur in about 60 plant families and are frequent or abundant in the Labiatae, Rutaceae, Geraniaceae, Umbellifereae, Asteraceae, Lauraceae, Graminae and Fabaceae families. Any part of the plant may be the source of essential oil. They are used in making perfumes, soap and other toiletries. Many have therapeutic and antiseptic properties. Several others are used as solvents in the paint and varnish industries, as insecticides and deodorants and in the manufacture of synthetic scents and flavors. The important essential oils produced in India are oils of sandalwood, Lemon grass, palmarosa, eucalyptus, khus and linaloe.

Estimated production of some of the important essential oils produced in India are about total 2,830 tons.

1.4.6 Fibers and Flosses

A. Fibers: Fiber fall into three categories, soft, hard and surface. Soft fibers are obtained from the bast or stem of plants; hard fibers from the leaf; and surface fibers are those which are borne on the surfaces of stem, leaves, seeds etc. based on their general use they are classified as textile fibers, brush fibers, plaiting and weaving fibers, filling fibers, natural fabrics and paper making fibres. The most important fibers coming from the forests of India are from the families of Bambacaceae, sterculiaceae, Tiliaceae, Fabaceae, Asclepiadaceae, Myrtaceae, Moraceae,Urticaceae, Palmaceae, Musaceae and Gramineae.

Various species are commonly used by cottage industries but only Agave sisalana and Sterculia villosa have commercial importance. Agave fibers are used in making ropes and mats. The fiber is also useful for cordage, twins and nets.

Regeneration: Agave plants usually grow in semi-arid tropical regions. They are propagated from rhizomes or bulbils. Sterculia villosa is mainly found in Uttar Pradesh, Tamil Nadu and Kerala, although it is scattered throughout most of India.

Annual production and value: It is estimated that around 2,500 tons per annum of agave fibers are produced in the country, with a present value of Rs. 45 million.

B. Flosses: Flosses are obtained from certain wild fruits. Important species are Bombax ceiba and Ceiba pentandra. Bombax ceiba grows throughout the Indian plains and Deccan plateau. Ceiba pentandra trees are found in Western and Southern states and the Andaman Islands.

Uses: The floss from Bombax ceiba is obtained from capsule and is known as “Indian kapok”. The floss is soft and strong and used in life-saving devices for boats, stuffing for cushions, pillows and mattresses, thermal insulation and sound proof covers and walls. Flosses obtained from the fruit of Ceiba pentandra are elastic and are used in the manufacture of life belts and buoys.

Annual production and value: About 300 tons of kapok are produced annually in India with a value of Rs. 30 million.

1.4.7 Grasses

Grasses are used for paper making, cattle fodder, matting, ropes, thatching and in manufacturing furniture, baskets and screens.

Regeneration: *Eulaliopsis binata, Saccharum munja, Cenchrus ciliaris, Vetiveria zizanioides, Thysanolaena maxima* and some other fodder grasses are planted using cutting, slips or seeds.

Annual production and value: Some 0.3 to 0.4 million tons of grass could be harvested annually in India. Some 60,000 to 80,000 tons of sabai grass are purchased each year by paper mills. The price of sabai grass is around Rs. 300 per ton.

1.4.8 Tannin and dyes

A. Tannin: Tannins are polyphenolic compounds widely distributed among India's flora. They occur in varying concentrations in all plant material, but only certain plants contain concentrations permitting commercial exploitation. Tannins are classified as condensed or hydrolizable. Different parts of plants may contain different types of tannins.

Uses: Ninety **(**90) percent of the total vegetable tannins in the world are used by the leather industry. India has the largest livestock population in the world.

The important tannin yielding plants species are *Terminalia chebul*(Myrobalan)*, Acacia mollissima* (Wattle), *Acacia nilotica* (Babul), *Cassia auriculata* (avaram) etc.

Annual production and value: Around 78,000 to 100,000 tons of myrobalan nuts are estimated to be produced annually, valued at 15 to 20 million. Over 23,000 tons of wattle bark are harvested every year, valued at Rs. 38 million. Annual production of avaram bark is estimated at 23,000 tons, valued at about Rs. 35 million.

B. Dyes: Over 2,000 plant pigments are known of which only a few are of a commercial importance. Various parts of plants like roots, stems, bark, leaves, fruits and seed may contain colouring material which can be exploited commercially. Some plants have more than one colour depending upon which parts of the plants are used. Dyes are substances that impart colour to a material and are generally soluble in water. The pigments are generally not soluble in water. To be applied to a staining material they are first ground into a fine powder and thoroughly mixed with some liquid (dispersing agent). Vegetable dyes have not been able to successfully compete with artificially dyes in recent years.

1.4.9 Drugs and Spices

India's medicinal plant wealth is comprised of about 1,500 species. Every region of India has contributed to its development. Drugs have been classified depending upon the plant organ from which they are derived: roots and other underground parts, bark, wood, leaves, flowers and fruit and seed. The important species are *Dioscorea deltoidea,Salanum khasianum, Costus speciosus, Datura stramonium, Atropa acuminate, Rauwolfia serpentine* and *cassia angustifolia.*

1.4.9 Spices

Spices are aromatic vegetable products characterized by pungency, strong flavors and sweet or bitter taste. They occur naturally in some forests and are also cultivated in some regions. The important spice–yielding plants are *Alpinia glanga* (greater galangal), *Cinnamomum zeylancium* (cinnamon or dalchini), *Curcuma spp. (*haldi), *Elettaria cardamomum* (cardamom) and *Piper longum* and *P.nigrum* (pepper).

1.4.10 Animal products

A. Lac: Commonly known as "shellac" in its refined flake form, lac is a resinous secretion from the insect Laccifer lacca, which feeds on the plant sap.

Uses: Lac is presently used for various purposes in plastics, electrical, adhesive, leather, wood finishing, printing, polish and varnish, ink and other industries. It is also the principal ingredients of sealing wax.

Annual production and value: About 14,500 to 20,000 tons of stick lac is produced annually in India. Its price varies from Rs. 4,500 to 16,000 per ton depending upon quality most of the produced sells around Rs. 14,000 per ton. Thus, the total value of the annual production in India is Rs. 203 million to Rs. 280 million.

B. Honey and wax: Honey forms a natural nutritious food for the rural people. It is also used widely for medicinal purposes. Two species of bees, Apis dorsata (rock bee) and Apis indica (Indian bee) produce honey. The former is wild in montane and sub-montane regions throughout India.

Annual production and value: About 250 tons of rock bee honey and 98 tons of Indian bee honey are produced annually. At a price of Rs. 40 per kg, the total value of honey produced is Rs. 139 million.

Bee's wax is used in the manufacture of furniture and floor polishes, dressing and water proofing of leather goods. About 28 tons of wax are produced annually, valued at approximately Rs. 1.6 million.

C. Silk: India produces four kinds of silk: mulberry, tassar, muga and eri. Silk is obtained from cocoons of silk worms. Its production has four components; 1) cultivation of host plants for silk worms, 2) rearing silk worms up to cocoon stage, 3) reeling of cocoons into continuous filaments called raw silk and 4) silk throwing and weaving by which filaments are twisted and woven into fabrics.The silk worm Bombyx mori is fed on mulberry leaves cultivated in plantations. There are other silk worms which are found wild on forest trees, the best known of these is Antheraea paphia, which produces the famous tassar silk of India. It feeds on several trees such as Anogeissus latifolia, Terminalia tomentosa, T. arjuna, Lagerstroemia parviflora and Madhuca indica.

Annual production and value: Estimated annual production of tassar silk is 130 tons. Production of other types of silk exceed 10,000 tons.

1.4.11 Edible plant products

Natural forests supplements the food supply for human beings. Several forest fruits and seeds, flowers, rhizomes, tubers, roots, barks etc. are consumed by people during periods of food scarcity and in normal times. A number of tree species provide such edible products. Important fruits are from *Bachanania lanzan* (Chironji), *Anacordium occidentale* (kaju), *Pinus gerardiana* (chilgoza), *Emblica officinalis* (aonla),*Tamarindus indica* (tamarind),*Aegle marmelos* (bel), *Feronia elephantum* (kaitha), *Artocarpus lakoocha*(Barhal), *Syzygium cumini* (jamun), *Annona squamosa* (custard apple), *Carrisa opaca* (karaunda), *Juglans regia* (akhrot), *Moringa oleifera* (drum stick) and *Zizyphus jujube* (ber).

The following forest species are particularly important in producing delicacies consumed by rural people: *Buchanamia lanzan* is commonly known as chironji, achaar or char. It is frequently found in dry, mixed deciduous forests of Uttar Pradesh, Bihar, Madhya Pradesh, Orissa, Maharashtra, West Bengal and Andhra Pradesh. The market price is about Rs.120 per kg.

Anacardium occidentale is a small tree, known as cashew nut or kaju. It is grown in Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Goa and Western Maharashtra. The average yield

of kernels per tree ranges from 9 to 18 kg. The price of raw kernel is Rs. 30 per kg and that of processed nut is from Rs. 80 to 120 per kg.

Pinus gerardiana is an evergreen pine known as “chilgoza” or “neoza”. The species is endemic to a part of Himachal Pradesh in the Himalayan dry temperate forests. A tree on an average yield about 7.4 kg of seeds.

Natural regeneration is limited because local inhabitants aggressively collect the cones to extract the chilgoza nuts. Attempts to raise chilgoza plantations by sowing have not succeeded because the seeds are readily eaten by various animals. Some success has been achieved, however, in planting seedlings and by heteroplastic grafting. About 140 tons of nuts are produced every year. They are priced at approximately Rs. 100 per kg.

1.4.12 Challenges associated with increased exploitation

As development of NWFPs increases, there is a danger of unsustainable exploitation. Unsustainable extraction practices may occur for many reasons. Increasing demand can lead people to disregard traditional harvesting techniques. For example, prices of *chironji* seeds *(Buchanania lanzan, B. latifolia)* or Cuddapah almond, used as a substitute for almond in various delicacies, have increased more than 150 times or so within a span of five years in India. Many tribal people prematurely harvest *chironji* fruits and overexploit them to the extent that natural regeneration is now being hampered, especially in Madhya Pradesh.

In West Bengal, faulty techniques of collecting mahua flowers (the collectors break the apical twigs which affects flowering in the following year) were found to do considerable damage to the natural stock (Rama Krishna Mission Lokashiksha Parishad, 1992). In Central India, mahua forests are burnt repeatedly to simplify collection of the yellow flowers from the forest floor, damaging regeneration. As a result, young mahua trees are becoming scarce and some experts suggest that the species will be extinct by AD 2200.

Similarly, the indiscriminate collection of raw materials from forests for the incense stick (*agarbatti*) industry in Karnataka State in southern India has created large environmental losses in some areas. Two examples out of many in the state are the extensive loss of *gulmavu (Machilus macarantha)* trees in Coorg and Malanad districts resulting from debarking of the trees, and of species such as *Ailanthus malabarica (halmaddi)* and *Borewellia serrota* owing to unsustainable exploitation (Parameswarappa, 1992). Similarly,

the indiscriminate felling and collection of NWFPs from uppage *(Garcinia cambogia)* trees in Karnataka has resulted in widespread losses.

1.4.13 Policy and institutional challenges

Institutional and organizational processes need to be better understood in order to help communities manage NWFPs as part of a larger livelihood strategy, while maintaining an equitable distribution of responsibilities and benefits. It is possible for inappropriate, although well-meaning, policies to have an effect contrary to that desired.

A very good example of a policy and institutional response that proved inappropriate is governmental intervention in the NWFP industry in India. In an attempt to tap the potential more fully in terms of production and employment generation of the forestry sector in India, the Government of India set up the Forest Development Corporations (FDCs) in 1976, on the recommendation of the National Commission on Agriculture. One of the major objectives of the FDCs was to help tribal NWFP collectors by eliminating the large profit margins pocketed by local entrepreneurs and passing these benefits to tribal people in terms of better wages and working conditions.

An FDC was set up in each state; in addition, several government-supported cooperatives were also established. But the functioning of these cooperatives has often been detrimental to the interest of tribal people, and such organizations have not been cost-effective. As a result, tribal people sometimes receive as little as 10 to 40 percent of the sale price in the nearest NWFP market (Chambers, Saxena and Tushaar, 1990).

1.4.14 Tenure and ownership issues

Another challenge relates to tenure and ownership. Unless access and usufruct rights are given to users, there is little incentive to manage NWFPs sustainably. In an attempt to develop these resources, some Indian states nationalized many NWFPs. For example, Madhya Pradesh nationalized bamboo, khair, sal seeds, harra, gums and tendu leaves, among others. The tribal people were required to sell their produce exclusively to the Forest Department to the agent contractors appointed by them.

Production levels of some NWFPs declined sharply following nationalization (Chambers, Saxena and Tushaar, 1990). For example, production of tendu leaves in Madhya Pradesh declined from 5.1 million bags in 1981/82 to 3.9 million bags in 1985/86 - a decrease of 23.5 percent. In Orissa, the production of tendu leaves stagnated over a longer period. Similarly,

after nationalization, the collection of sal seeds fell from 200000 tonnes in 1979 to only 60000 tonnes in 1987 -a decline of 70 percent. The average annual production of lac also declined from 32000 tonnes during 1961-70 to 16000 tonnes during 1981-86 - a decline of about 50 percent.

Nationalization can significantly reduce the remuneration to collectors of NWFPs. For example, the government of Madhya Pradesh, a central Indian state, paid only Rs 0.55 per kilogram of sal seeds collected as opposed to Rs 1.31 per kilogram, which a study (Chambers, Saxena and Tushaar, 1990) estimated could have been passed on to collectors after meeting all the expenses and margins of the Forest Department.

It can also result in delays in payment to gatherers, as government agencies often find it difficult to make prompt payments. This can stimulate the development of black market activities, with associated higher margins required to cover the costs of illegal activities. All these factors reduce tribal people's collection and incomes (Chambers, Saxena and Tushaar, 1990).

A number of experiments are under way to empower local communities in the protection and management of forest resources. India's Joint Forest Management programme in which local communities become partners with the State Forest Department, sharing responsibilities and benefits from forests, is an exciting step in this direction.

1.4.15 The size of enterprise development

Another challenge associated with the increased exploitation of NWFPs is a shift from small-scale to large-scale activities. If not carefully planned and managed, this shift can produce undesirable results, particularly in terms of benefits to local people.

Case-studies from India, Indonesia and Latin American and African countries on NWFP-based activities reveal that NWFP-based small-scale enterprises have some common characteristics. Obviously, these are small in size, are based in the household and are frequently seasonal in labour and employment generation. They are labour-intensive, are based on simple technologies, have low capital requirements and provide direct benefits to the local economy. Most important, they are accessible to low-income and socially disadvantaged groups and are most often managed by women (FAO, 1987; 1991a).

Large-scale enterprises typically incur higher collection and processing costs compared with small-scale enterprises because NWFP resources are scattered and hard to reach, making

mass extraction and transfer costs high. Furthermore, for large-scale enterprises the minimum output required to break even may demand unsustainable exploitation and rapid moves in and out of the market. A very good example of the latter is the depletion of natural stands of edible palm species in southern Brazil during the 1960s by the palm-heart canning industry which has now moved to the states of Pará and Amapa. Further, unsustainable harvesting practices of palm hearts are stressing the resource base in these states too (Richards, 1993).

However, small-scale enterprises also face some common constraints, including limited access to institutional finance and a lack of tax incentives, highly risky market environments and income-sharing problems. Moreover, as NWFP markets expand and efforts are made to increase local processing capacity in order to capture the value-added benefits, traditional patterns of management, income distribution and the division of labour can become disrupted (FAO, 1991a; 1991b). In Karnataka, studies by the Indian Social Studies Trust showed how increased commercialization of one product and improved technologies applied to another negatively affected the predominant user group as in each case women. As men saw greater value attachedof and felt attracted by new, more mechanized technology, women were marginalized (FAO, 1991b). A similar story can be heard from Raigarh village of West Bengal, India (Rama Krishna Mission Lokashiksha Parishad, 1992). About six or seven years ago, NWFP collection was a low-key activity, mainly done by women in Raigarh village. But, after the introduction of a Joint Forest Management programme under the Forest Department, as NWFP collection became a major activity for some families, men have taken over women's employment.

1.4.16 Requirements for sustainable management

Given the considerable potential of NWFPs to contribute to local livelihoods, there is a real need for field-level research; synthesis and collection of information on NWFPs from as many published sources as possible, and their dissemination in the form of practical guidelines for NWFP identification, regeneration, extraction management, collection, processing, storage and marketing; and training on technical issues, including silviculture, extraction management, processing and marketing issues.

The sustainable extraction levels of NWFPs are not easy to calculate, and yet they are a prerequisite for NWFP-based development. In order to ensure this, much more information

is needed on current rates of extraction and on productivity rates for different products. Indiscriminate extraction practices have already resulted in the depletion of natural regeneration and local extermination of species in some cases.

Without good yield data and matching data on extraction rates (the flow) per unit of area, it is almost impossible to decide whether a given practice is sustainable in the long term or not. What is needed are systematic methodologies for rapidly assessing the distribution and yields of NWFPs and current and potential extraction levels.

More precise research is needed on the ecological requirements and functions of NWFP species, their regeneration rates and yields in different forest types and ecological zones and on innovative silvicultural techniques for managing multiple products.

Research is needed to clarify tenurial arrangements and understand the often conflicting layers of traditional rights, use pattern settlements, concessions and privileges and gender relationships.

Institutional processes and organizational arrangements need to be better understood in order to help communities manage NWFPs as part of a broader livelihood strategy, while maintaining an equitable distribution of responsibilities and benefits.

Research is needed on the values of selected commodities in village, district, national and international markets, on the marketing chain and the profits of collector/producers, processors and entrepreneurs.

The impact of product substitution and the possibility of creating new markets need to be examined, together with the impacts of changes in collection, processing and marketing patterns. Price supply and demand trends will need to be assessed to determine the medium- and long-term economic viability and market absorptive capacity of each NWFP.

1.5 SUMMARY

NWFPs cover a wide range of products (goods & services) from thatching materials to medicinal plants. These products are essential needs of local communities. Some NWFPs, such as latex, gums, resins, essential oils, flavours, fragrances and aroma chemicals help to promote value added processing, niche marketing and export trade. NWFPs can provide increased employment opportunities and income earning capabilities. It is estimated that 60 percent of the total production of NWFP is consumed locally. The contribution of some of

the NWFP, through sales comes to nearly 50 percent of the total revenue from the forestry sector in India. Nearly 400 million people living in and around forests depend on NWFPs for their sustenance and supplemental income. NWFPs provide as much as 50 percent of the income to about 30 percent of rural people. The focus of interest is now on whether sustainable harvest from wild, cultivation on private farmland and commercialization of NWFPs can support local people to achieve sustainable livelihood in changed socio-economic scenario.

Terminal Questions

1. Describe the status of NWFPs in India.
2. Give the details of Regeneration status and production of various categories of Non-Wood Forest Products.
3. Evaluate the different forest products which maintain the status of NWFPs.
4. Describe the economic importance of Non-wood forest products.

References

Campbell, J.Y. 1988. Putting people's products first: multiple-use management for non-wood forest products in India. (unpublished draft)

Chambers, R., Saxena, N.C. & Tushaar, S. 1990. *To the hands of the poor: water and trees.* New Delhi, Oxford & IBH Publishing. 273 pp.

Durst B.Patric, Ulrich W. and M. Kashio 1994. Non-Wood Forest Products in Asia. Published by Oxford & IBH, New Delhi. Pp. 151.

FAO. 1989. *Household food security and forestry: an analysis of socio-economic issues.* FAO Community Forestry Note No. 1. Rome.

FAO. 1987. Review of forest-based small-scale processing enterprises. In *Small-scale forest-based processing enterprises,* p. 5-30. FAO Forestry Paper No. 79. Rome.

FAO. 1991a. *Case-studies in forest -based small-scale enterprises in Asia: rattan matchmaking and handicrafts,* edited by Jay. Campbell. FAO Community Forestry Case Study No. 4. Bangkok.

FAO. 1991b. *Women's role in dynamic* forest *based small-scale enterprises: case-studies on uppage and lacquerware from India.* FAO Community Forestry Case Study No. 3. Rome.

Gupta, R., Banerji, P. & Guleria, A**.** 1982. *Tribal unrest and forestry management in Bihar.* CMA Monograph No. 98. Ahmedabad, India, Indian Institute of Management. 88 pp.

Malhotra, K.C., Deb, D., Dutta, M., Vasula, T.S., Yadav, G. & Adhikari, M. 1991. *Role of non-timber forest products in village economy: A household survey in Jamboni Range, Midnapore, West Bengal.* India, Indian Institute of Bio-social Research and Development.

Mukherjee, A.K. 1994. India's forests: a status report: concepts, definitions, trends, controversies. Paper presented at the International Workshop on India's Forests Management and Ecological Revival. New Delhi, 10-12 February.

Rama Krishna Mission Lokashiksha Perished**.** 1992. Role of NWFP in forest fringe dwellers' economy and current status of forest flora: a case-study at Raigarh Forest Protection Committee under Bankura South Division, Ford Foundation Project Report. Delhi.

Richards, M. 1993. The potential of non-timber forest products in sustainable natural forest management in Amazonia. *Commonw. For. Rev.,* 72(1): 21-27.

Roderick P. Neumann and Eric Hirsch 2000. Commercialization of Non- Timber Forest Products: Review and Analysis of Research. Published by Centre for International Forestry Research, Bogor, Indonesia. Pp. 187.

World Resources Institute**.** 1990. The World Bank in the forest sector: a global policy paper. *Wasteland News,* 8(2): 6-12.

Worldwatch Institute**.** 1991. Quoted in *Wasteland News,* (July-August): 22.

Unit 2: Types of NWFPS

Unit Structure

2.1 Learning Objectives

After you have studied this unit, you should be able to:

- develop basic knowledge on the different types of NWFPs in India and their socio economic importance to the rural people
- understand the classification and definition of NWFPs

2.2 Introduction

Non- Wood Forest Products (NWFPs) is an umbrella term used for a vast array of goods of biological origin other than timber derived from the forests. However, considering many conservations, cultural and ethical issues related to wild animals and their derivatives, these have been excluded from being considered as NWFPs. These are a wealth of useful goods with significant potential to ensure livelihood security at community level. Based on origin, NWFPs may be arranged broadly in four classes viz., plant fruits, seeds and nuts; plant exudes-latex, resin, and nectar; plant parts-stem, leaf, roots, bark, apical buds, flowers, mushrooms and orchids and non plant products such as lac and silk. Commonly collected

NWFPs in the Himalaya include a variety of medicinal and aromatic plants (MAPs), pine resin, lichens, moss, wild mushrooms, berries and honey. The values of NWFPs in poverty alleviation of marginalized forest-dependent communities has for long been acknowledged. The focus of interest is now on whether sustainable harvest from wild, cultivation on private farmland and commercialization of NWFPs can support local people to achieve sustainable livelihood in changed socio-economic scenario.

The contribution of non-wood forest products (NWFPs) to the forestry sector in most countries is significant, and studies are showing that they have been undervalued in the past. A recent valuation undertaken by the Ministry of Environment and Forests in India estimated that 220 million tonnes of fuelwood, 250 million tonnes of grass and green fodder and 12 million m^3 of timber are removed from India's forests annually. These products are estimated to be worth US$ 10 billion (Mukherjee, 1994).

2.3 Classification of NWFPs

The various NWFPs found in India may be broadly classified on the basis of product type into the following categories

1. Edible plants (including fodder species)
2. Medicinal and Aromatic Plants
3. Spices
4. Fibre yielding plants.
5. Paper and pulp yielding plants.
6. Gums and resin yielding plants.
7. Dyes and tans yielding plants.
8. Bamboo species.
9. Insect byproducts (Honey, Silk etc.) promoting species.
10. Fatty and essential oil yielding plants.
11. Plants used for making soap.
12. Species of other importance.

2.3.1 Edible plants

Many plants species found in the region are suitable for human consumption. These are *Aegle marmelos,Agave Americana, Bauhinia vahli, Bauhinia variegate, Corylus jacquemontii, Cyperus rotundus, Dendrocalamus strictus,Dioscores belophylla, Diploknema butyraceae, Emblica officinalis,Ficus spp.,Fragaria indica,Juglans regia, Mangifera indica, Mentha spicata, Moringa oleifera, Morus alba, Myrica esculenta, Pyrus pashia, Rhododendron arboreum,Rubus spp.,Bombax ceiba, Shorea robusta, Syzygium cumini, Utrica parviflora, Zizyphus mauritiana* etc. The important and most common edible plants of the Himalayan region along with the edible part have been given in table 1.

Table1.The important edible plants of the Himalayan region

(T= trees,S=shrubs,H =herbs and C= climbers)

S.N.	Botanical name	Edible part	Distribution
1.	*Actinidia callosa*(C)	Fruit	In Himalayas, altitude between 1200-2400m elevation
2.	*Actinida strigosa* (C)	Fruit (pulp)	In Himalayas between 1200-2400m elevation.
3.	*Aesculus indica* (T) (Bankhor)	Embryo eaten by hill people	Western Himalayas between 1000-2500 m altitudes.
4.	*Ampelocissus rugosa* (C)	Fruit	Himalayas between 1500-2000m
5.	*Berberis asiatica* (s)(Kingora)	Fruit Pulp is edible	Himalayas up to 2500m.
6.	*Berberis lycium* (S) (Chatroi)	Fruit	Throughout Himalayas up to 2750 m elevation
7.	*Bischofia javanica* (T) (Paniala)	Fruit	Sub- Himalayan forest from Kumaun to eastwards throughout eastern India.
8.	*Buchanania lanzan*(T) (Chironji)	Flesh of ripe fruit eaten raw as well as roasted seed used in sweet meats.	Dry deciduous forest in central India
9.	*Bunium persicum* (H) (Kala- Zirah)	Fruit are used as spices	Himalaya between 2000-3000m altitude.
10.	*Bursera serrata* (T)	Pulp of fruit	Himalaya between 2000-3000m altitude

11.	*Carissa carandas* (S) (Karaunda)	Half ripe fruit is used pickled and full ripe is edible	Dry deciduous forest also cultivated.
12.	*Corylus colurna* (T) (Bhutia Badam)	Fruit	Himalaya between 1500-3200m
13.	*Crataegus oxyacantha* (T) (Ban-sanjli)	Ripe fruits are eaten	Himalaya between 1500-2700m altitude.
14.	*Debregeasia longifolia* (T) (Sansaru)	Ripe fruits are eaten fresh	Sub- tropical Himalaya at an elevation of 600-2100m.
15.	*Duabanga grandiflora* (T)	Ripe fruits are edible	Himalaya up to 1000m altitude.
16.	*Ehretia acuminate* (S or T) (Pandayan)	Ripe fruit is eaten and unripe fruit is used for pickled	Himalaya up to 1800 m altitude
17.	*Elaeagnus latifolia* (S) (Ghiwain)	Ripe fruit is eaten	Sub- Himalayan tract up to 1500-2400 m altitude.
18.	*Ficus auriculata* (T) (Timla)	Fruits are eaten as vegetable and ripe eaten raw	Himalayas up to 1800 m altitude
19.	*Ficus neriifolia* (T) (Parphuta)	Ripe fruits are edible	Himalayas up to 2400m.
20.	*Fragaria vesca* (H) (Pahari rasbhari)	Fruits edible	Himalayas up to 1600-3200m elevation
21.	*Grewia elastic* (T) (Bimla)	Ripe fruits are eaten	Outer Himalayas up to 1500m elevation.
22.	*Juglans regia* (T) (Walnut)	Fruit	Himalayas between 1500-3500m elevation.
23.	*Morus serrata*	Ripe fruits are eaten	Throughout Himalayas
24.	*Prunus armeniaca*(T) (zardalu)	The ripe fruits both fresh ane dried are eaten	North- Western Himalaya up to an altitude of 300m
25.	*Prunus cerasoides* (T) (Paddam, Phaya)	Ripe fruits are eaten raw	Himalayas between 1200-3600 m altitude.
26.	*Pyrus pashia* (T) (Mahal)	Pulp of ripe fruit is eaten.	Himalayas up to 600-2500 m
27.	*Viburnum cotinifolium* (S)	Ripe fruits are eaten.	Himalayas up to 1200-3000 m altitude.

2.3.2 Fodder species

There are about 350 species from 116 genera growing throughout the region between 500 and 4500 m amsl (Singh and Singh, 2006). The Himalayan region support about 84 trees

and 40 shrubs of fodder value that the people use (Negi, 1977). Singh and Singh (2006) estimated that in the Uttarakhand fodder leaf production from forests, agricultural sector, orchards and bushes/ perennial herbs account for 77%, 12%, 2.7% and 19.2% respectively. Singh *et al.* (1988) computed contribution of different sources of fodder for the Uttarakhand Himalyan. A few case studies compiled from different parts of Uttarakhand reveal that the contribution of crop residue ranges from 13-41% and that of grazing from the surroundings forests and grazinglands from 35-40%. According to Nautiyal *et al.* (1998) 20% of annual fodder requirement is met from farm trees and 30% from crop by-products in a typical village located in sub-montane zone of Garhwal where traditional agroforestry is well developed. In many villages a sizable chunks of land (also referred to as Ghasnis) have been developed as grasslands to cater to the fodder need of the livestock that also serve as a source of income to the household that maintain Ghasnis. In general grazing in forests, unculturable wastelands and seasonal cropland follows are the mainstay for animals in Uttarakhand and fodder trees, shrubs and crop residue contribute significantly to the livestock dietary demands. A cost estimate of the fodder and leaves collected for cattle bedding from the surrounding forests and private support land revealed that each year a total of 5,748kg (equivalent to Rs. 6,380) fodder is extracted from the reserved forests 2,037 kg (equivalent to Rs. 2,260) from the private support system consisting of private grass lots and fodder trees, 3,471 kg bedding leaves (equivalent to Rs. 1,920) from reserves forests for cattle sheds per ha of croplands has been recorded (Singh *et al., 2002)*. Further analysis showed that on average 30 animal units have been found dependent on each hectare of cultivated land that in the state consume fodder costing Rs. 14,700 annually to produce an output of Rs. 3130 (milk, Rs. 585; animal labour utilized Rs. 1,340; and dung Rs. 1205), with the output; input ratio of 0.2 (Singh *et al.,*2002).

Some prominent fodder tree species of the region are *Bauhinia spp.,,Celtis australis, Carpinus viminea, Debregeasia velutina, Desmodium elegans,Diploknema butyraceae, Ficus spp .,Grewia optiva, Melia azedarach ,Morus spp. ,Prunus cerasoides, Quercus spp.,Robinia pseudoacacia, Salix wallichiana* etc.

2.3.3 Medicinal and Aromatic Plants

Any discussion on NWFPs from the Himalaya would almost certainly focus on this very important group of plants for which the Himalaya is best known. While many of the important

MAPs are herbs or small shrubs, a good example of a perennial form would be Yew tree (*Taxus baccata*) which gained great attention due to the anticarcenogenic properties of taxol mainly found in its bark.

Himalayan Yew: *Taxus baccata*: This tree occurs between 1800 and 3300m amsl in central Himalayan . It is one of the high value medicinal plants of Uttarakhand. The anti- cancer drug Taxol (paclitaxel; a diterpenoid) is isolated from the stem bark. Extracts of *T.baccata* is also known to be source of a drug called '*Zarnab'*, which is prescribe in the Unani system of Indian medicines and used as sedative and for the treatment of bronchitis, asthama, epilepsy, snake bites and scorpion stings, besides applications as an aphrodisiac (Beckstrom- Sternberg and Duke, 1993). The use of its bark as a substitute (or mixed with) tea is also known. Taxol is currently used in the treatment of several forms of breast, liver, lung, blood and gynecological cancers. Average taxol content in the bark of yew trees across an age series was found to range between 0.064 and 8.032 g/ tree, and a tree of about 100 yrs age can yield about 5.74 kg dry bark.

The other tree associates with it being *Cedrus deodar, Abies pindraw, Aesculus indica, R.arboreum, Lyonia ovalifolia, Quercus floribunda* etc. Due to its medicinal importance large-scale exploitation has been continuing until recently from this region. Consumption of seeds along with aril (a sweet, fleshy cup like structure surrounding the seed) by birds, monkeys and humans causes regeneration failure to this tree. Efforts for conservation and mass multiplication of this species using growth *hormones* are being made by G B Pant Institute of Himalayan Environment and Development(GBPIHED. The most important medicinal and aromatic shrubs and herbs are *Acorus calamus, Adhatoda vasica, Adiantum venustrum, Artemisia nilagarica, asparagus racemosus, Atropa acuminate, Berberis asiatica,Berginia ligulata, Cannabis sativa, Centella asiatica,Coptis teela, Datura stramonium,Dioscorea bulbifera, Euphorbia royleana, indigofera pulchella, Mentha sylvestris, Ocimum basilicum, Potentilla fulgens, Selinum tenuifolium, Thalictrum foliolosum,*etc. The most important tree species are *Aesculus indica,Cassia fistula, Cinnamoum tamala,Diploknema butyraceae, Emblica officinalis, Juglans regia, Lyonia ovalifolia, Mallotus phillippinensis,Myrica esculenta, Pinus roxburghii, Syzygium cumini, Terminalia belerica, Terminalia chebula* etc.The exotic species included *Atropa belladonna, Digitalis lanata, Digitalis purpurea, Hyoscyamus nigar, Plantago ovate, Saussuria lappa, Chrysanthemum cinerariaefolium, Mentha citrate, Ferula narthex, Glycyrrihiza globra* etc.

2.3.4 Fibre yielding Plants

There are a number of natural fibre yielding plants present in the region. Most of these grow wild near villages and deforested areas as *Xerophytes* plants except for *Bhimal* which is being cultivated usually for subsistence use. Fibre is generally used for making ropes and mats. The region yield an immense quantity of material for ropes, cordage, mats and twines. The main fibre yielding species are- *Agave Americana, Calotropis gigantean, Cannabis sativa, Daphne papyraceae, Eulaliopsis binata, Giraradiana heterophylla, Gerbera langinosa, Grewia optiva, Salix wallichiana, Utrica parviflora* etc.

2.3.5 Pulp and paper yielding plants

There are numerous varieties of trees and grasses in the region, which can yield material for paper and pulp. The *babar* grass found in sufficient quantities in the region and is a suitable material for making coarse cordage and paper. *Dendrocalamus spp.* can be utilized in the same manner. The pulp manufactured from *Daphne papyraceae* yields material for a paper that gives the engraver finer impressions than any English-made paper and nearly as good as the fine Chinese paper that is employed for what are called India-paper proofs. The paper made from this shrub in Kumaun is almost as strong and durable as leather and was largely used for village records and court proceedings. It is exported to Tibet in the north and to the plains in the South for manuscripts and account-books. Apart from this many other plants have paper value. Some important plants are *Daphne papyraceae* (Satpura), *Dendrocalamus strictus* (Bans), *Dendrocalamus hamiltonii* (Bans), *Eulaliopsis binata* (Babar), *Wikistroemia canescens* (Chameliya), *Desmodium tiliaefolium* (Chamara).

2.3.6 Gums and Resin Yielding Plants

Many important species found in the region produce gums and resins of high economic value. In fact resins is only next to timber in earning highest revenue amongst the various forest products. The species which produce gums and resins are-:

Gums- *Bauhinia variegate* (kwairal), *Toona ciliate (*Tun), *Prunus cerasoides* (Padam), *Woodfordia fruticosa* (Dhaula).

Resins- *Pinus roxburghii* (Chir), *Pinus wallichiana* (Kail): Resin is mostly extracted from *Pinus roxburghii* for the production of rosin and turpentine oil. However, *Pinus wallichiana* yields high-grade resin.

2.3.7 Dyes and Tanin Yielding Plants

In Kumaun region, the dyes of vegetative origin are extracted only from plants or tress growing wild or which are cultivated for some other use. Turmeric (*Curcuma longa)* and a great mass of dyes are exported from the hills as a portion of minor forest produce, but of little commercial value. The tanning materials produce by plants that grow wild afford a valuable assistance to the supply of similar materials found in the plains. Some popular dyes and tans are extracted from the following plants- *Acacia catechu* (Khair), *Alnus nepalensis* (Utis), *Bauhinia variegate* (Kwairal), *Berberis aristata* (Kilmora), *Toona ciliate* (Tun), *Cotinus coggygria* (Gardh tungs), *Curcuma longa* (Haldi), *Emblica officinalis* (Aonla), *Ficus glomerata* (Gular), *Flacourtia indica*(Bilongra), *Juglans regia* (Akhrot), *Prunus persica* (Aru), *Punica granatum* (Anar), *Quercus floribunda* (Moru), *Rubia cordifolia* (Majethi), *Sapium sebiferum* (Pahari shisham),*Taxus baccata* (Thuner), *Terminalia chebula* (Harar), *Woodfordia fruiticosa* (Dhaula).

2.3.8 Bamboo Species

In Uttarakhand, some of the marginal communities such *Ruriya* and also other traditional communities inhabiting higher altitude areas of the state are dependent on bamboo resources for part of their livelihoods. The most common bamboos of the state are Ringal (*Arundinaria falcata)* and Tham abundantly occurring in temperate and subalpine forests. Local craftmen make a variety of household items such as baskets and mats from this resource. Ringal and Tham bamboos are also used as a thatch material for covering roofs. Of late, local craftmen have started making a number of fancy handicraft items from Ringal bamboo which are sold to a large number of tourists and pilgrims visiting the state.

Establishment of the Uttarakhand Bamboo and fibre Development Board (UBFDB) a few years ago has greatly increased the focus on bamboo planting and handicrafts made from bamboos. Bamboo planting has been included Training of bamboo artisan and products such as the 'Badrinath pooja basket' which has been used by thousands of pilgrams has greatly increased the value of this NWFP. Three main bamboo species- locally known as *Ningal or Ringal* are found in the Kumaun region are:

- *Arundinaria falcata- Gol-ningal*
- *Thamnocalamus falconeri- Deo- ningal*
- *Thamnocalamus spathiflorus- Tham-ningal.*

2.3.9 Insects by-products (Honey, Silk etc.) promoting species

Silk and honey are the two most important insects by-products of the region. The region has a very high percentage of Oak species, which are suitable for tasar production. *Morus alba* can be increased sufficient to promote silk industry. Similarly, the potential of honey is also high as the region abound in suitable species for good quality honey production, for example- *Bombax ceiba* (Semul), *Citrus spp. Diploknema butyraceae* (Cheura), *Prunus spp.*etc.

In the Himalaya, much of the honey production is dependent on the pollen of wild trees, bees are very important pollinator of cultivated crops. A decline in the yield of fruit trees in many parts of the Himalaya has been linked with depleted honey bee population. The principles species of bee which are kept in hives and managed for honey production and crop pollination are *Apis cerana* and *Apis mellifera*. *Apis cerana*, the native honey bee is not popular among commercial beekeepers in the Himalaya because of its low honey yield and undesirable behavioural traits such as frequent swarming and absconding.

Apis florae, Apis dorsata and *Apis laboriosa* are wild species of the honey bee and cannot be kept in hives. These species build single comb nests on tall trees and cliffs.

Apis melifera, the European bee was introduced to the region to promote beekeeping as a commercial enterprise and it has a high honey yield and a hive can yield 30-50 kg of honey per year. However, it is susceptible to disease and low temperature and cannot easily be maintained in the mountains unless beekeepers, which largely replace *Apis cerana,* the ecological implications of which are still not known.

In Uttarakhand, wall-hives with colonies of *Apis cerana* have been traditionally nurtured. The practice had declined somewhat for several reasons, such as a change in construction material (from stone walls to brick walls) that make wall hives more difficult to keep and maintain, and also because of declining bee populations attributed to indiscriminate use of pesticides in fruit growing areas. However, bee- rearing is seeing a small resurgence in the region. A few NGOs and enterprenuers have aggressive programmes aimed at increasing bee colonies and the yield of honey per colony.

Honey yield can be increased from about 2-3 kg per hive annually to 5-7 kg per hive through use of better technologies such as removable combs. In newer wall hives frames are often inserted which allow for non-destructive removal of the hive and harvesting of honey rather

than the old practice of cutting the hive out of the wall which resulted in its destruction and necessitated that bees build a fresh comb which in turn reduced honey yield.

2.3.10 Tasar silk

A niche activity is the production of tasar and other non- mulberry silks through use of leaves harvested from from the forest. *Quercus semecarpifolia* has been most commonly used. Eri and muga silks have also been produced in Uttarakhand in the limited quantities using species such as *Listea* and *Castor(Ricinus)*. However, the scope in terms of using forest resources vis-a vis productivity needs to be assessed for promotion of Tasar Silk in the in the state.

2.3.11 Pants used for making Soaps

The most important local species is *Sapindus mukoiossi* (Reetha) which has a tremendous commercial use in herbal –shampoos, woolen detergents etc. *Agave Americana* (Rambans) is also used for making soap-substitute.

2.3.12 Species of other importance

Other species of NWFPs importance are mentioned briefly under this category. The first and foremost species are grasses, the utilization of which is intimately connected with forest works. Grasses are used for a variety of purposes e.g. paper pulp, cordage, matting, thatching, essential oils, khus khus tatties, screens, chairs, stools and tables. Some important grasses of Kumaun are mentioned below:

Aplude mutica (Sachla), Arundinella nepalensis (Tutnalia), Arundo donax (Narkal), Arundinella setosa (Murkiya/Pileri), Cenchrus ciliaris (Anjan), Chysopogon gryllus (Kush/ Salama), Chyrsopogon fulvus (Gauriya), Cynodon dactylon (doob), Cymbopogon martini (Babila), Dicanthium annulatum (Nail), Dactylis glomerata (Orchards grass),Erianthus munja (Munja), Eragrostis unioloides (Bansiya), Euragroshis curvela (Luv grass),Eulaliopsis binata(Babar grass), Heteropogon contortus (Kumeriya), Imperata cylindrica (Siru), Neyrandia arundinaceae (Nalsura), Pennisetum orientale (Vimalsa), Saccharum spontaneum (Kaus), Setaria nandi (Nandi), Themeda anethera (Piriya), Themeda arundinaece (Ula), Vetiveria zizaniodes (Kush Kush).

There are several species of other importance for example *Bauhinia vahlii* (Maljhan), *Shorea robusta* (Sal) and *Ficus auriculata (Timla)* the leaves of which are used for making platter;

Camellia sinensis (Tea beverage), *Cinnamomum tamala* (*Dalchini)* used for spices and condiments; *Salix* (Bainsa) is used for handicrafts etc.

2.4 Summary

The values of NWFPs in poverty alleviation of marginalized forest-dependent communities has for long been acknowledged. The focus of interest is now on whether sustainable harvest from wild, cultivation on private farmland and commercialization of NWFPs can support local people to achieve sustainable livelihood in changed socio-economic scenario. The various plants of NWFPs importance found in India may be broadly classified on the basis of product types. They are edible plants (including fodder species), Medicinal and Aromatic Plants, Fibre yielding plants, Paper and pulp yielding plants, Gums and resin yielding plants, Dyes and tans yielding plants, Bamboo species, Insect byproducts (Honey, Silk etc.) promoting species, Fatty and essential oil yielding plants, Plants used for making soap, Species of other importance.

Terminal Questions

1. How many types of NWFPs can you identify in your locality?
2. Give details about the edible plant species and species which yields pulp and paper.
3. Enlist aromatic and medicinal plants.
4. Write the name of plants that can yield gum and resin and fibre and flosses.
5. How many species of Bamboos are found in India.

Reference

Durst B.Patric, Ulrich W. and M. Kashio 1994. Non-Wood Forest Products in Asia. Published by Oxford & IBH, New Delhi. Pp. 151.

Roderick P. Neumann and Eric Hirsch 2000. Commercialization of Non- Timber Forest Products: Review and Analysis of Research. Published by Centre for International Forestry Research, Bogor, Indonesia. Pp. 187.

Unit 3 Livelihood Implications

Unit Structure

3.1 Learning Objectives

After you have studied this unit, you should be able:

- to develop a basic understanding of the importance of NWFPs in livelihood generation of the local community
- to learn about the various success stories relating to NWFPs and livelihood.
- to understand the role of important NWFPs in enhancing livelihood options of the people and to full fill the market demand also.

3.2 Introduction

NWFP species such as wild edible plants and medicinal plants have been regularly utilized in daily livelihood in the hill region of India, Nepal and Pakistan. Wild edible plants are mostly consumed with daily meals whereas medicinal plants are used for primary health care at

household whenever necessary and also trading for economic development. The following sections provide a more detailed description of wild edible plants and medicinal plants than other NWFPs species. The wild edible plants are still being utilized in daily livelihood to mitigate the existing problem of food deficit, and nutritional demand or a supplement of food and nutrition.

In the hills, agriculture is the key source of livelihood. Aside from agriculture, trading of economically valuable NWFPs species including other off-farm income generating activities are other livelihood activities to support daily household needs. Annual agriculture production is not enough to support the livelihood throughout the year, and as a consequence, they have to engage in other off-farm activities. The off farm activities are mainly collection of NWFPs and their marketing. We have tried to document a study from Nepal for bringing out the importance of wild edible plants in the livelihood of the people residing in the remote hill regions.

3.3 Consumption of Wild Edible Plants

In remote hill region of Nepal Roti *(Chapattis)* are mostly supplemented with wild edible plants such as the tender leaves of the stinging nettle Bicchu Ghass [*Urtica dioca*] throughout the year except during the period of mid-May to mid-June when the plant is usually found to be infected with insects, and between mid-December to mid-January when the plants are dry. Stinging nettle is consumed more between mid-March to mid-May when food deficit reaches its peak. In these months, every household has less stock of food grain. To cope with the situation, *local residents* mix stinging nettle with bitter buckwheat flour, and cook it in water and prepare soup. In this way, locals coped during food deficit months, and fulfilled their nutritional requirement from wild edible foods. They prefer stinging nettle more than vegetables such as cauliflower, cabbage, pumpkin, brinjal etc., because according to them it tastes better than other vegetables, particularly the vegetables grown from hybrid seeds distributed by the District Agricultural Office under the Government of Nepal and some other NGOs working in the agricultural sector/s. Additionally, stinging nettle is easily available in nearby settlements, farmlands and pasturelands. In this context, Chakra Bahadur Buda [40 years old] of *Syaandaa* village said, “We would be dying of starvation if God did not give us this stinging nettle. The combination of the curry of stinging nettle and *roti* is the best among

all staple plants available in the region. Important NWFP's which provide livelihood to hundreds of people in Uttarakhand have been discuss here under.

3.4 Resin from Chir Pine (*Pinus Roxburghii)*

Resin is an important NWFP and obtained from the genus *Pinus* which is best known as a source of this product. In Uttarakhand, resin is collected almost exclusively from *Pinus roxburghii* trees.Resin collection and managed by the State Forest Department. In areas dominated by *P. roxburghii* it is an important activity and contributes significant revenue as well as employment opportunity in Uttarakhand. In 2005-06, revenue generated from resin production in the state was Rs. 453 million (Uttarakhand Forest Statistics 2005-06). Resin is collected from the forest according to working plans made by the State Forest Department (SFD). The State Forest Department employs registered labour for tapping and collection of resin. Till 1996, resin was collected largely by cup and lip method, which damaged the trees. Thereafter, the rill method is used which not only has much lower impact on trees but also increases resin production. Resin is collected and transported, in tin canisters, from jungle head and then road head depots. From these it is transported to the following three main head depots in the state:

Rishikesh, Narendranagar Forest Division

Sultannagri, Kathgodam, Nainital Forest Division. .

Tanakpur, Champawat Forest Division.

Processing is done by the units after resin is sold by the State Forest Department. Resin is processed by simple distillation method to form two main products namely rosin and turpentine oil used in varnish, paints and polishes, paper manufacturing etc.

3.5 Lichens and Mosses

In terms of volume, lichens and mosses are the most common NWFPs that are collected from the state and have significant livelihood implications. While biologically very different, these two NWFPs are often grouped together due to their similarity of appearance.

Lichens or Jhula, are symbiotic associations of algae and fungi. They are most abundant in temperate forests at altitudes from about 1500m and above. Often associated with Oaks and rhododendrons, they are also commonly found on apple and other fruit trees. Lichens of the genus *Parmelia* are most commonly collected. In Ukhimath range (Rudraprayag district),

over the past 8 years approx. 17.0 t of lichens were removed annually. This however would appear to be an under- estimate and reflects only Government records. Independent estimates from the region put the actual collection at closer to 200.0-250.0 t per year. As per estimates made by forest officials in Chamoli district, between July and March about 60-75 trucks of lichens are collected every year. Given an average of about 3.0 t per truck this would translate to about 180-200 t annually. Further a price of about Rs. 25 per kg to the collectors translates to value of Rs. 4,500,000- 5,000,000 from the district. However, mandi prices are Rs.55-60 which translate to a value of Rs. 10 million for Chamoli district alone.

While the collection of lichens per day is not destructive to trees, due to the relatively low profitable and use of outside contract labour, the harvesting is done without any concern for the trees and branches are indiscriminately lopped off rather than scraping off the lichens from the branches. This causes severe damage to the trees. While there is considerable unrecorded trade, a significant proportion of the lichens harvested is sold through official channels as described below:

3.5.1 Collection/ procurement

The SFD allots land to UFDC, Kumaun Mandal Vikas Nigam and Bhesaj Sanghs for lichen collection. The registered collectors of these agencies, often assisted by local or migrant labour, collect and pack the produce in sacks. The field officer of the UFDC inspects the material and takes a permit from the concerned Range Officer of the SFD and after the verification; it is brought it to the above mentioned three main depots for sale.

Big traders purchase Jhula in bulk. A small amount is also bought by the local pharmacies within the state. After processing and gradation, dealers sell lichens in bulk amount to spice and ayurvedic manufacturers (such as Himalaya Drugs, Dabar, Jhandu) and to small traders.

3.5.2 Products

The products made out of Jhula are: Spices, Ayurvedic Medicines, Organic Dye and Hawan Samgri.

3.5.3 Market

The market for Jhula is spread all over the country but has special demand in Gujarat, Mumbai and South India. A large part of lichens collected in the Himalaya goes to a place

called 'Nander' in Gujarat where there is a hub of spice manufacturers. In the North India lichens are mainly used in Ayurvedic medicines and as Hawan samgri. The traders also sell it in the Khari Bawli market in Delhi.

3.5.4 Mosses

Mosses are easier to collect and used largely by florists and garden shops for moss-sticks. While lower in value than lichens and collected in smaller amounts, the market is nonetheless worth several hundred thousand rupees. Among mosses genus Sphagnum is collected most commonly. It is abundantly found in oak forests and grows well in cool and humid areas. Its main use is in plant nurseries where it is used as a medium of propagation by cutting and air layering. It is said to have a fungicidal effect and thus helps in protecting newly emerging seedlings and roots. It is used in making moss sticks, which gives support to trailing vine type ornamental plants. It can soak moisture 8 to 10 times its weight and thus is used to support indoor basket plants. It is also used as a base of small plants that have to be transported over long distances as it retains moisture for longer period of time.

Collection and trade is carried out in a manner similar to lichens and these two NWFPs are often grouped together in policy matters. Traders purchase it from Government operated mandis and then sell it to nurseries etc. At present the sale rate from the depot is Rs. 25 to Rs. 27 according to the quality of the product. The price of the moss after processing and cleaning ranges from Rs. 35 to Rs. 50 per kg. At present the collectors pay royality of 50 paisa per kg to the SFD.

3.6 Bamboo Resources

In Uttarakhand some of the marginal communities such Ruriya and also other traditional communities inhabiting higher altitude areas of the state are dependent on bamboo resources for part of their livelihood. The most common bamboos of the state are Ringal (*Arundinaria falcata)* and abundantly occurring in temperate and sub alpine forests. Local craftsmen make a variety of household items such as baskets and mats from this resource. Ringal and Tham bamboos are also used as a thatch material for covering roofs. Of late, local craftsmen have started making a number of fancy handicraft items from Ringal bamboo which are sold to a large number of tourists and pilgrims visiting the state.

Establishment of Uttarakhand Bamboo and Fibre Development Board (UBFDB) a few years ago has greatly increased the focus on bamboo planting and handicrafts made from

bamboos. Bamboo planting has been included in forest working plans and several thousand hectares of bamboo have already been planted across the state. Training of bamboo artisans and products such as the 'Badrinath pooja basket' which has been used by thousands of pilgrims has greatly increased the value of this NWFP.

3.7 Medicinal and Aromatic Plants

Any discussion on NWFPs from the Himalaya would almost certainly focus on this very important group of plants for which the Himalaya is best known. While many of the important MAPs are herbs or small shrubs, a good example of a perennial form would be the Yew tree (*Taxus baccata)* which gained great attention due to the anti-carcinogenic properties of taxol mainly found in its bark.

3.7.1 Himalayan yew: *Taxus baccata* subsp. *wallichiana*

Taxus baccata L. is one of the high value medicinal plants of Uttarakhand. The anticancer drug Taxol (paclitaxel: a diterpinoid) is isolated from the stem bark. Extracts of *T. baccata* is also known to be a source of a drug called "Zarnab", which is prescribed in the Unani system of Indian medicine (CSIR, 1976) and used as sedative and for the treatment of bronchitis, asthama, leprosy, epilepsy, snake bite and scorpion stings, beside the applications as an aphrodiasic (Beckstorm-Sternberg and Duke 1993). The use of its bark is a substitute (or mixed with) tea is also known. Taxol is currently used in the treatment of several forms of breasts, liver, lung, blood, gynaecological cancers. Average taxol content in the bark of yew tree across an age series was found to range between 0.064 and 8.032 g/tree, and a tree of about 100 years age can yield about 5.74 kg dry bark (Nadeem *et. al.. 2002).*

This tree occurs between 1800 and 3300 m msl in central Himalaya, the other tree associates being *Cedrus deodara*, *Abies pindrow*, *Aesculus indica, Rhododendron arboretum, Lyonia ovalifolia, Quercus floribunda* etc (Nandi *et al.* 1998). Due to its medicinal importance large scale exploitation has been continuing until recently from this region. Consumption of seeds slong with aril (a sweet, fleshy cup like structure surrounding the seed) by birds, monkeys and humans causes regeneration failure to this tree. Efforts for conservation and mass multiplication of this species using growth hormones are being made by G.B. Pant Institute of Himalayan Environment and Development, Almora.

3.7.2 Kira jari (*Codyceps sinensis*)

It is also known as Yarchagumba kira- jari. It is a rare species of parasitic fungus that grows on the bodies / head of insect larvae (*Hapialis virescens).* Studies from Nepal indicate that it takes 5 persons about a month tocollect 3500-4000 speices of kira-jari which weighs about 1 kg. Locals involved in collection said that the skill of the collector was very important and an unskilled collector would not even be able to collect 10g in a month while a proficient collector might collect over a Kg in less than a month. Prices of about Rs. 120,000 to 150,000 per kg were quoted by collector. While the quantum of collection is estimate of over 800 to 1000 kg are not uncommon from Uttarkhand which would have an approximate value of over Rs. 100 million. It is mostly used in Chinese system of medicine.

3.7.3 Kutki (*Picrorhiza kurrooa*)

Found between 3200-4500m, the roots of kutki are used to treat abdominal pains and fever. It is being cultivated at lower altitudes through support provided by Herbal Research and Development Institute (HRDI). Locals in Joshimath (Chamoli) estimated that approx 100-120 quintals of Kutki were harvested from the forests. At a cost of Rs. 180 per kg., this would put the value of kutki harvested from the area at about Rs. 2,000,000. In Uttarakhand, the High Altitude Plant Physiology Research Centre's efforts to promote the cultivation of *Picrorhiza kurrooa* (Kutki), a high value medicinal plant, differ significantly from similar attempts by other agencies. Farmers are given not only technical but comprehensive support, including assistance in marketing. Taking a farmer system approach, Centre provides planting material and training to farmers. More important is that they have arranged a buying contract with a commercial company that commits to purchase the complete production of Kutki at a guaranteed minimum price. This has been made possible through a tripartite agreement between the farmer, the company, and the Centre.

3.8 Wild Fruits

Several forest trees and shrubs bear fruits that are consumed locally and some items even marketed. Fruits such as Kaphal (*Myrica esculenta*) while valued and consumed locally, rarely made it to the market in the past can now be increasingly seen in markets during early summer. Similarly squash is prepared from *Rhododendron* flowers and sold in local market. Some of the important wild fruits found in (1000-2000 m msl) of Uttarakhand include:

- Kaphal (*Myrica esculenta)* stony berries rich in vitamin C.
- Hisalu (*Rubus ellipticus*), Kingori (*Barberis asiatica*) and related shrubs with tasty berries.
- Wild apricots (Chuli or Churu) (*Prunus armeniaca)*
- Mehal or wild pear (*Pyrus pashia)*

Other important fruits include the wild bel (*Aegle marmelos*), pangar or wild chestnut (*Aesculus indica*) Himalayan amla (*Emblica officinalis*), *Ficus roxburghii* (Wild Himalayan fig).

Myrica esculenta locally known as Kaphal, is small or moderate sized evergreen tree occurs in pine oak and mixed oak forest of middle altitudes of Uttarakhand. The genus *Myrica* is one of the non leguminous angiosperm nodulated by *Frankia spp.* and hence capable of fixing atmosphereic nitrogen like legumes. This tree yields delicious fruits during May-June and eaten as raw by the local people.

It is much cherished wild fruit of the region and particularly attracts children and women while they frequently visit the forest for daily needs of fodder and fuelwood. In the Kumaun region, Kaphal fruit is sold in local markets during summer for the last more than two decades. A detailed study conducted by Dhyani and Dhar (1992) reported that a number of villagers in Almora district are involved in collecting the raw fruits, which are sold directly and also through the middle-men in the nearby urban centre. They reported the yield of fruits ranging from 30-111 kg per tree and on average a person collected and sold about 20 kg fruits per day (@Rs. 12-20 per kg.) and about 567 kg fruits / month. Thus earning about Rs. 8364/ season. Another study conducted by Bhatt et al., (2000) reported that local people in Kumaun region can earn over Rs. 1.4 million per season from selling this fruits. They recorded the maximum fruit yield in chirpine forest (42.1 Kg./tree) and minimum in mixed oak forests (28.9 kg/ tree) and potential yields as 2-4 .3 tonne / hectare of forest area. Of the total fruit crop only 2.87 % was harvested across different forest sites. In some sampled villages as many as 60% of the total households were involved in collection / sale of these fruits. The observations during 2007 revealed that rates touched is as high as Rs. 80– 100 / Kg (Amar Ujala May 2007). However, the same day in the evening the rates dropped by Rs. 20-40/Kg as the fruit is perishable and its flavor and juice deteriorate rapidly. Also in the recent years the fruit selling trade has still grown up and Kaphal fruits are sold in bulk by

local women to the traders early in morning at some locally fixed trading centres in townships of Almora and Ranikhet and immediately transported to Haldwani where they are sold at much higher rates.

3.9 Honey

In the Himalaya much of the Honey production is dependent on the pollen of wild trees, bees are very important pollinators of cultivated crops. A decline in the yields of fruit trees in many parts of the Himalaya has been linked with depleted honey bee population.

The principal species of the bee which are kept in hives and managed for honey production and crop pollination are *Apis cerana*, *A. mellifera*. *A. cerana,* the native honey bee is not popular among the commercial bee keepers in the Himalaya because of its low honey yields and undesirable behavioural traits such as frequent swarming and absconding.

Apis florae, A. dorsata and *A. laboriosa* are wild species of honey bee and can not be kept in hives. These species build a single comb nests on tall trees and cliffs. *A. mellifera* the Europen bee was introduced to the region to promote bee keeping as a commercial enterprise and it has a high honey yield and a hive can yield 30-50 kg of honey per year. However, it is susceptible to disease and low temperatures and can not easily be maintained in the mountains unless bee keepers moved boxes to the lower altitudes during winters. Nevertheless it is very popular with commercial bee keepers which largely replace *A. cerana*, the ecological implications of which are still not known. In Uttarakhand wall hives with colonies of *A. cerana* have been traditionally nurtured . The practice had declined somewhat for several reasons such as a change in construction material (from stone walls to brick walls) the market wall hives more difficult to keep and maintain and also because of declining bee population attributed to indiscriminate use of pesticides in fruit growing areas. However, bee rearing is seeing a small resurgence in the region. A few NGOs and entrepreneurs have aggressive programmes aimed at increasing bee colonies and the yield of honey per colony.

Honey yields can be increased from 2 – 3 Kg per hive annually to 5-7 Kg per hive through use of better technologies such as removable combs. In newer wall hives farmers are often inserted which allow for non-destructive removal of hives and harvesting of the honey rather than the old practice of cutting the hive out of the wall which resulted in its destruction and necessitated that bees build a fresh comb which in turn reduced honey yield. There are no accurate estimates of honey production in Uttarakhand. Appropriate technology India (ATI)

involved in large scale honey trade and sells approximately 70 tonnes annually much of it collected from Rudraprayag and Chamoli districts. Much of the honey in the districts is consumed locally or sold directly to tourists, as the prices for direct sell (Rs. 100-150 per litre) is typically much higher than prices when sold to institutions that brand and further market the honey (Rs. 30-70 per litre). The price of certified organic honey is however, significantly higher and can significantly increases the farmer incomes. Overall Himalayan honey can fetch higher prices than honey produced in the plains because a buyer is likely to pay a premium for honey produced in what is considered to be a relatively pristine and pure environment.

3.10 *Morchella esculenta:* A High Value NWFP of Higher Himalayan Forests

This is an edible mushroom and is found growing naturally in the humus rich forest floors of broadleaf-mixed conifer forests in Uttarakhnad. The fruiting body (Scientifically called ascoacarp) appears on soil surface soon after rains during march-april. People set surface fire every year during winter and believe that such a practice improves *Morchella* yield. The ascocarps collected during May-June, are cooked with rice and vegetables and considered nutritious. The decoction of ascocarp after boiling with water is used in medicine and health care system by the local communities. Out of the five species of *Morchella* found in India, *M. esculenta* is expensive because of its rich nutritional value and coupled with a unique flavor.

In the Niti valley of chamoli district approx. 40 villages inhabited by about 1600 families mostly involved in the collection of *Morchella* during summer. On average, a person may collect 2-3 kg. freshly weighing *Morchella* per day. The ascocarps are then hanged under roofs of the houses for 15-20 days for air drying. Every season a family (3-5 persons) collect a average 1.5 Kg air dry weight of *Morchella* that is sold by the local middlemen @ Rs. 5000 per kg. It has been realized that though the local people earn good amount of money from this wild resource, its indiscriminate extraction and traditional practice of setting fire on forest floor leads many fold negative impacts on forest biodiversity and ecosystem services and calls for more studies to find out an environment friendly technique to harvest this useful product of nature.

3.11 NWFPS: Success Stories on Livelihood

Case study No: 1

Bee Keeping: As a Tool for Poverty reduction in Chitral: Mr. Mehoboob Ali of village Goldor Chitral in Pakistan, the sole supporter of eight family members, having no cultivable landholding in his possession always wanted to earn some extra money to support his extended family. Once the field staff of Non-wood forest produce came to his area for providing training, he very receptively followed their trainings instructions in honey bee keeping. As honey bee keeping occupies only a small space was very ideal source of additional income for him. He joined the NWFP promotion Committee Gouldor Chitral along with others group and was trained by Directorate of Non-wood forest produce, NWFP Forest Department Chitral.They were also provided bee boxes to him on subsidy rate. He takes very good care of his bee boxes due to the training he received from the NWFP Department. In the first year he collected 12 kg of honey and out of which he sold 8 kg in a local market at Rs: 600/- per Kg and earned Rs.5000/- with which he paid off his daughter school fees which was due on him. Now his young daughter also helps him in the management of honey bees. Mr. Ali is planning to buy 10 more bee boxes this year and wants to establish a farm near his house**. As, Mr. Ali said, "beekeeping is a good business and brings in good profit as bee flora is abundant in the surrounding area".**

Case study No: 2

Medicinal plants as a source of livelihood promotion: Dilshad Bibi a poor widow of 60 years of age with four daughters and two sons lives in a small house in the remote village of Bomburat kalasha valley Chitral. Dilshad was trained by Non-wood forest produce, department Chitral in medicinal plants collection and its storage during valley training program in kalash valley. After receiving the training Dilshad was motivated enough to such an extent that in July 2008 Dilshad borrowed an amount of Rs. 2000/- as loan from a local shopkeeper in Bomburate to open a small store in her house. With the amount she purchased all the medicinal plants that the villagers collected. She repaid back the whole amount well before the repayment date and borrowed another amount worth Rs.5000/-. **"I have earned a profit of Rs.5000/- from the sale of the medical plants in Drosh market", as she said**. Apart from her this source of income she also sells basketry products in the local shopes. Now she is not an active member of NWFP promotion Committee Bomburat but also motivates other women of the area to adopt NWFP activities to earn income. Now she is very well established in her life and is really thankful to NWFP Department for

extending help in such a way that taught her to catch the fish and made her independent and not dependent on any one else to support her family.

Case study No 3

A shift from timber to Non-wood products: Gingerate village is situated about 16 Km from the Main Drosh Bazaar. The soil of the area is very fertile and agriculture is the main source of livelihood of the area. The area being rich in forest resources also has become vulnerable to timber trade where people are involved in illegal cutting of the forest for sale purposes to earn for his living. Once a NWFP Field staff visited the area and arranged a meeting with the community on the non-timber forest produce as an alternate source of income to forest logging. The people accepted the fact of the forest of the area being under immense pressure due to over harvesting and the reason they cited were lack of employment opportunities. The forest protection member pointed out the names of those involved in timber trade and was causing great damage to the forest. Mr. Subaddar was one of them, being involved in timber trade, had also established a mini timber depot at his home and was selling timber in Drosh market at a very high price. When the Staff of Non-timber forest produce Directorate, NWFP Forest Department, Chitral contacted him and tried to motivate him that forest being a very important source of survival of people and the removal of vegetation could cause high flood and erosion and can cause great damage to his area. **Then he said, "I have no other source of income and therefore had to get involved in timber trade".** At this the NWFP staff briefed him about different NWFP and its market value. After an extensive meeting with him he agreed to leave this profession and start the cultivation of medicinal plants in his farm land, and also demanded for bee boxes. The said person has a huge number of wild olive that can be utilized as source of income. Now Mr. Subaddar is an active member of NWFP promotion committee. The local communities are very much happy at this achievement of NWFP department and also requesting for the engagement of the other similar people in NWFP activities and involve them in income generating activities and thus save the valuable forest resources.

Cases study No 4

Tasar culture as a source of livelihood in Ukhimath region of Uttarakhand: Appropriate Technology India (ATI), a local NGO with the help of Appropriate Technology International has been promoting silk culture by providing silk worms to the local formers for developing

silk cocoons with a buy back facility. The silk worms are fed on leaves of *Quercus semecarpifolia* (Kharsu oak). Locals have been trained in weaving a silk cloths. The activity has been a success providing livelihood to several families in the area.

Case study 5

Chilgohza (*Pinus girardiana)* seed as a livelihood option in Himachal Pradesh: In Kinnaur,HP, Chilgohza pine is a valuable non-timber forest product of the area and is serving as a good source of income for the local community. But due to the lack of proper knowledge and awareness the local community is unsustainably using these resources; the local community removes 100% cones from the Chilgohza tree during collection, and cut its branches in order to collect the pine nut. Due to this the natural generation of this valuable species is badly affected. According to an estimate about 10-15 tones of pine nut is collected from the area by the local community..

Case study 6

Cultivation of Medical Plan (An extra source of income): Mr. Rasheed, Belongs to Gingerate, Drosh in southern Chitral. He completely dependent on his land to earn living and support of his extended huge family. But due to old methods of farmer and non availability of certified seeds his production was less. When the Directorate of NWFP Forest department Chitral Field staff visited the area and arranged a meeting with the local community for the promotion of livelihood. Mr. Rasheed showed his willingness for the cultivation of medicinal plants but has no idea about their cultivation and seeds of the plants. Then, the NWFP Staff trained him in the cultivation and propagation of medicinal plants and also provided him seeds of medicinal plants to cultivate on his farm land. Now 6 species of medicinal plants sp grows in his farm land, like Saffron, Banafsha, Alsi etc. and he has also gained a lot of knowledge and experience in the cultivation of the medicinal plants. He has also placed a request for the grafting of his wild olive tree surrounding by his house in order to get more income from it too.

3.11 Potential of NWFPs in solving livelihood problems

NWFPs species offer opportunity to alleviate the existing livelihood problems of the rural people. The studies conducted so far in Nepal and India has found several NWFPs that can be instrumental in solving livelihood problems. Out of these three different tradable NWFP medicinal plant species have been dealt in detail. They are: “atis” [*Delphinium himalayai*],

"jatamansi" [*Nardostachys jatamansi*], and "kutki" [*Picrorhiza scrophulariiflora*]. All these tradable NWFPs species are sold for their medicinal properties. In addition, people also collect one mushroom species called "guchchi " [*Morchella conica*]. "Guchchi", which has a high economic value, is used to make mushroom soup and vegetable, and has been exported to Germany, Switzerland, Canada etc [Roy *et al.*, 2009]. Presently, these tradable NWFPs species and fungi are being collected from public lands such as government forests and pasture lands. Hence, availability of these resources is scattered. As a result, the amount of time and labor that people invest in collecting these valuable resources are greater than the monetary value they can derive from the species collected. In addition, competition among the primary collectors worsens the situation, resulting in people collecting pre-mature NWFPs species in order to maximize the economic gain in the face of such competition. This situation puts more threat on the natural regeneration of the NWFPs species, and as a consequence, there is a possibility of extinction of the over harvested NWFPs species. To solve this problems cultivation of these species along with several others can help in the conservation of the species and provide good monetary benefits to the local growers. NWFPs can be sold at a good price. In order to ensure supply, cultivation of economically valuable NWFPs species on private lands was found to be the most prevailing livelihood opportunity.

3.13 Summary

NWFP's provide livelihood to marginalized hill communities in the entire Himalayan region. Several wild edible plants have become a major part of the daily livelihood and several other are a source of earning. However, unsustainable collection of several NWFP's has resulted in their overexploitation. There is a need to educate the locals about sustainable collection and techniques of raising NWFP's for developing livelihood opportunities as well as elevation of their economy.

Terminal Questions

1. How NTFPs are useful in enhancing livelihood generation for rural people?
2. Explain some important NWFPs having potential of income enhancement?
3. Medicinal and aromatic plants (MAPs) are useful in livelihood improvement?
4. Explain the importance of NWFPs in livelihood improvement by giving case studies?

Unit 4 Valuation, Value Addition and Enterprise Development

Unit Structure

4.1 Learning Objectives

After you have studied this unit, you should be able:

- To have basic understanding of valuation and value addition
- To understand how value may be added by the local scientific technology to Bamboo and Rattan.
- To understand how the value of several oil yielding species has been enhanced.

4.2 Introduction

It simply means adding economic value to a particular raw material by any process like simply drying the plant material, grinding it, or extracting a compound from it by any process of distillation or boiling etc. We can understand it better with an example of *Rhododendron arboreum* (burans) flowers which are plucked from the tree and the collectors sell them at a meagre price varying from 10-20 Rs/kg. However, when the burans juice is extracted the bottled juice is sold at rates varying between 50-70 Rs/litre. Similarly there are various medicinal and aromatic plants herbage of which (leaves and shoot parts) if sent to a distillation unit can cost several thousand rupees in transportation but if a small distillation

unit is available with the grower, he can extract the important compound in a small bottle which he can take to any market, get a high net return without any transport charges. There are several such examples which can be quoted for value addition to NWFP's. In this chapter we have discussed the problems of low returns to the marginalized communities if the product is un processed, market information is not available, value chains and women empowerment and several case studies to provide an in depth knowledge on what is being done locally for value addition to NWFP's.

NWFPs offer great promise for producers in the informal economy. Although official production and trade statistics and research have somewhat neglected the sector, there is a sizeable and growing international market for NWFPs. These include essential oils, medicinal plants, gum arabic, rattan, bamboo, natural honey, edible nuts, mushrooms, various types of fibres, and other types of wild nuts and seeds used in cooking, skin care and for other purposes. While exports include some without value added, there is an increasing trend towards local processing of a range of more sophisticated products (Belcher and Schreckenberg 2003). Together these NWFPs involve millions of workers and producers, including many indigenous women and men in the most remote areas of developing countries. Several agencies, including IFAD (International Fund Agriculture Development), have increased their support – in the form of loans, grants and technical assistance – to enable indigenous populations to take advantage of these new economic opportunities and to share equally in the increased gains from globalization. Although new economic opportunities exist in this sector, it is not easy for people to take advantage of them.

- If NWFPs are not processed locally, they yield low returns.
- Forest dwellers do not have access to market information.
- Expansion of the NWFP sector can result in overexploitation or the loss of access to the natural resource base

Low returns: Resource-poor people find NWFP activities attractive because of the low technical and financial entry requirements, freely available resource base and instant cash in times of need. However, if they do not process NWFPs locally, the raw materials tend to yield low returns and offer little prospect for accumulation of the capital needed to escape poverty.

Remote areas are among the poorest and least informed, with little formal education. Without access to market information, forest dwellers have little knowledge of how much a consumer in the city or in developed countries will pay for the final product, and they have little or no means of bargaining for an increased stake in growing profits. As mentioned, they typically receive less than 10 per cent of the final selling price. Without organizing into producers' or marketing groups and without access to information and technological and economic resources, women have very little chance of increasing their control over returns from the productive process. Membership in a group would enable them to gain a more powerful position in the value chain, and access to resources would enable them to add value at the source. Only when forest dwellers receive resources to address these constraints directly they will be able to adopt strategies that help them use forest resources as a means of escaping poverty.

4.3 Value Chains and Women's Empowerment

Women and men living in poverty in rural communities are trapped at the production end of global value chains. Most profits go to traders, distributors and retailers, who tend to be men from less remote and richer communities. But even at the production level, women are likely to work in the lowest skilled and lowest paid jobs. Given their major role in lifting themselves and their families out of poverty, any poverty reduction programme should ensure that women can position themselves more favourably within these large and complex chains. Several recent publications offer suggestions on how value chain analysis can examine the integration of poor rural women into NWFP global value chains, as well as on how to improve their position (Marshall, Schreckenberg and Newton 2006; Royal Tropical Institute (KIT) 2006; Kaplinsky and Morris 2001). These publications present variations on four ways in which the upgrading or improvement of value chains can benefit poor rural women producers and, in particular, indigenous women from remote communities:

Process upgrading: Process upgrading is carried out in order to increase the efficiency of production within or between stages of the value chain. Typically, forest dwellers accumulate larger quantities of the product or use a new technology, supported by access to credit and training. An example of this is the introduction of improved beehives or oil expellers. To the extent that women have less time than men to increase output and less access to credit, technology and training, they are at a disadvantage at this level of upgrading.

Product upgrading: In order to improve the quality or introduce new products using the same raw materials product upgrading . This is particularly common in NWFP value chains and can enable producers to gain access to a more specialized 'niche' market and protect themselves against product substitution. Examples include diversifying from honey into organic honey or other bee products, such as royal jelly and propolis, which have very high value in niche markets.

A**ctors:** Women who simply gather and handle NWFPs, with no involvement in processing the product or in managing the value chain

Integrators: Women who do some processing of their product, but still have no say in management of the chain and rely on intermediaries to reach markets

Partners: Women who do no processing of their product, but do have a say in management of the chain

Co-owners: Women who both add value and have a say in management – thus increasing both returns and power. This is an important form of analysis, as far too many projects and interventions concentrate only on raising income, without concern for increasing ownership and empowerment.

In the section given hereunder we have tried to quote several examples of the methods used for value addition:

4.4 Bamboo and Rattan

Bamboo is the world's largest plant in the grass family. Drawing on a long history of use, it has been integrated into the modern technological world, with many types of goods produced – from high-quality paper to chopsticks, woven baskets, *agarbatti* (incense sticks), crafts, furniture, plywood and floorboard. Some of the newer bamboo based products include soaps, water purifiers, pain relievers, lotions and textile products. Over one billion people live in bamboo houses, and in Tokyo and Hong Kong, the scaffolding of high-rise structures employs bamboo. China is the richest bamboo-producing country in the world, with over 500 bamboo species and sales of some US$2.4 billion in bamboo products annually. The value of one culm is US$1, while the value of a final bamboo product, even if made at the village level, can be significantly higher, thus adding much-needed income at the local level.

Bamboo shoots are another major export product, with exports from Taiwan alone reaching US$50 million per year.

Rattan provides sustainable income to some of the most disadvantaged people living in and on the fringes of forests. In the 1970s, Indonesia became the major supplier of rattan, accounting for nearly 70 per cent of global trade. The value of rattan exports in Indonesia has increased a stupendous 250-fold in just 17 years, with lesser but still very large increases in other countries in South-East Asia. Overall global trade is worth US$4 billion annually, and domestic trade is worth US$2.5 million. Markets for rattan consumption in Europe, North America and Japan are growing steadily.

Both bamboo and rattan are environmentally friendly. A 60-foot bamboo grows in only 59 days, versus 60 years for a tree. Rattan 'hugs' trees and saves them from the logger's axe by providing equal or more benefit than the companion tree, without disturbing the natural habitat.

In Uttarakhand, non-Government organization like appropriate technology in India and the Bamboo and Fibre development board have taken initiative to add value to raw bamboo material by training the local people in weaving baskets, mats, and other decorative items which fitches a much higher value than the raw material.

4.5 Wild Mushrooms

Traditionally, peoples in all parts of the world have collected wild mushrooms such as oyster, chanterelle, morel and shitake/ matsutake from the forest floor. Recently, there has been a loss of skill in identifying safely edible mushrooms, and local populations are reluctant to consume them. Export markets for higher-value mushrooms such as shitake/matsutake have grown considerably, in part because of the high demand of large consumers such as Japan. This is resulting in a shift in the division of labour in supplying countries. Men and women participate increasingly in all parts of the global value chains for high-value mushrooms. Mushrooms provide a major source of nutrition for local populations. They are high in protein and essential minerals, and remote poor populations often use them as a substitute for meat. They also have great medicinal value: people use them widely in parts of the world as they believe them to boost the immune system. However, as they degrade quickly they need to the transported to cities.

Simple processes like drying of mushrooms and preserving them with local preservatives can add value to this important NWFP. However, it is important that the wild edible mushrooms are identified by an expert before consumption.

4.6 Bee Products

In the hills value has been added to the honey by getting it certified by relevant agencies as organic honey. This has also resulted in the price going up several fold. Raw honey, either on its own or in combination with other products, is well known for its healing qualities. These include disinfecting wounds, killing bacteria that cause stomach ulcers and diarrhea, alleviating symptoms of arthritis and colds, lowering cholesterol levels and boosting immune systems (Krell 1996). Honey-hunting has traditionally been a male activity, partly because it involves climbing trees, which is not culturally suitable for most people.

4.7 Medicinal and Aromatic Plants

Globally, Gibb (2007) estimates sales of herbal medicines alone to have exceeded US$12.5 billion in 1994 and US$30 billion in 2000. Annual growth rates range from 5 to 15 per cent. In 2000, the Secretariat of the Convention on Biological Diversity reported the world market for herbal medicines, including herbal products and raw materials, at US$60 billion and forecast it to reach US$5 trillion by 2050. Hundreds of thousands of medicinal plant species around the world constitute:

- the basis of health care systems throughout much of the developing world
- a source of compounds on which to base new pharmaceutical products
- a major component of the burgeoning markets for herbal health care remedies and natural products
- a source of income for growers, traders, collectors and manufacturers of plant based medicines

Unfortunately, some medicinal plants are already in short supply. In Europe, the trade structure is complex and dominated by a few wholesalers. In producer countries, diverse types of traders, including local dealers, village cooperatives and district traders, buy plant material from collectors and cultivators. They then pass it on to wholesalers, manufacturers or directly to retailers. The wide range of manufacturers includes production of

pharmaceuticals, extracts, cosmetics, foods and colouring agents. The length of the trade chains and a perceived need to protect information lead to a lack of transparency.

A direct consequence is that people at the start of the chain have little idea of the market value of the medicinal and aromatic plants they are supplying and are unaware of the value added from source to end-use World Wide Fund for Nature (WWF) 2002. Medicinal plants are an important source of livelihood for millions of people in developing countries, particularly women, indigenous peoples and very poor people. Traditional knowledge associated with medicinal herbs is a highly gender-specific activity in most countries. While women tend to be the repositories of indigenous knowledge relating to the uses of medicinal plants, both women and men collect them (Gibb 2007). Women collect plants from forests closer to home and combine this activity with others, such as collecting firewood and fodder. The plants they collect tend to be of lower value and destined for local markets. Men make special trips to more distant locations, including the highest altitudes where higher-value plants are found. These often end up in the more complex value chains related to export markets, and men tend to dominate the trading and exporting functions in these chains. While demand for medicinal herbs has risen in global markets, inequitable trade practices have meant that only a small portion of the profits trickle down to collectors. Concerns include recognition of the intellectual property rights of traditional users and biopiracy. Increasingly, scientists and industry are appropriating, adapting and patenting the knowledge of traditional medicine with little or no compensation to its original custodians and without their informed consent. There are two crucial, related concerns:

- People who depend on traditional medicine may lose access to medicinal plants if pharmaceutical companies patent them.
- Over-harvesting of commercially valuable medicinal plants in the wild could result in their extinction, with both health care and livelihood impacts for indigenous and traditional peoples (Gibb 2007). Although companies and entrepreneurs specialized in the commercializing of NWFPs

Hills Leasehold Forestry and Forage Development Project (HLFFDP): In 1990, the Government of Nepal and IFAD signed a loan agreement for HLFFDP, with the twin objectives of raising the incomes of hill families living below the poverty line and contributing

to improvements in the ecological condition of the hills. A decade later, the development community of Nepal recognized HLFFDP as an innovative, unique project that had a significant impact on the lives of its group members, especially women, as well as on the environment. In particular, HLFFDP contributed to an enhanced sense of self-confidence and bargaining power among women participants. It achieved this through the incorporation of gender issues and the targeting of poor women in the strategy and implementation of the project. To overcome the problem of the scarcity of women staff in the Department of Forestry and the line agencies implementing the project, HLFFDP hired women group promoters to organize women's and mixed groups and to train men and women in gender awareness at the grass-roots level. In addition, a team of three women Nepalese technical assistants joined the project coordination unit to develop mechanisms for mainstreaming gender considerations. The team identified gender focal points (mostly men) within the implementing line agencies and developed their gender skills through training, coaching and guidance. These focal points worked closely with the women group promoters. According to one male focal point, "these group promoters are like our own family. If we had not given them this support, the project would not have been successful. They are our messengers to leasehold communities and help us conduct meetings. Since they have come, the participation of women has increased. Through gender training, we have become aware of women's knowledge and roles in natural resource management." (Gurung and Lama 2002). Continue to exploit local communities, there are some examples of methods that can protect their rights. In 1997, the South African Council for Scientific and Industrial Research (CSIR) licensed a United Kingdom-based company to develop and commercialize an appetite-suppressant drug that CSIR had isolated from hoodia, which has long been used by the San people to ward off hunger. In 2001, media reports led to increased interest in the drug and alerted the San to the potential use and value of their traditional knowledge. This resulted in the South African San Council signing a memorandum of understanding with CSIR, which acknowledged the San as the custodians of their traditional knowledge. CSIR also agreed to share the benefits of commercialization of the new drug. The potential income for the San could exceed US$7 million annually for the 15-20 years before the CSIR patent expires. It will be deposited in a San hoodia trust for development of the San community (Schreckenberg 2003).

Overexploitation of several valuable medicinal and aromatic plants has resulted in some governments banning exports of raw materials. In addition to conserving the natural resource base, such policy changes have also promoted local processing and increased employment levels and foreign exchange earnings. In Nepal, forest dwellers used to export over 90 percent *Jatamansi* (an aromatic plant of the valerian family) as raw material. Following a change in trade policy, they now process over 75 per cent into oil before export. Of course, a corresponding increase in financial and technical support for local processing should accompany policy changes. Ideally, it should enable most of the value added to stay within local communities. Transfer of forest resource management to community forest user groups (CFUGs) and investment in local, community-owned distillation units in Nepal has led to substantial increases in income for indigenous collectors – both women and men. CFUGs also help put collectors on a more equal basis with traders and thus increase their control over the market chain. Nepal has affected major policy shifts on exports and on the transfer of ownership of forest resources.

4.8 Fruits, Nuts and Seeds

Indigenous trees are yielding valuable raw materials, primarily for the cosmetics industry. These trees have been harvested sustainably for generations by indigenous and marginalized rural women. The creation of viable, ethical domestic and export markets for these products can add local value and preserve the traditional culture associated with their use. This, in turn, enhances rural women's livelihoods and food security and protects the trees (see the website of PhytoTrade Africa, www.phytotradeafrica.com, the Southern African Natural Products Trade Association headquartered in Harare). Tree types include shea, marula, baobab and mongongo. Producers process the fruits in a variety of ways: traditional processing by women using simple technologies; by women's groups using improved technologies; or in more-sophisticated factories using capital-intensive technologies. The end product is an oil or butter that has widespread use locally as a cooking oil, in soap-making and in skin and health care. Users brew some fruits for local consumption and sale, and eat others as a nutritious snack food. They feed the cake left over after pressing to livestock. Few indigenous communities could survive without these multipurpose trees. Cosmetics industries in Europe, North America and Japan have a high and growing demand for these oils and butters, often met through fair-trade markets. However, they often

do final processing in the consumer country to ensure the meeting of proper standards (Bekure et al. 1997). Shea is increasingly being used in chocolate manufacture in northern countries. Demand has increased, in particular after August 2003, when a new European 'norm' went into effect that allows for the use of up to 5 per cent non-cocoa fats. Women's associations in West Africa that produce shea butter report an increase in orders following the change in regulations (Gordon 2004). Women who collect the fruits and depend on them for their livelihoods are failing to benefit equitably from these growing markets. As can be seen in figure 5, the production chains are long and complex. They involve a range of processors, traders, exporters, importers, wholesalers, manufacturers and retailers, who rake off much of the profit, leaving women collectors with little or no increase in income. Governments and development agencies should assist women in increasing their control over the marketing chain and in sharing more widely in the gains of globalization (Carr et al. 2000).

Interventions: Given the high visibility of these products in the global market place, interventions have been well documented. There are several good examples of how a variety of actors can come together to enable women collectors to take advantage of expanding export markets. In Namibia, 3,000 women who collect marula seeds have formed a cooperative that is a member of PhytoTrade Africa. The cooperative exports both seed and processed oil to the Body Shop International, which advertises the use of 'community-traded' marula oil in its whole cosmetics range. The Centre for Research-Information-Action in Africa/Southern African Development & Consulting (CRIAA SA-DC), a local NGO, has enabled the cooperative to enter into direct negotiations with The Body Shop. It has also linked cooperative members with local artisans, who have developed appropriate processing equipment in response to members' needs (Schreckenberg 2003). PhytoTrade Africa, which is an IFAD grant holder, has had a number of other success stories in southern Africa. In 2006, almost 30,000 primary producers (93 per cent women) sold raw or value added NWFPs worth US$340,000 to PhytoTrade Africa members located in seven countries in the region. The network has built robust supply chains, which make possible the delivery of high-quality products to global markets on time and to specification. Its exports are 19 per cent fair-trade certified (PhytoTrade Africa, 2007). In West Africa, development agencies and the private sector have combined resources to respond to requests from governments for help in developing the shea sector. In Burkina Faso, 400,000 rural women participate in the

harvesting and processing of shea nuts. A joint project of the United Nations Development Fund for Women (UNIFEM) and CECI has introduced improved technologies and international marketing assistance. These activities have led a major cosmetics company (l'Occitane) to purchase shea butter directly from a network of 100 shea groups. The company also provides training and pays for the butter in advance, thus promoting greater economic security.

4.9 Value Addition in Cheura (*Diploknema Butryacea*)

Cheura (*Diploknema butryacea*) belongs to the family sapotaceae and popularly known as Indian butter tree which is mainly found in Uttarakhand state. It is a multipurpose tree and its untapped vast potentials need to be harnessed. It is also known as Phulwara, Fulwa, Pahari Mahua, Gophat or Indian Bitter Tree in Kumaun region of Uttarakhand state. Commercially, the Cheura oil extracted from the seeds, is marketed as Phulwara Ghee.Cheura is a native of Nepal and distributed from India through Nepal to Philippines and from Garhwal, Kumaun eastwards to Sikkim and Bhutan (Sub-Himalayan tracts and outer Himalayan ranges). It also occurs sporadically in tropical moist deciduous, semi-deciduous and evergreen forests of Andaman Islands. It is a fast growing tree borne oilseed and found in the elevation ranges between 400-1400 meters mainly along the sides of ravines and in shady valleys.

Cheura starts flowering in the months of October- November at the age of 8-10 years. Its flowers are either white or yellow colour with a special fragrance. Generally, an alternate bearing has been observed in this tree. The fruits start ripening in June-July months. Fruits are oval in shape and initially with green colour which turns light yellow after ripening during June-July. Fruits are harvested during second week of June till July end.

The weight of seed is 20% weight of the fruit whereas the kernel weighs 76-80%. Seed and kernel contain 42-47% and 60-66% oil, respectively. The market price of raw fruits of cheura is 20-30 Rs/kg but it dried price is 80-100 Rs/kg, but the extraction of oil with seed on commercial scale the value price increased several times more than raw fruit value. In Gurna, after the establishment of an oil expeller the value of cheura oil has gone up significantly as more oil is extracted per kg dried kernels and the outer fleshy portion of the fruit is being used by the local cottage industries of preparation of juggery, chutney etc. Cheura oil is used as Ghee and butter which is known as 'Phulwara Ghee' for cooking and

frying of vegetables and food. Cheura butter is used for preparing medicines, ointment, candles, cream and other user-friendly products.

4.10 Value Addition of Wild Apricot (*Prunus Armeniaca*)

The wild apricot (*Prunus armeniaca* Linn.) is an important tree borne oilseed crop of mid hills and dry temperate regions of the country. Wild apricot belongs to the family *Rosaceae* and sub-family *Prunoideae*. In the Himalayan region of the country, local communities known it by different vernacular names viz. ”Chulli”, “Shara”, “Khurmani”,”Chulu” etc.

The cultivated apricot has its origin in North-Eastern China, whereas, wild apricot appears to be indigenous to India. Wild apricot locally called Chullu is found in the dry temperate region of North-Weastern Himalayas. In Kumaun region, wild apricot is found in all the three districts of Nainital, Almora and Pithoragarh. Pithoragarh district has maximum density of wild apricot tree in the Kumaun region.

Wild apricot fruits generally start maturing during from last week of May and continue upto August end depending upon altitude and location. They are harvested manually by shaking the tree branches and no mechanical harvesting is practiced. Change of surface colour, from full bloom to harvesting and fruit total sugar solids (TSS) are considered as the best indices of maturity. For fresh marketing, fruits should be plucked when they change their surface colour from green to yellow. Fully ripened fruits are harvested for freezing, canning and drying. The fruits should be harvested in morning hours and direct exposure of fruits to sun should be avoided during grading and packaging tree. It starts bearing fruits at the age of 4-5 years and continues to bear well for 50-60 years. The full bearing occurs at about 10-15 years when it yields about 85-100 kg. fruits per tree. The stone yield varies from 12-17 percent of fruits and the kernel yield ranges 3.14-4.81 kg/tree. The yield of a full- bearing well maintained plant tree varies from 120-150 kg.

Kernel oil closely resembles expressed almond oil thus it is employed as an adulterant or a substitute for almond oil. An essential oil that is identical with bitter almond oil is distilled from the cake. Apricot kernels are cheaper and give higher yield of oil (0.8-1.6 percent) than bitter almond oil. The oil of the seed is also edible and is used mixed with other edible oil like mustard oil. The fetches very high in the cosmetic industry. It is also medicinal and used for joint pain. The strained baby foods from pulp are nutritious and a good source of calcium, phosphorus and iron.

4.11 Gums

Gums are a type of resin exuded from a variety of trees, partly as the result of natural phenomena and partly from injury to the bark or stem of a tree. They exude in liquid form and, on exposure to air, dry into translucent tears that remain stuck to the bark of the stem or branch, from which collectors can then pluck them. People use gums for a variety of purposes: as adhesives; for clarification of liqueurs; finishing of silk; preparation of quality water colours; in pharmaceuticals, printing inks and the sizing and finishing of textile fabrics and dyeing; in the paint industry; in cosmetics – to bind creams, lotions and ointments; in preparing ice cream, chewing gum and other confectionary items; and in soft drink manufacture (Grams 1998). There are two major types of gum: Arabic and karaya. Both types are primarily for the export market, where a wide range of industries use the semi-processed product to produce finished retail goods. Sudan is the largest supplier of gum arabic and had more than 90 per cent of the world market until the 1970s. The country's leading position has declined in recent years, owing to internal political factors and the development of artificial substitutes. India is the world's largest exporter of gum karaya. Exports have declined in volume (although not in value) in recent years, due in large part to a loss of trees because of the widespread use of non-scientific and harmful tapping methods. The value chains and gender division of labour involved in these two types of gum are quite different. In the Sudan, men are totally responsible for collection of gum arabic, which they then transport over long distances to one of 13 central auction markets, where approved merchants buy it at an agreed price. They deliver the gum to their cleaning sheds, where teams of local girls select and handgrade it. The merchants then sell the graded gum to the Gum Arabic Company, which is 30 per cent government owned. The company is the sole permitted exporter (Grams 1998). In India, the system is more decentralized and women participate more in the collection, transport and sale of gum karaya. However, the methods of tapping are very primitive, resulting in injuries to both the pickers and the trees. Gum pickers live in some of the most remote parts of the country. Until recently, they worked in isolation, without advice on improved production methods and without information on markets, prices or local legislation on the use of forest products. As a result, while gum karaya is a valuable product and a major source of export earnings for the country as a whole, the tribal women and men involved in collection earn a pittance for long, unpleasant hours of work (Mehta 1998). The value chains vary from state to state.

Interventions: In India, state governments control the collection, sale and marketing of gum, issue collection licenses and buy the gum from licensed collectors. In Gujarat, thousands of the State's poorest women rely on gum collection for their incomes. Most do not have a collection license and are thus forced to sell to local licensed contractors at a very low price. The Gujarat State Forest Development Corporation Ltd. has allowed prices to vary according to changes in conditions (such as an influx of cheap imports from the Sudan) and has no market linkages or plans. An intervention by the Self- Employed Women's Association (SEWA), a women's union, helped collectors organize into groups. These groups secured collection licenses for their members and were able to negotiate higher selling prices with the forest corporation. Eventually, the women also won the right to sell on the open market, where prices are higher. The women's union is developing more direct market linkages on behalf of the gum collectors.

GCC and the Andhra Pradesh Tribal Development Project (APTDP): The Girijan Cooperative Corporation Ltd.(GCC) undertook research on the processing and marketing of forest products collected by tribal peoples. Its initiative on gum *karaya* was a good example of the benefits of combining a concern for tribal people with dissemination of scientific knowledge and professional marketing techniques. Gum *karaya* is the most important NWFP procured by GCC, accounting for about one half of total procurement, and it is a major source of income for almost 12,000 tribal people.

GCC's employing of a pharmaceutical specialist led to the development of scientific tapping and post-harvest practices, modernization of storage and quality control. It engaged nearly 80 consultants and 400-500 liaison workers to train and supervise the collection of gum. Within two years, the price of grade 1 gum tripled and tribal income rose proportionally. The improved tapping techniques also extended tree life. GCC organizational expansion, facilitated by APTDP, led to the creation of the Commercialization, Research and Development Division, illustrating the importance that GCC assigns to issues related to market linkages. (Government of the Republic of India 2002).

In Andhra Pradesh, on the contrary, thousands of tribal women and men gum collectors have been assisted directly through the Girijan Cooperative Corporation Ltd. (GCC). The State Government set up GCC to procure and market NWFPs, with the assistance of the IFAD-supported Andhra Pradesh Tribal Development Project. GCC's managing director was reluctant to lower prices when the corporation was unable to sell stocks of gum owing to the

poor quality of the product. Instead, he looked for scientific solutions to resolve marketing problems through improving quality. GCC employed young, tribal volunteer workers to liaise with gum collectors and scientists to develop and disseminate solutions. As a result, the quality of gum has improved, prices paid by traders and the incomes earned by collectors have increased, and the life span of gum trees has been extended. Because scientists worked with gum collectors on technology development, there has been a beneficial blending of modern and traditional technologies.

Karaya value chain (Andhra Pradesh, India): An Analysis: Global value chains for most NWFPs are highly skewed in the direction of distributors and retailers. Forest dwellers at the collection end of the chain typically receive much less than 10 per cent of the total selling price. As is the case with many other products originating in developing countries, NWFP chains are highly gender specific. Women mostly deal with lower-value products and lower-value activities than men, and do not have the same access to the technology, credit and training needed to redress the balance. However, there are many ways to alter the distribution of returns and power in favour of indigenous communities and the women within them. To return to the terminology of chapter I, a major of objective of gender-sensitive NWFP projects is to increase the income of indigenous women by adding value to their forest resource base. Projects should also enable women to control the subsequent marketing process to benefit on a sustainable basis. In other words, projects need to move women from being 'actors', where they are mere price-takers, to 'co-owners', where they have an equal say in price-setting and marketing with those further down the value chain. Implicit in this approach is the need for women to have control over the use of the resource base. The following examples demonstrate various ways to achieve this:

- In Nepal, the producers of wintergreen target mainstream European markets. A change in government policy banned the export of raw wintergreen plants, so there is now more processing at the local level. There has also been investment in local, community-owned distilleries and a gender-sensitive programme to transfer forest resources to user groups. These measures have resulted in significant increases in income and control for the women who have traditionally collected this aromatic plant.
- In Namibia, the producers of marula oil target 'niche' fair-trade markets. Innovations in the supply chain have resulted in a women's cooperative being able to capture 47 per

cent of value added, where the norm for primary producers would be less than 10 per cent.

- In Andhra Pradesh, the producers of gum karaya target mass industrial markets. Gum collectors and scientists employed by their associations have developed improved collection and processing technologies that have doubled the incomes of tribal communities and extended the life of the gum trees.

Major Interventions: Assisting local population in capturing a greater proportion of value added in globally marketed NWFPs – and doing so in an institutionally and environmentally sustainable way – will require finding innovative approaches to:

- dealing with resource scarcity
- increasing competitiveness and improving market linkages/access While these tasks are important within the context of local/domestic markets, they become crucial in supplying global markets and require a mix of skills and resources from a range of actors. The range and mix vary from product to product and from place to place:

  Bamboo and rattan: there are examples of NGOs supporting women's self-help groups in collaboration with national and international research institutions.

  Mushrooms/bee products: there are examples of social entrepreneurs, private companies, socially-owned businesses, community enterprises and internationally supported research-and development programmes linking women gatherers and producers with national and global markets.

  Medicinal and aromatic plants: community forest user groups, community enterprises and local and international research-and-development institutions have enabled women to share in the benefits of growing global markets.

  Fruit, nuts and seeds: women gatherers and processors of marula, shea and other indigenous fruits have been supported by women's unions and associations, the private sector and local and international NGOs.

  Gums: women gum collectors have been assisted directly by state government institutions as well as by collector associations, women's unions and local research-and-development resources.

In addition, national governments and private traders deal with all product groups. Governments have played a major role in formulating policies and programmes in support of women's participation in and benefits from NWFP expansion. These policies and programmes range from bans on the export of raw medicinal plants in Nepal, to prioritization of the shea nut sector in Burkina Faso, and the implementation of an apiculture export strategy in Uganda. Private traders are key links in the value chains of most NWFPs and especially those destined for export markets.

To better understand the role of these different players in the NWFP commercialization process, it is useful to examine them in the light of resource scarcity and competitiveness/market access. The process of supplying local markets has continued in much the same way for generations. However, moving to the supply of sophisticated national and international markets requires major changes. Some type of process upgrading is usually necessary to improve quality and meet international standards. It may also be necessary to take on new functions such as marketing, with the associated need to establish a brand name or achieve certification. The opening up of global markets offers new economic opportunities that demand new skills in identifying and diversifying into new products. Government policy has a major role in ensuring an economic environment conducive to investment and innovation. Governments also have an important role in providing institutions and infrastructure to support such investment and innovation. For example, they can offer business development services, national monitoring services, training resources, public-sector research and export promotion boards. One good example of a package of government services to promote growth in output and exports of a specific NWFP is that of bee-keeping in Uganda: the national strategy promotes public/private partnerships and development of the industry through the private sector. Entrepreneurship, which drives the innovation process, comes largely from the private/civil society sector, with backing from international research-and-development institutions and development agencies. Private entrepreneurs, private traders, social entrepreneurs, leaders of producer associations, and, less often, NGO staff tend to be the social vehicles of technological innovation. On occasion, entrepreneurship is also found in more surprising places as, for example, the managing director of the state NWFP agency in Andhra Pradesh. Clearly, there is an amazing amount of innovation taking place in linking indigenous women with domestic supermarkets and global markets. In the case of technology, while the private sector tends

to buy commercial equipment (often imported), community based organizations and social enterprises have innovated at the local level. They have come up with technologies that are low cost, use local materials and do not depend on imported spare parts or need sophisticated skills to maintain and repair them. Sometimes they build on indigenous technical knowledge, and they always draw on local technical skills and incorporate a mutually beneficial dialogue between artisan and user. Several of the bee-keeper associations in Uganda have adapted improved beehives to lower the cost of production and incorporate features such as pest control. Others have developed technologies that enable the poorest bee-keepers to diversify into higher-value products. Although bee-keepers can draw on research and development undertaken by regional research institutions such as ICIPE, they are also very capable of innovating on their own behalf and their efforts in this respect deserve recognition and support. In the case of credit, private companies and social entrepreneurs have introduced innovative and successful user-friendly schemes. These work in situations in which microfinance options exist but fail to meet producers' needs and circumstances. In Uganda, the private company Bee Natural Products gives credit to every registered farmer/supplier. This is repayable over a four year period from honey harvests. Unlike many microcredit schemes, the company recognizes that it takes some time before a hive can be harvested, and it schedules repayments accordingly. In Kenya, the social enterprise Honey care has introduced microleasing schemes as opposed to microfinance. Incorporation of such financing options in NWFP projects is crucial to their success. Also important is the concept of payment of guaranteed prices on (or before) delivery. In Burkina Faso, advance payment from l'Occitane to women shea groups has promoted economic security, whereas in Namibia, lengthy delays in payment from The Body Shop to women marula oil producers have had the opposite effect. There have also been innovations in market access through collaboration with international networks and research centres such as INBAR, ICIPE and PhytoTrade Africa. INBAR's programme of development and diffusion of technologies for small holder producers emphasizes improved product and market development. Its work with incense sticks and cane baskets in India incorporates innovative ideas, such as selling under a brand name to obtain and maintain market visibility. ICIPE's programme of bee-keeping technologies in East Africa incorporates research on market linkages in collaboration with private traders. The programme is examining the possibility of creating a common brand for the products developed (preferably fair-trade certified), as well

as providing quality assurance (ISO certified) and organic certification for beekeeping enterprises. PhytoTrade Africa is a member of the International Fair Trade Association (IFAT) and assists its members in linking with global markets by requiring that they sign on to a collective Fair Trade Charter. Such assistance is obviously crucial in situations where the aim is to provide rural women with access to speciality niche markets – which is so often the case with NWFPs – and where costly and complicated certification schemes exist.

4.12 Conclusions

Spreading the gains of globalization to those communities that depend on forest products for their livelihoods and well-being is a major challenge for policymakers and development practitioners. Isolation and the usually low educational level of forest dwellers, and especially women, creates an uneven balance of returns and power within the global value chains into which they are increasingly integrated. However, significant new economic opportunities are opening up for these communities. And a range of strategies can help communities take advantage of these opportunities. There is no one recipe for success. Different strategies work in different locations and cultures and for different products within locations. Thus designers will need to plan interventions that help women increase their incomes from their forest resource base on a site- and product-specific basis – and in consultation with the women themselves. There are, however, some general guidelines that apply to most interventions. First, no one agency or individual can improve the position of local marginalized communities within global value chains. Because of the complex nature of these chains, one agency may take the lead in implementation, but it will need to draw on the resources and expertise of many other agencies and individuals to bring about positive change. A significant trend is that of public/private partnerships in which governments provide training and capacity building, while the private sector provides marketing and business development. Combining social issues with profitability and competition in global markets is not something that has been undertaken successfully by government agencies or NGOs working in isolation. Success is more likely if each agency takes responsibility for what it does best and then unites its resources with others.

4.13 Summary

Value addition to NWFP's results in increasing the monitory benefits to the local collectors. By applying simple techniques for which the scientific knowledge and the microfinance are

available the cost of the products can be increased several times over. In the current chapter we have tried to highlight the various processes for the most important NWFP's that can add value to them. Certification of the fact that the honey collected by the local collectors is organic has increased the cost of the honey. Similarly, grinding of Ritha seeds to powdered form can doubled its cost.

Terminal Questions

1. What do you understand by valuation and value addition?
2. How value addition and women empowerment are related?
3. What are the different steps in value addition? Please explain in brief.
4. Please explain briefly the valu addition of Bamboo and rattan.
5. How wild mushrooms can be useful for income enhancement of rural poor through value addition?
6. Explain some important value additions which can be usefull in uplifting rural economy.
7. How medicinal aromatic plants can enhance rural household incomes?
8. How value may be added to fruits, nuts and seeds?

References

Belcher, B., and K. Schreckenberg. 2003. NWFP commercialisation – a reality check. Keynote paper presented at the side session on Non-Timber Forest Products of the 12th World Forestry Congress, Quebec City, 21 28 September 2003.

Bekure, Z., M. Donlan, Y. Gordon and J. Thomson. 1997. *Local to global: the international market for shea butter*. New York: UNIFEM.

Carr, M., and M. Chen. 2002. Globalization and the informal economy: how trade and investment impact on the working poor. Working Paper on the Informal Economy No. 1. Geneva: ILO.

Gibb, H. 2007. Gender dimensions of intellectual property and traditional medicinal knowledge.

Background study for the Gender and Trade Policy Paper prepared for UNDP. Asia-Pacific

Trade and Investment Initiative, UNDP Asia-Pacific Regional Centre, Colombo, Sri Lanka.

Gurung, J.D., and K. Lama. 2002. *Empowered women and the men behind them: A study of change within the Hills Leasehold Forestry and Forage Development Project in Nepal*. Rome: IFAD.

Gordon, C. 2004. *News: The new taste of chocolate in Europe*,

Grams, J. 1998. Women's role in the international market for gum: summary of findings, unpublished report. New York: UNIFEM.

Kaplinsky, R., and M. Morris. 2001. *A handbook for value chain research*. Brighton, UK: IDS,

University of Sussex; Ottawa, Ontario: IDRC.

Kumar, A., and S. Reza. 2007. *A pathway out of poverty: Production of bamboo incense sticks* (agarbatti) *as a livelihood option for rural women*. Bangalore, India: INBAR-CIBART Documentation Centre, Centre for Indian Bamboo Resource and Technology.

Krell, R. 1996. *Value added products from beekeeping*. Agricultural Services Bulletin No. 124.

Rome: FAO.

Marshall, E., K. Schreckenberg and A.C. Newton, eds. 2006. *Commercialization of non-timber forest products: factors influencing success*. Nairobi: UNEP/WCMC.

Mehta, A.K. 1998. *Sustainable interventions for poverty alleviation: A best practice case of gum karaya in Andhra Pradesh, India*. New Delhi: UNIFEM.

Non-Wood News 13 (April 2006). Rome: FAO.

Non-Wood News 14 (January 2007). Rome: FAO.

PhytoTrade Africa. 2007. *A report of the impacts and achievements during 2006 of the Southern African Trade Association*. Harare.

Rao, I.V.R., B. Motukuri and S. Karpe. 2008. *Rural livelihoods development in Konkan, Maharashtra, with bamboo: An analysis of results and outcomes*. Bangalore, India: INBAR-CIBART Documentation Centre, Centre for Indian Bamboo Resource and Technology.

Royal Tropical Institute (KIT). 2006. *Chain empowerment – supporting African farmers to develop markets*. Amsterdam.

Sastry, C.B. 2005. Rattan in the 21st century – an overview. *Unasylva* (FAO) No. 205.

Schreckenberg, K. 2003. Appropriate ownership models for natural product-based small and

medium enterprises in Namibia. Report prepared for Namibian Ministry of Trade and Industry. Windhoek.

Yang, E., and Y. Sucuiwei. 2004. A gender assessment study on bamboo-based rural development and utilization activities – case study in Yunnan, China. Working Paper No. 53. Beijing: INBAR.

WWF. 2002. *Trade in medicinal and aromatic plants*. Fact Sheet No. 4. Gland, Switzerland.

Unit 5 Fibres and Flosses

Unit Structure

5.1 Learning Objectives

After you have studied this unit, you should be able:

- To understand the importance and uses of fibre and flosses
- To develop an understanding of the major plant species (tree, shrubs and herbs) and their parts that yield fibres
- To identify the major plant species (tree, shrubs and herbs) and their parts that yield fibres
- To differentiate between fibre and flosses

5.2 Introduction

Forests have been traditional source for supply of fibres and flosses. The most common examples are ropes, cordages, mattresses made by the rural people for several domestic purposes traditionally. Fibres of both vegetable and animal origin have been used long before the dawn of history, for the spinning of the thread and cordage and weaving of coarse fabrics. Among the earliest of such fibres wax flax; cotton, the greatest of modern textile fibre came later. Fibres generally occur as sclerenchyma cells and serve to provide rigidity to the plant. They are as a rule long cell with thick walls and small cavities. They are found in

various parts of the plant such as stems, leaves, roots, fruits and even seeds. Fibres of economic importance are furnished by many different families. Forests have been the traditional source for supply of fibres and flosses for the rural population. Fibres obtained from the forests are used for making ropes, cordages,mattresses and for several other domestic purposes.

Natural fibres are susceptible to microbial decomposition. They have an affinity for water, both in liquid and vapour form. This property of absorbing moisture makes them suitable for clothing. These fibre are non-thermoplastic i.e. they soften when heat is applied.

5.3 Classification of Fibres

Classification of the fibres is done on the basis of their origin, texture, morphology and uses. On the basis of origin, fibres can be classified into: (i) fibres from roots, (ii) fibres from stems, and (iii) fibres from leaves. On the basis of texture, fibres can be classified into the following three types:

Soft fibres: Fibres obtained from the innermost bark of the stem are called soft fibres, e.g. jute, hemp, flax, etc.

Hard fibres: Fibres obtained from leaves of plants are hard fibres, e.g., Manila hemp, etc.

Surface fibres: Fibre obtained from the surface of plant parts (stem, leaf, seed etc.) are generally called surface fibres.

On the basis of morphology, fibres can be further classified into the following categories on the basis of their morphology (Mehta, 1981; Dwivedi, 1993):

(i) Hair borne on the seeds or the inner wall of the fruits: Among the commercially important fibres in this group are Cotton, Kapok and Akund floss.

(ii) Fibres occurring in the innermost tissue or bark of the stem: Some of the commercially most important fibres are found in this group such as flax, hemp and jute. These are generally known as bast fibres or soft fibres to distinguish them from the hard fibres obtained from the leaves of several species.

(iii) Fibres obtained from the leaves of the plant and which are a part of the fibres of vascular system of the leaves. The most important fibres of this group are cordage fibres, abaca or Manila hemp and Sisal. (iv) Woody fibres of trees and plants consist of various elements which constitute the fibre vascular tissues of wood. These are used in paper making.

Table1. Important fibre and floss yielding tree species in Uttarakhand

Name of the species	Fibre/Floss yielding part	Uses
Butea monosperma	Roots/ bark fibre	Making ropes
Grewia optiva	Stem fibre	Ropes and clothing
Utrica dioca	Stem fibre	Cloth making
Cannabis sativa	Stem fibre	Ropes and fabrics
Ougenia oojeinensis	Branch fibre	Making coarse ropes
Ficus bengalensis	Bark and aerial roots	Coarse ropes
Careya arborea	Bark fibre	Cordages and ropes
Agave americana	Leaf fibre	Bags, ropes
Populus ciliata	Pods yields floss	Filling pillows and mattresses
Bombax ceiba	Pods yields floss	Filling pillows and mattresses
Kydia calycina	Bark fibre	Drag ropes
Erythrina suberosa	Bark fibre	Cordages
Bauhinia vahlii	Bark fibre	Ropes

5.3.1 Fibre from roots

The fibres are extracted from the young roots of *Butea monosperma* (a small deciduous tree commonly known as the flame of forests). Young roots of the plants yield fibre, which is used in making ropes and cordage. For obtaining the fibres, the young roots are dug, taken out and cut into 0.5 m long pieces. When these are green, the end portion of the root is crushed against stones, which forces the fibres to release from the root. These fibres are then caught and torn from the remaining portion of the root and removed by beating them lightly. The fibres are generally used for making ropes and cordages. The ropes are generally coarser and better for use under wet conditions. During dry period, the rope becomes brittle and breaks easily (Mehta,1981; Dwivedi, 1993).

Pandanus odoratissimus is another plant which is exploited for fibre from its roots. It is a densely branched shrub, found along the coastal regions and in Andaman islands. The roots of the plant are fibrous and are used by basket makers for binding purposes. The fiber obtained is used in making paint brushes and brushes for white wash. It is used as a substitute of bristles in brushes.

5.3.2 Fibres from stems

In some plants, the stem yields fibre. In such plants fibres are extracted from the bast tissue of the stem of woody species. The type of the fibre varies from plant to plant. Some plants

yield long and strong fibres, while some plants yield silky fibres, which are used in textiles. Retting is the commonly used process of extracting plant fibre in which the stems are submerged in ponds or streams for 10-15 days. It is the process of separating the fibres after loosening them from the woody plant tissue. This process depends on the age of plant, type of species, type of fibre required and the temperature of water used during processing. Over retting is harmful for the plant tissues, as they loose the luster on over treatment. The common best fibre yielding species are as follows:

Calotropis spp.:Two species of Calotropis (C. *gigantea* and C. *procera)* yield stem fibres. These are moderate sized shrubs commonly found in the dry tracts of the country on the wasteland or as an associate in dry mixed deciduous forests. The barks of the stem yield a white, silky, strong and durable fibre. Which is superior to cotton in tensile strength. It is extensively used for making fishing nets and lines, bow strings, twines, etc. Extraction of the fibre from the plant is done by steaming of the stem followed by pressing it in between wooden rollers and water retting followed with mallet beating. It can also be extracted by soaking the bark in water for 24-48 hours followed by autoclaving to avoid encrustations. The separated fibres can be bleached to yield white flexible, cylindrical fibres. These fibres can be spun alone as well as mixed with cotton.

***Marsdenia tenacissima* (Marsdenia):** It is large twinning shrub commonly found in the sub-Himalayan tracts of the country. It is occasionally found in the Khair forests and less frequently in sal forests. The fibre extracted is used in making fishing nets and lines, bow strings, netting and cordage.

***Acacia leucopholea* (Hiwar):** It is a small to moderate sized tree, found in the tropical dry deciduous forests in arid and semi-arid regions of the country. The bark of the plant yields a strong fibre when soaked in water and beaten. The fibre obtained is commonly used for making fishing nets and coarse cordage.

***Bauhinia vahlii* (Malu):** It is a large evergreen climber, generally found in the moist localities and shady hill slopes with rock outcrops. It is common in almost all forest types in India. It causes great damage to the forest trees. The fibre obtained from the inner bark of the plant is strong and is used for making rough ropes. The bark of *Bauhinia racemosa* also yield fibre (Mehta,1981; Dwivedi, 1993).

***Butea monosperma* (Palas):** The bark of the plant also yields fibre (beside the roots) which is used in making ropes and cordage. The fibre obtained from the bark is inferior than the fibre obtained from roots. *Butea parviflora* (Butea bel) is another species which is a woody climber, found in most parts of the country which also yields fibre from the inner part of the bark is used for making ropes. The fibre obtained is strong and durable.

***Hardwickia binata* (Anjan):** It is a moderate sized deciduous tree very common in Madhya Pradesh. It is characteristic of dry teak and degraded dry deciduous forests of central and southern India. The young shoots and branches of the plant yield a strong, reddish brown coloured fibre. The fibre is widely used in making well ropes and also for other agricultural purposes (Dwivedi, 1993).

***Ougenia oojeinensis* (Sandan):** It is a medium sized deciduous tree generally found in tropical deciduous forests. In Uttarakhand this tree is found on rocky habitats in warm valleys. The new branches yield fibre, which is used for making ropes and cordage.

***Ficus bengalensis* (Bargad):** It is a large sized evergreen tree, found almost throughout the country in the plains upto 600m and in the hills. The bark and the aerial roots of the tree yield fibre, which is used as coarse rope. The other species of the same family which yield stem fibre generally used for making ropes include *Ficus cunia* and *Ficus religiosa*.

***Helicteres isora* (Marorphal):** This moderate sized tree is commonly found in the dry and moist mixed deciduous forests of India. The fibre is extracted from the inner bark of the plant by retting it in water, pool, ponds and rivers. Rotted branches are then taken out from the water and beaten lightly to separate the fibre. The fibre obtained is light brown to grayish green in colour, soft, silky and lustrous. It is durable, but is inferior to jute fibre in strength. The fibre is mostly used as cordage for sewing sacks, gunny bags and cattle harness. The quality of the fibre which can be spun into good yarn and woven into canvas and better quality of durable fabrics by selecting the equal aged stalks and retting them properly and scratching the dried fibre on appropriate modern machines. In Southern India, Kerela, tamil Nadu and Karnataka, the shrub is collected from the forest for extracting fibre (Dwivedi, 1993). Its fibres are twice durable than Jute (Corchorus capsularis) which is cultivated extensively in Kerala, West Bengal, etc.

***Grewia elastica* (Dhaman, Bhimal):** It is a tree with grey bark that grows in sal and mixed forests in outer Himalayas. This moderate size tree is mostly cultivated in the lower hills of

Uttarakhand by the farmers around their farmlands. This is multipurpose tree which yields quality fodder, fuelwood and fibre. The bark of the stem yields strong white fibre which is used for cordages and rope making. *Grewia tiliaefolis* (Daman), *Grewia optiva* (Bhimal) and *Grewia vestita* are other species which yields a coarse, strong and yellow brown coloured fibre useful for rope making and for domestic purposes. It is a small medium sized deciduous tree, 8-10 m in height of Family Tiliaceae. The species is found abundantly in the entire Himalayan region upto 1800m. The bark of the species yields fiber. The fiber is used for making ropes and clothing.

***Utrica dioca* (Stinging nettle) Bichhu:** It is herbaceous perennial plant (Genus Utrea). They grown like weeds and are generally eradicated. The fiber is removed nettle plants have long from stem, stingy fiber that can be separated by retting. Nettle fibers are better than those of hemp and can even be used for cloth making. Nettle may also be used as a dye, producing yellow colour from roots or yellowish green from leaves.

***Cannabis sativa*:** It is a plant native to Asia. The term 'hemp' may refer to the tall, coarse plant itself or to the coarse tough fiber the plant which can be used to make rope, fabrics etc. the fiber is one of the valuable parts of the plant. It is commonly called bast hemp fiber can be between 2.5 to 3.5 m long depending in the height of the plant.

***Ceiba pentandra* (Kapok tree):** It is a large tropical tree species which can attain height upto 50-60m on certain localities. The pods contain the floss along with the seeds. The fiber is light very buoyant. It is used for filling mattresses, stuffing toys etc.

***Sterculia villosa* (Udal):** It is a small to moderate sized tree, found in the tropical deciduous forests throughout the greater part of India. A coarse and strong fibre is obtained from the inner layers of the bark. The fibre strips off in broad flakes having a net like appearance. The fibre is commonly used for making bands for elephants used for dragging timber. The fibres are made into ropes for tying cattle and sheep and for making cordages. The cordage made, if frequently wetted in the initial stages becomes stronger. The other species of the same family which yield rope fibres but are not so common for this purpose are *Sterculia urens, S. foetida* and *Firmiana colorata* (Dwivedi, 1993).

***Trema orientalis* (Jiban):** It is a large shrub or a small sized tree found in tropical deciduous forests. The tree yields a long light brown fibre. The fibre can be easily stripped off from the

bark of the tree in thin narrow bands. The fibres, on drying, can be easily separated. The fibre obtained is mostly used for making ropes, twine and coarse cloth.

***Girardinia hetrophylla* (Nilgiri nettle):** It is a medium sized shrub commonly known as stringing nettle and commercially as Nilgiri nettle. It is found in the Himalayas and in the peninsular region of India. It yields a fine, soft and silky fibre, which is used for making ropes, twine and coarse cloth. The plant is not given high priority for fibre because of the difficulties like high cost of collecting and clearing the fibre.

***Kydia calycina* (Pola):** It is a large sized tree generally found in tropical moist deciduous forests. It yields a strong fibre which is used from making ropes and cordage generally put to several uses in forestry. It is also used for making drag ropes. This tree is also found in Bhabar area of the Uttarakhand.

***Careya arborea* (Kumbhi):** It is a moderate sized tree, found as a common associate of moist mixed deciduous forests. The inner bark of the tree yields fibre which is used for making coarse cordage and ropes for tying carts and rafters. The fibre is also used in paper industries. *Careya arborea* is a deciduous tree that grows up to 15m. Its leaves turn red in the cold season. Flowers are yellow or white in colour that become large green berries. The tree is a common associate of sal forest and grows throughout India. In Uttarakhand it is commonly found in Bhabhar and Tarai regions.

***Cerbera manghas* (Cerbera):** It is an evergreen tree or large shrub with milky latex. It is found in the tidal forests of India commonly in the Andamans. The bark of the tree yields a fibre of minor importance (Dwivedi, 1993).

***Cordia dichotoma* (Lasora):** It is a small or medium sized tree with crooked trunk. It is found in the warmer regions of the country. The bark of the tree yields fibre which is used for caulking of boats. Another species, *Cordia rothii* (Lasora), *Cordia myxa* and *C. oblique,* which is found in the drier parts of the country also yields a fibre used for caulking boats and making ropes. It is a small sized tree with twisted trunk. It is found in the warm regions of the country. The bark of the tree yields fibre which is used for sealing joints of boats.

***Erythrina suberosa* (Daul dhak):** It is a medium sized tree, found scattered throughout the dry forests of India. The bark of the tree yields a fibre used for making cordages. A medium size tree with very attractive maroon reddish coloured flower clusters. Young stems are

prickly. The fibre is removed from bark and used for cordages. It is found grown extensively in Bhabhar amd Tarai regions of Uttarakahnd.

Erythrina variegata: It is found in Andaman and eastern coastal states of India. The fibre is removed from bark and used for cordages.

***Lannea coromandelica* (Jhinhan):** It is a moderate to large sized deciduous tree, distributed throughout the greater part of India up to 100 m elevation. The bark of the tree yields a strong fibre used for ropes and cordages (Dwivedi, 1993).

***Miliusa velutina* (Dam sal):** It is a middle sized tree, found in the moist deciduous forests. The bark of the stem is locally used for extracting fibre which is used for making ropes and cordages (Dwivedi, 1993).

***Thespesia populnea* (Ban kapasi):** It is a compact quick growing evergreen tree, found in the coastal regions of India, commonly in the Andamans. The bark of the tree yields a strong white fibre used for cordage, fishing lines and coffee bags. It is also used for caulking boats (Dwivedi, 1993).

***Urena lobata* (Unga):** It is an under shrub occurring throughout the hotter parts of India. The plant is often cultivated as a fibre crop. To obtain good quality fibre, the harvesting is suggested when the plant is full in flowers. If harvesting is done before the time recommended, the fibre obtained is less in quantity and fine in texture. If the harvesting is done after the time of flowering, the fibre obtained is less shiny and coarse in texture. Its fibre closely resembles with jute in chemical composition. It is mostly used for making ropes, sacks, cordages and carpets. Mixed with other fibres, it can be worked on machinery and can be utilised for making artificial silks, upholstery and sail cloth. *Urena repanda* is another species (a deciduous under shrub), which yields fibre of the same quality as of *U. lobata.*

5.3.3 Fibres from leaves

***Agave spp.* (Sisal):** Sisal (*Agave* spp.) is perhaps the most important and valuable among the fibre yielding plants. *Agave* consists of about 300 species. These species are native of tropical and sub-tropical North and South America. They have been introduced to a large number of countries in East Africa, West Indies, Indonesia, Israel, South Africa, Philippines, etc. Agaves have been introduced in India as hedge plants. These are generally planted in gardens, fields and along the road and rail sides. In India, *Agave sisalana* was first

introduced in Orissa by Christian missionaries in the late of 19th century. Since then a large scale plantations of these species have been taken up in different parts of India particularly in Orissa, Madhya Pradesh, Maharashtra, Tamil Nadu and some part of Uttar Pradesh. The common species planted in India are *Agave sisalana, A. fourcroydes, A. cantala, A. wightii* and *A. americana.* In Uttarakhand efforts were made to cultivate this plant on wastelands on a large scale. The planting of *Agave* species is done in the forest and the modern practice is the use of bulbils for plantation. These bubils are placed in nursery about 12-19 cm apart before transplanted in the field. The plants, which are ready for planting out should be generally 50-70 cm in height. It is recommended that plants less than 35 cm in height and 1 kg in weight should not be out planted. Planting is done generally at a spacing of 2.5 m x 1.5 m. The leaves of this plant yield a valuable fibre and the fibre is considered to be one of the important hard fibres. It is mostly used for making ropes, cordage and twine. Some time the short fibres of the genus are used for making mops and brushes. The fibre compares favourably in durability with Manila hemp for marine cordage. Recently, the fibre is used for manufacturing coarse fabrics. It is extensively used for binders, twine, fishing nets, hammocks, door mats, rugs, carpets, etc. The remains left after extracting the fibre from the leaves, are used for making paper and paper boards.

In areas with sufficient moisture, the plant produces 6-8 new leaves per month but during dry period, no new leaves sprout. This adversely affects the yield of the fibres. A single green leaf weighs about 600-1000 gms and contains about 2 to 5 per cent of fibres. The yield is determined by the number of leaves produced on the plant and by the amount of fibre collected. From the available data under Indian conditions, weight of a single leaf from the plant is generally found 900 gms and total number of leaves produced during the life time is about 240. The harvesting of leaves can be done after 36-40 months of planting. Generally the mature leaves are harvested twice a year, first in the month of January and secondly in the month of September. About 10-15 tonnes per ha leaves are generally available in the plantation areas. The fibre is extracted from leaves by decorticating them. After decortication, fibres are sun dried. The moisture content in dry fibres should not be more than 8-15 percent. After drying they are boiled and packed for transport.

There are several species of *Agave* which are mainly grown for fibre production. *Agave americana* is grown as an ornamental garden tree and also grown as a hedge plant on the boundaries of the field. The leaves of this plant yield about 5 percent of fibres used for

making ropes and cordage. *Agave angustifolia* is commonly found in the sub Himalayan tract and outer Himalayas. The leaves of the species yield some what shorter fibres. *Agave sisalana* has been planted on a large scale in several states of India. The species grows well in areas with an annual rainfall of about 700-1300 mm. It succumbs to water-logging and can not tolerate very low temperatures. The species has been planted in Deccan plateau and adjacent areas of Sambhalpur, Sundargarh, Ranchi, Hazaribag, Palamau, Bankura, Purulia and Birbhum. The length varies from 1 to 2 m. The fibres are strong, medium, fine and recovery is about 4.2 to 4.8 per cent of the leaf weight. *Agave veracruz* is native of Mexico and is also found throughout the greater part of India. It is found commonly in Assam, Bengal, Bihar and southern parts of India. The leaves yield about 1.5-2.5 per cent fibre. The fibre is coarser and stronger then the *Cantala* fibre and is used for making ropes, mats and cordage.

***Caryota urens* (Indian sago-palm):** Indian sago-palm is one of the most important leaf fibre producing plant. This palm is found in the moist regions of western and eastern coasts in cool and shady places. The leaves of this plant yield strong fibres. The fibres are obtainable from the base of leaf sheath, petiole and flowering stock. The fibres are straight, strong and smooth and very elastic. The fibres are like horse-hair type in appearance and used in making rope of great strength. The fibres are used by fishermen for preparing fishing nets and fishing lines. They are also used for making soft brooms.

***Musa paradisiaca* (Plantain tree):** It is also commonly known as the red plantain. It is found along the west coastal region. The plant yields strong fibre but the collection of fibre is not profitable profitable as these species are not plentiful and are found sporadically distributed in the depressions of the low hills that lie along the coast.

***Musa textiles* (Banana tree):** It is a tall stout stoloniferous plant. It is native of Philippines and successfully cultivated in India for its fibre. The fibre is extracted from the leaf sheaths of the mature plant. The leaves yield a strong and durable fibre known as Manila hemp. The leaves of the plant consists of three layers. The outer fibrous layer is strong and brown or dark brown in colour. The middle layer contains some quantity of soft-white fibre. The third layer is without fibre. The fibre is stronger than the fibre obtained from hemp and sun hemp. It is mostly used in making twines, ropes and cable. The fibre is spun into thread and is used in coarse weaving, upholstering and preparing fine fabrics.

***Pandanus odoratissimus* (Pandanus):** It is a densely branched shrub, found along the coastal region of India and in Andaman Islands. The leaves of the plant yield fibre used for making sacks for coffee, grains, sugar etc. The fibre is also used for making ropes, mats, cordage, hats, baskets and other fancy articles. To get the superior quality of mats, young and freshly harvested leaves are used.

5.3.4 Fibre from grasses

Important grasses which yield fibres for making mats, ropes, cordage, fishing nets include *Eulaliopsis binata, Desmostachya bipinnata, Sacharum bengalense, S. spontaneous, Themeda arundinacea, Phragmites* spp, *Arundo donax, Typha elephantine,* etc. *Eulaliopsis binata, Saccharum spontaneum, S. Bengalense* and *Desmostachys bipinnata* are used for making ropes, cots and fishing nets. These are also used for making cordage and mats. Some of these grasses are highly suitable for making paper.

Eulaliopsis binata is cultivated on a large scale in Shiwalik region of Himalayas. It also grows in Madhya Pradesh and Orissa. The grass is used for making ropes. It is also used for making paper.

5.4 Flosses

The outer loose pieces of silk of a cocoon or other waste fibres which do not easily spun are termed as flosses. Many forest trees and shrubs in India produce silky flosses within their fruit. Flosses are generally used for stuffing mattresses, pillows, cushions, upholstery and packing. They are also used for the manufacture of life belts.

Some of the important floss yielding species found in the forests of India are as follows:

Populus ciliate: A large deciduous tree with a straight bole growing extensively in the Himalayan region between 1500-2600m. However, it is not a forest forming species and has restricted distribution. It grows on early successional condition especially along watercourses in the Central Himalaya. The ratio of male and female tree varies from site to site. The new leaves appear towards the end of March or early April. The catkins appear immediately before the young leaves. The female trees have new flush of leaves simultaneous with the flowering while male trees do not unfold leaves untill the dehiscence of pollen is over. The seed dispersal takes place from the end of May to June depending upon the climate of the locality. The species yields abundant floss which is enclosed around

the seeds in the pods. The floss is put to several uses in the villages for filling pillows and mattresses.

***Bombax ceiba* (Semal):** It is medium to large sized deciduous tree, typical of alluvial savannah type of forests. The species is found growing sporadically in mixed deciduous forest of sub-Himalayan region, and moist deciduous forests of west coast. Fibres are obtained from the inner side of the capsule. It is slightly brownish yellow in colour. The floss from this tree is known as Indian kapok. The green capsule of this tree yields soft and strong floss about 4.5-6.0 kg per tree in full bearing. Kapok is similar to the true Java kapok and is used in life saving appliances and other general flotation purposes. The floss is used for stuffing quilts, mattresses, cushions and pillows. Articles stuffed with kapok are said to be vermin proof. It is also used as an insulating material for refrigerators, sound proof covers and walls. It is considered to be the best for making padded surgical dressings. In the recent years, with the help of the modern modified carding machines, the floss can now be easily spun in to yarn.

5.4.2 *Calotropis gigantea* (Aak, Akund floss)

It is a common shrub found in the Sub-Himalayan regions Central part of India and in the South zone. The seeds bear fine, soft, glossy and resilient floss. Through inferior to Indian kapok in strength and resilient properties, it has a good buoyancy. The floss from this species is used in stuffing mattresses, pillows, etc. It can be spunned either after chemical treatment or mixed with cotton but it can not be bleached.

5.4.3 *Ceiba pentandra* (Kapok)

It is a medium sized deciduous tree found widely distributed in the hotter parts of western and southern India and in Andaman Islands. The tree is commonly called as silk cotton or kapok tree. The floss is obtained from the pods of the plant. Unopened pods are collected from the tree with hand and are allowed to dry in the sun. After drying, on beating with mallet, the pods are split open. The floss is taken out along with the seeds and dried in sun. On beating lightly, the seeds yield a white or pale yellow coloured floss. The floss is light brittle, elastic and lustrous. The yield of the floss varies with the age of the plant. As the age advances, the yield per tree also increases. It finds use in bedding and upholstery industries. It is used in stuffing pillows, cushions and mattresses. It is also used for making padded surgical dressing. Due to water qualities, it is used for manufacturing life jackets and belts,

waistcoats, fishing and aviation suits and other naval life saving devices. Recently, with the help of modern machines, the floss of this species has been spun either alone or in admixture with cotton into yarn. This yarn can be dyed or bleached like cotton. It is used for insulation of refrigerators, cold storage plants, offices, theatres, motor cars and aeroplane for sound insulation. It is used in aeroplane cabins, studios, hospitals, auditorium and theatres. It is useful for packing water pipes exposed to forest.

5.4.4 *Cochlospermum religiosum* (Silk cotton tree)

It is a small or medium sized deciduous tree, commonly called as the yellow cotton tree. It is common in hot dry and stony regions. It is found almost throughout India. The seeds of this species are covered with soft and resilient floss which can be used as substitute for kapok. It is mostly used for stuffing mattresses, pillows, cushions and life belts.

5.5 Coir

The fibre obtained from the drupe of the coconut tree is termed as coir. Coconut (*Cocos nucifera)* is a tall, straight palm. In India, it is found in the coastal and the deltaic regions of south India. This species yields a variety of products viz., ripe coconuts, copra, coconut oil, coir, etc. Coir is extracted from the thick fibrous husk of the fruit. Retting is the process implied for the extraction of coir. It is usually carried out in the saline back waters. The retted husks are washed with water then the fibres are separated by beating the husks with wooden mallets. The separated fibre is dried, beaten and finally passed through the cleaner. The coir fibre is light, elastic and highly resistant to water and mechanical wear. It is considered to be the best material for the manufacturing shock proof packing material and hard boards for panels, doors and battery containers.

5.6 Summary

Fibre and flosses are useful for human beings. The main source of supply of fibre and flosses are forests. Fibres are of plant and animal origin. Fibres are used in spinning of thread and cordage and weaving of coarse fabrics. Fibres occurs generally as schlerenchyma cells of the plants. They are found in various parts of plants such as stems, leaves, roots, fruits and seeds. Important fibres are obtained from roots of *Butea monosperma* (Palas), *Pandanus odoratissimus*, from stems of *Calotropis spp., Bauhinia vahlii*, *Grewia optiva* etc. from leaves of *Agava americaana, Caryota urens, Musa textiles* etc. Flosses are the outer piece of silk

of cocoon or other waste fibres which do not easily spun as they are short. These are generally used for stuffing mattresses, pillows, cushions etc. The main species which yield flosses are *Bombax ceiba, Calotropis gigantean, Cochlospermum religiosum* etc. Fibres are more important than flosses particularly for spinning purposes. These plant products are not only important to human beings but also provide livelihoods to a section of our society.

Terminal Questions

1. Give a brief description of important fibre yielding plants of India.
2. Differentiate between fibre and flosses.
3. Describe various plant parts which yield fibre with some important examples.
4. Give a brief description of various plants yielding flosses.
5. Describe different methods of extraction of fibre from plants.

References

Dwivedi A.P. 1993. Forests: the non-wood Resources. International Book Distributors, Dehradun. 352 pp.

Indian Forest Utilization, Volume (II). Forest Research Institute Press, Dehradun. 941pp.

Mehta, T. 1981. Forest Utilization. International Book Distributors, Dehradun.296 pp.

www.hear.org/pier/species/urena_lobata.htm

www.fruitipedia.com/phalsa%20Grewia%20asiatica.htm

Unit 6 Tannins and Dyes

Unit Structure

6.1 Learning Objectives

After studying this unit, you should be able to:

- To differentiate between tannins and dyes.
- To understand the importance and uses of tannins and dyes.
- To develop an understanding of major plant species including herbs and shrubs and their parts that yield tannin and dyes.

6.2 Introduction

In this section we will try to understand what are Tannins and Dyes and their importance in our daily life along with the name of plants and parts that produce them. There are several plant parts like bark, root, leaf, stem that produce dyes and have tannin properties. Tannin and dyes are secretion products found almost universally in plant tissues in small or large amounts. Tannins and dyes are comparatively simple chemical compounds of carbon, hydrogen and oxygen along with some nitrogen in case of dyes. However, economically

important and commercially exploited plants are those that yield these natural products in large quantities. For the sake of convenience in this unit we will deal with tannins and dyes separately.

6.3 Tannins

As mentioned above tannin are simple chemical compounds of carbon, hydrogen and oxygen secreted almost universally by plant tissues in small or large amounts. Tannin is a generic name applied to large classes of organic substances which often differ widely in chemical composition and reaction but have one common property that reacts with animal hides and skins and make them resistant to decomposition and at the same time leave them flexible and stronger. It is only after the skins and hides of animals have been treated with tans that they are called tanned leather.

The name 'tannin' is derived from the French 'tannin' (tanning substance) and is used for a range of natural polyphenols. Since ancient times it is known that certain organic substances have tanning properties and are able to tan animal skins to form leather. Prehistoric tribes already knew about the tanning of animal hides with brain material and the fat of the killed animals. However, precisely what happens to the skin during the tanning process was only elucidated during the twentieth century with the help of modern analytical techniques. Real tanning is understood as the cross linking of the skin's collagen chains, while false tanning entails the filling of hollow spaces between the skin's collagen chains. High tannin concentrations are found in nearly every part of the plant, such as in the bark, wood, leaves, fruits, roots and seeds. Frequently an increased tannin production can be associated with some sickness of the plant. Therefore, it is assumed that the biological role many tannins in the plants is related to protection against infection, insects or animal herbivory. The tannins appear as light yellow or white amorphous powders or shiny, nearly colourless, loose masses with characteristic strong smell and astringent taste.

The tannins are known over millennia (Mediterranean since 1500 BC), through medicinal uses to uses in the food industry. In medicines, especially in Asian (Japanese and Chinese) natural healing, the tannin- containing plant extracts are used as astringents, against diarrhea as diuretics, against stomach and duodenal tumors and as anti-inflammatory, antiseptic and haemostatic pharmaceuticals. Tannins are used in the dyestuff industry as caustics for cationic dyes (tannin dyes) and also in the production of inks (iron gallate ink).

In the food industry tannins are used to clarify wine, beer and fruit juices. Other industrial uses of tannins include textile dyes, as antioxidants in the fruit juice, beer and wine industries and as coagulants in rubber production.

Recently the tannins have attracted scientific interest especially due to the increased incidence of deadly illnesses such as AIDS and various cancers. The search for new lead compounds for the development of novel pharmaceuticals has become increasingly important, especially as the biological action of tannin containing plant extracts has been well documented. During the last twenty years many representatives of this class of compounds have been isolated and characterized. Currently known tannins with unambiguously determined structures already number far more than 1000 natural products. In extensive biological tests many representatives of tannins were found to have antiviral, antibacterial and especially antitumor activity.

Besides natural tannins (plant material) mineral and synthetic substances called 'syntans' are also used in tanning. But they are not very widely used as they lack certain properties necessary to produce heavy leathers and therefore cannot the regarded as true replacement materials for plant based tannins (Dwivedi,1993). Approximately 90 percent of the plant based tanning materials is used for tanning leather. In India it is a flourishing industry earning large foreign exchange. With a large livestock populations in India, annual production of ran hides is relatively large requiring a sizable quantity of tanning material. There are more than 1000 tanneries in India (big and small) utilizing fifty thousand tons of wattle extracts, four lac tones of barks and more than fifty thousand tons of myrobalans as material for tanning. Some tanning material is still being imported (Dwivedi,1993).

Tanning materials are obtained from different parts of the plant. On the basis of their presence in plant parts, these are classified into the following four groups:

- Wood tans
- Bark tans
- Fruit tans
- Leaf tans

6.3.1 Wood tans

Forest trees with wood yielding tanning material are termed as wood tans. Among the most important wood tans is Quebracho (*Quebracho colorado*) tree which is widely distributed in South America. The heart wood contains 20-27 percent tannin, which is obtained by cutting the wood into small chips and extracting the tannin with water. India imports sizable quantity of this extract from South America. Another important example of wood tans is *Acacia catechu (Khair).* In India, the cutch obtained from khair heart wood is used for tanning purpose. This tree grows in khair-sissoo forests, southern thorn forests and very dry teak forests. In India, it is found growing in Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Jammu and Kashmir, Maharashtra, Punjab, Rajasthan, Uttar Pradesh and Uttarakhand. The estimated availability of the cutch extract from an organized sector is about 4000-5000 tonnes. Cutch is used as blend along with wattle, it is used for producing heavy leather. It is also used for dyeing leather.

6.3.2 Bark tans

Barks of several tree species yield tannins, which are commercially exploited. The species known to yield bark tans are *Acacia mearnsii, Acacia nilotica, Cassia auriculata, Shorea robusta, Terminalia arjuna, Cassia fistula, Ceriops roxburghiana* etc. Some other trees such as *Acacia leucocephala, Bridelia retusa, Lagerstroemia spp., Tamarix aphylla, Terminalia alata, Quercus spp. and Castanopsis spp*. also yield bark tans and are locally important. Most of these trees are found naturally in the forests and some of them are also being planted under several plantations programmes. The bark is chipped off from the stem by debarking axes or debarking spade as a byproduct when the tree is harvested for timber or firewood. Only *Cassia auriculata*, which is a small shrub, is harvested solely for the production of bark. Trees with faster rate of growth contain more bark tan than slow growing trees. Generally, the beginning of the growing season (mostly spring through summer) is considered to be the most optimum period for harvesting bark for collecting tans, as tannin content is the highest during this period. The bark is collected, dried, stored and marketed. Some important plants those yield bark tans are mentioned below:

***Acacia mearansii* (Wattle, mimosa, black wattle):** The species is a native of South Australia and has been planted successfully in India. It is cultivated in many parts of the country for its bark. In India, it has been found to grow in Tamil Nadu, Nagaland, Kerala; hilly

region in Jammu and Kashmir and Meghalaya. The bark yields an excellent quality of tannin. In India, the estimated availability of tannin extracted from the species is about 5000 tonnes per year. The tree is largely cultivated for tanning material. It is astringent, catechol type of tannin. The important characteristic property of the tannin obtained from this tree is that the liquor has a good shelf life, i.e., on standing; the liquor does not loose its stability. It penetrates into the dried hide of animals easily and rapidly. The leather produced with the liquid plant extract when exposed to light, becomes reddish in colour. The liquor provides very little acid on fermentation. The leather obtained by the tanning extract is firm and possesses an average degree of tanning, which can be further improved by retreating after acidifying the liquor. It is used in blends. It is also used in plywood industries in adhesive formulations.

***Cassia auriculata* (Avaram):** Avaram bark is obtained from Cassia auriculata. In India the species grows wild in the Deccan plateau and South India. It thrives best on dry stony hills and black soils. Its bark is mostly used as a tanning material in Tamil Nadu and South India. It also occurs in Andhra Pradesh, Maharashtra, Karnataka and Rajasthan. The estimated yield of bark is 2.00 lakh tonnes per year. The bark has 23% tannin material. The method of collection of bark consists of cutting of shoots from the base and striping off the bark from shoots and drying it. The bark of the species is regarded as one of the best tanning material in India. Avaram tannin obtained from the bark produces lightly tanned, pale coloured leather with good strength. The tan liquor obtained from this species is stable and has low tannin loss on standing. An important feature of this bark is that it is easy to use and yields uniformly successful results. It was used in the production of famous East Indian leather. The method of collection of bark consists of cutting of shoots from the base and striping off the bark from shoots and drying it. The bark of the species is regarded as one of the best known tanning material in India. Avaram tannin obtained from the bark penetrates the hide very quickly and produces lightly tanned, pale coloured leather with good strength. The tan liquor obtained from this species is stable and has low tannin loss on standing. In past, the half tanned leather was exported, where its tannage and preparation for a variety of uses were carried out. It was used in the production of famous East Indian leather. It is also used in medicines and as a green manure (Mehta,1981).

***Acacia nilotica* (Babul):** Both bark and fruits of babul (*Acacia nilotica*) is used as a tanning material on a large scale. Babul is a common species of northern and southern tropical thorn

forests and southern tropical dry mixed deciduous forests. It is a native of India and widely occurs all over the country. It is found in almost all states of the country viz., Rajasthan, Gujarat, Andhra Pradesh, Madhya Pradesh, Karnataka, Maharashtra, Tamil Nadu, Bihar, Orissa, West Bengal, Uttar Pradesh, Haryana, Punjab etc. (Mehta,1981). The tree is largely grown in homestead and field bund plantations in rural India. The wood has several uses as a building material and firewood. The bark is generally removed when the tree is felled for timber or fuel. In India, the estimated yield of tannin from the bark of this species is about 1 lakh tonnes. The bark is largely consumed by tanneries in Kanpur. The tannin content is comparatively higher in older tress than younger trees. The tannin content in the bark of branches is about 7-12 percent only. The deep colour and high non-tannin content are the two main drawbacks of this tree bark tan. It is considered to be good for heavy leather. It gives a dark coloured, firm and durable leather. It is not considered good for kips and half tanned hides.

***Cassia fistula* (Indian laburnum) (Amaltash):** Konnai (Cassia fistula) bark is also used in India for tanning purposes. The tree is widely distributed throughout the tropical India. It is found scattered in the tropical moist and dry deciduous forests and occasionally in the sal forests of the country. The total bark production obtained from this tree per annum is not precisely known. The minimum tannin and the maximum non-tannin content calculated on moisture free basis is 12 and 13 per cent, respectively. This tree is commonly used among the tanners in southern part of Tamil Nadu. It produces smooth grained, pale leather. Instead of the bole bark, the twig branches are used for improved leather colour. It is used in the tannage of kips and light weight hides. Bark is sometimes used as a substitute for avaram bark in blends. It cannot be used alone. Tannin obtained from the bark of this tree possesses low penetrating power.

***Ceriops roxburghiana* (Mangrove, goran):** It is evergreen mangrove tree, found in the coastal forests. In India, this species is predominant in Sunderbans (West Bengal), Tamil Nadu, Gujarat, Maharashtra, Andaman and Nicobar islands. The species produces valuable tannin material and leaves are also considered to be an important tan stuff. The bark contains 20-37 per cent tannin, while the leaves contain 9-15 per cent tannin. The bark is suitable of preparing extracts, the minimum tannin content in the solid extract and sprayed dried extract calculated on moisture free basis is 70 percent and 72 percent, respectively, and the maximum non-tannin content in the solid extract and spray dried extract calculated

on moisture free basis is 35 percent and 34 percent, respectively. The minimum tannin content in the bark calculated on moisture free basis is 22 percent. The bark tannin of this tree imparts red colour to leather, which can be avoided by blending the bark with myrobalans and Babul bark. It can also be improved by decolorizing and bleaching. The bark is an astringent material. When used, it imparts red colour to the leather and is mostly used for manufacturing heavy leathers. The penetration power of the tannin is slow. The important characteristic of the mangrove liquor is its stability and low loss of tannin on standing.

Ceriops tagal and *Rhizophora mucronata* are also mangrove trees similar to C. roxburghiana, which find use in tanning industries. The bark is rich in tannin content and contains an excessive quantity of colouring material. The extract prepared from the bark of these species is also known as cutch and is used in local tanneries (Dwivedi, 1993).

***Terminalia arjuna* (Arjun):** It is a common tree of India and widely occurs in Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh, Bihar, Andhra Pradesh and Tamil Nadu. The tree grows in waterlogged areas. The tannin content in the bark varies considerably. Tannin content in dry bark of the main stem is about 20-24 per cent, while that in the lower branches is 18 percent. On an average, the tannin content and the non-tannin content are 15.8 percent and 8.2 percent, respectively. Tannin of this bark is widely used in large tanneries. It produces upper leather and very good quality sole leather. The bark of the tree is generally cut repeatedly to get fresh crop of bark. It is also used in medicines.

***Emblica officinalis* (Aonla):** It is a popular forest fruit tree distributed all over India in dry and moist deciduous forests. Aonla fruits are also used as tanning agents and also consumed for a variety of medicinal purposes. Aonla pickle is the most popular product consumed by people. The stem bark yields 8-9 percent tannin. The twig bark is richer in tannin content and contains about 20 percent tannin. The tannin extracted from the bark of this tree is used locally.

***Terminalia alata* (Laurel):** The tree is a common associate of sal and teak trees in tropical semi-evergreen and moist and dry deciduous forests. It is gregarious in Uttar Pradesh, Madhya Pradesh, Orissa, Maharashtra, Gujarat, Bihar and other parts of country. The tannin content and the non-tannin content in the bark is about 18.7 percent and 5-7 percent, respectively. It produces red leather which is somewhat similar in appearance to mangrove

tanned leather. The bark of the species is generally harvested for oxalic acid (Diwedi, 1993; Mehta, 1981; Forest Utilization vol II).

***Shorea robusta* (Sal):** It is a large evergreen tree. The species occurs in the northern and the central region of India. It ascends to 1000m elevation in the hills. It is found in the forests of Uttar Pradesh, Uttarakhand, Madhya Pradesh, Bihar, Orissa, West Bengal and Assam. The minimum tannin and the maximum non-tannin content calculated on moisture free basis in the tree bark is 8 percent. Shorea robusta bark is widely used in local tanneries. It furnishes very tough leather with reddish tinge. The tannin is of condensed (catechol) type.

6.4.1 Fruit tans

Fruits of some of the forest trees are used in tanning industries for the extraction of different tannins. The various important species yielding fruit tans are as follows:

***Acacia nilotica* (Babul)**: The pods of Acacia nilotica produce tannin of good quality. The tannin and the non-tannin content in the pods is found 17.5 and 28.08 percent, respectively. The tannin content is about 18-27 percent in the pods after the seeds have been removed from the pods. Large quantities of pods of babul are used locally for tanning purposes in Maharashtra, Madhya Pradesh and Uttar Pradesh. In tanning industries, pods are used not only for tanning but also to soften and impart a good colour to the leather. An estimated yield of pods from an average tree is about 10-15 kg.

***Caesalpinia coriaria* (Divi-divi):** It is a small tree, native of South America and has been successfully cultivated in India. In India, it has been planted in parts of Tamil Nadu and Maharashtra. The parts of this tree yield divi-divi of commerce. Central and South American countries export a large quantity of this tanning material to different countries. On moisture free basis, the tannin and soluble non-tan content in the pods ranges between 28-41 percent and 21-29 percent, respectively. The important feature of pods is high tannin content and the easy extraction process. The leather is soon affected with climatic conditions. In moist conditions, the leather becomes soft and spongy and in dry weather, it looses its pliability. Therefore, it is blended with other tans to overcome this drawback. It is also used as moderating agent in textile industries.

***Zizyphus xylopyrus* (Kath bor):** The species is a common shrub and generally occurs in the scrub forests and occasionally with sal forests. In India, it is found in the sub- Himalaya tract, north-western India, Uttar Pradesh, Bihar, Rajasthan, central and southern parts of

India. The tannin and the non-tannin contents of the nuts are 9.3 and 16.7 percent, respectively. The penetrating power of the tannin to animal hide is slow. The tan imparts black colour to the leather, and is mostly used for tanning bags and purses (Diwedi, 1993; Mehta, 1981; Forest Utilization vol II)

***Emblica officinalis* (Aonla):** Aonla occurs in tropical dry deciduous forests generally, mixed with teak and sal forests. This tree is also found in rocky habitats of dry and warm valleys in Uttarakhand. The fruits of this species are used for tanning along with other tan stuffs. The tannin content in the fruits is about 28 percent (Diwedi, 1993).

***Shorea robusta* (Sal)**: As mentioned above bark of the tree is also used for tanning. The tannin obtained from the fruits of sal tree is of ellagitannin class of the hydrolysable type. The tannin content in the original and the deoiled seeds is 7.2 and 9.6 percent, respectively. The phenolic constituents present in the seeds are corilagin, chebulinic acid, gallic acid and ellagic acid. The seeds can be used as blend with Babul. These cannot be used as a self-tanning material.

***Tamirandus indica* (Tamarind):** It is a large tree and occurs in moist deciduous and tropical dry evergreen forests. It is commonly found throughout the warmer parts of India. It is extensively planted in Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. The estimated yield of tamarind fruits is about 30,000 tonnes per annum. The maximum non-tan and the minimum tannin content present in the testa calculated on the basis of moisture free basis are 15 and 20 percent, respectively. The seed testa yields dark colour leather. It is used with myrobalans and other hydrolysable tannins in the processing of heavy leather (Diwedi, 1993; Mehta, 1981).

***Terminalia chebula* (Myrobalan):** This tree occurs throughout the greater parts of India particularly in sal and mixed deciduous forests. It is found in Madhya Pradesh, Orissa, Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Himanchal Pradesh and Bihar and warm valleys of Uttarakhand. Fruits of the tree are one of the important sources of medicinal value besides tannin. The fruits are collected during the months of December-February. The total estimated yield of fruits is nearly 50,000 tonnes per annum. The minimum tannin content worked out on dry weight basis for fresh picked selected, leftover and crushed nuts is 35, 27 and 40 percent, respectively by the total weight. The minimum tannin content worked out on moisture free basis for solid extract is 58 and 60 percent by weight,

respectively. In the trade, myrobalans are usually known by the place of origin. For example, Bimilies (Bis) exported from Bimlipatam (Andhra Pradesh), etc. The myrobalans of Salem district (Tamil Nadu) are regarded as the best in India for colour and tannin content (Dwivedi,1993).

6.3.4 Leaf tanning material

Leaves of some of the plants provide tanning material for local use. They are not used extensively for tanning purpose by large tanneries. Generally, village artisans and shoe makers use leaves for tanning leather on a small scale. Important leaf tanning material is obtained from leaves of *Anogeissus latifolia, Carissa spinarum, Emblica officinalis, Lawsonia inermis* and *Rhus cotinus*. Leaf galls found on several trees such as Tamarix spp., Garuga pinnata, Prosopis cineraria, Terminalia spp. etc. are used locally for tanning purposes.

***Anogeissus latifolia* (Axle wood; Dhawa):** The tree occurs almost throughout the sub-Himalayan tract, Bihar, Chhota Nagpur, Central and southern parts of India upto 1000 m altitude. The leaves are locally used for tanning purposes. The tannin and non-tannin content in the dry mature leaves is about 32.5 percent and 10.5 percent, respectively. A mixture of green leaves, red leaves and petiole contain about 38.5 percent tannin. Maximum tannin content up to 55 percent is found in young leaves. The tannin is hydrolysable type and finds limited use in the leather industry. It produces pale coloured leather. The leather prepared is highly sensitive to light. The tannin is used as mordant.

***Carissa spinarum* (Karunda):** The species is extremely common and gregarious in scrub jungles along the foot hills of the Siwaliks (the outermost hilly tract of Himalaya). This thorny shrub is also found in the warm and dry valleys of Uttarakhand. Fruits are also eaten raw and used for making pickle. It is also common in central India. The tannin content in the leaves is about 9-15 percent. The tannage is slow and causes swelling in the hide.

6.4 Tanning Material, Problems and Solutions

Even though India has a high floral diversity in its forests and several plants and trees produce tannins, there are just a few that have high percentage of tans in their parts which can be commercially exploited. Some of them which are more easily available like myrobalan, kath bor, cutch etc. have some inherent problems. For example, hydrolysis of tannins results in the formation of sludge fermentation, mould growth and loss of tannin.

Similarly progressive polymerization leads to the formation of tannin reds resulting in an increase of insolubles and decrease in tannin content. Several studies have been carried out to reduce and overcome these defects in India and abroad. These have been divided into physical methods and chemical methods. Physical methods which include blending with other tanning material or treatment with synthetic or chemical tans. Chemical methods include sulphilation, sulphomethylation, aminomethylation etc.

Due to the commercial importance of the above mentioned plants for tanneries they are felled illegally for extraction of commercial plant parts ignoring its other important uses. For example, *Terminalia chebula* (harar) and *Acacia catechu* (Khair) trees has several other important medicinal values. But at times they are cut for tannin production. We need to increase the production of tannin through large scale plantation of tannin yielding plants as per altitudinal and climatic requirements of the species and also promoting their natural regeneration. Grafting techniques which are being practiced in some of the fruit bearing plants have to be evaluated for tannin ferrous plants to gain the advantage of different tannin materials having both condensed and hydrolysable.

6.5 Dyes (Natural)

Nature expresses itself in a wide spectrum of colour all around us. Dyes are the name given to substances which are used for imparting colour and staining purposes. The alchemy or colour started from an early time. The earliest record of the use of natural dyes is from China, way back in 2600 B.C. Indians have been forerunners in the art of natural dying. The advent of synthetic dyes caused rapid decline in the use of natural dyes. Various parts of plants like roots, stems, bark, leaves, fruits and seed may contain colouring material which can be exploited commercially. Some plants have more than one colour depending upon which parts of the plants are used. Dyes are substances that impart colour to a material and are generally soluble in water. The pigments are generally not soluble in water. To be applied to a staining material they are first ground into a fine powder and thoroughly mixed with some liquid (dispersing agent).

6.6 Classification of Dyes

- On the basis of their origin dyes can be classified into the following classes:
- Wood dyes
- Bark dyes

- Flower dyes
- Fruit dyes
- Root dyes
- Leaf dyes
- Animal dyes

6.7.1 Wood dyes

Cutch dye: Cutch dye is obtained from the wood of Acacia catechu (Khair). The tree is widely distributed in India. It is characteristic species of Khair- sissoo forests, southern thorn forests, ravine thorn forests and very dry teak forests. It is used for dyeing fishing nets, sail cloth, mail bags, leather, canvas, etc. the cutch extract is considered as the most valuable dye among all the wood dyes. It is used as tan and also commonly as dyeing agent for silk and woolen fabrics.

***Artocarpus* dye:** Artocarpus dye is obtained from the wood of Artocarpus heterophyllus and of A. lakoocha. The mixture of the wood gives a bright yellow dye. For obtaining the dye, the wood is cut into small pieces or chipped and boiled in water. The dye obtained from these species is used in dying industries for dyeing robes of monks and saints. It gives fast colour on silk cloth.

Brazilian dye: It is the trade name given to the dye obtained from the wood of Caesalpinia sappan commonly called as sappan. It yields a valuable red dye commercially known as Brazilian. It is cultivated as a hedge plant in many parts of South India. The dye is used for dyeing silk, cotton and woolen fabrics. The dye is mostly used for producing red and pink colours in calico printing. When dissolved with indigo colour, it produces purple colour.

Santaline dye: It is obtained from the heart wood of Pterocarpus santalinus. The tree is commonly known as the Red Sanders. It occurs mostly in Andhra Pradesh. It is a tree of southern tropical dry deciduous forest type, constituting a sub-type of forest called the Red sanders forest. The dye obtained is known as bright red Santaline dye. It is extracted from the heart wood of the tree. The dye obtained is used for dyeing leather and staining wood. It is also used as a colouring agent in pharmacy. A cloth dyed in a solution containing santaline dye mixed with alcohol or ether results in a beautiful pink colour cloth. The dye is used for dyeing silk and cotton clothes, when mixed with the Brazilian dye. A variety of colours can be obtained on woolen, cotton and linen cloth by the use of different mordant.

6.7.2 Bark dyes

The dyeing property in bark is meager. The maximum number of barks contain the tanning material. The bark mostly yield brown and black coloured dye. The plant species used for dyeing purposes are:

Acacias: The bark of few of acacia tree species viz., Acacia concinna, A. farnesiana and A. leucophloea yield a black dye (Mehta, 1981; Forest Utilization vol II).

Alnus species: The bark of Alnus nepalensis and Alnus nitida trees are used in dyeing to fasten the colour of the fabric previously dyed with brown dye of Himalayan madder (Rubia cordifolia). The tree is found in isolated patches along the cool and moist streams in Uttarakhand and other localities of Himalayan region.

Casuarina equisetifolia: The bark of this tree is used in dyeing and gives a light reddish colour. It is also used for toughening fisher men's net.

***Manilkara littoralis*:** The bark of this species yield a red colour dye.

***Myrica esculenta*:** The bark of this tree is rich in tannin content and it yields a yellow colour dye. This is an important tree that also yields delicious edible fruits and found in the temperate forests of Uttarakhand.

***Terminalia alata*:** It is used as a tanning as well as dyeing material. The bark of this tree gives black colour dye. Bark of the root of Ventilago patina is considered to be a valuable dye in the Decan and the Carnatic region of the country.

6.7.3 Flower dyes

Butea monosperma (Dhak): It is considered as the most popular tree to yield flower dye. The flowers on drying, yield an unstable yellow colouring matter. The colour is made less fugitive and dark with the addition of alum, lime or/ and alkali. In past, the dye was extensively used for dyeing sarees and other cotton and silk clothes.

***Toona ciliata* (Toon):** The flowers of this tree yield a red colouring matter. These are considered as an important source of natural dye stuff. It easily gives light yellow colour to the cotton and woolen fabrics, when immersed in boiling extract of flowers. The colour can be fasten by using suitable mordents.

***Nyctanthes arbortristis* (Harsingar):** The tube of the flower of this plant is rich in colouring material. It gives a beautiful orange or golden yellow colour, which is fugitive and is commonly used as an auxiliary to other dyes. The dye is often used to colour liquors.

***Mammea longifolia*:** The flower in the bud stage of this plant is used for dyeing silk fabric.

Crocus sativus: The stigma and the style of lavender flowers are used for the preparation of dye extraction having a deep yellow coloured dye, saffron crocus. Soon after the opening, the flowers are clipped and allowed to dry naturally or artificially. The colouring material is easily soluble in water and is used for colouring food and medicines (Mehta, 1981).

6.7.4 Fruit dyes

Mallotus philippensis: Commercially known as Kamela dye, it is common fruit dye almost throughout India. It is regarded as one of the best known fruit dyes. The dye is obtained from the red glands on the surface of the capsule of the tree species. The fruits are collected in large cloth bags or sacks and are lightly beaten for obtaining the dye. The dye is generally used for dyeing silk. It gives a bright orange or flame colour. When mixed with other mordants, the colour can be changed from pale yellow to dark red. It is also used for colouring oils, soaps, ice creams and soft drinks. The moderate size tree also grows in the sal forests of Shivalik foothills of Uttarakhand (Mehta, 1981; Forest Utilization vol II).

Bixa Orellana: The seeds of bixa orellana yield a well known dye, commercially known as Annatto. The tree is mostly cultivated in South India. The major colouring matter in the seeds is bixin. The arils around the seed are used for extraction of dye. A bright yellow coloured dye is obtained from the seeds. The dye is used for calico printing, woollen and silk fabrics (Mehta, 1981; Forest Utilization vol II)

***Wrightia tinctoria*:** The seeds of the plant species yield an indigo dye.

6.7.5 Root dye

***Berberis aristata*:** The species is reported to yield one of the best yellow dyes in the country. The dye is readily soluble in water and alcohol. The colour changes from yellow to brown on addition of alkali. The dye is used for the manufacture of Morocco leather (Mehta, 1981) . The shrub grows extensively in Uttarakhand and has been exploited recklessly for the medicinal properties of its roots.

***Datisca cannabina*:** The root of the plant is commercially known as alkabir and yields a yellow dye. It is used for dyeing silk, wool and cotton. It is commonly used in Kashmir and throughout the Himalayas.

***Morinda coreia*:** The root bark yields a red colouring dye. The dye obtained from the root of the species is generally used for dyeing handkerchiefs, turbans etc.

Punica granatum: The root of the species yield dyes of yellow and red shades.

Rubia cordifolia: The roots and the stem of the plant yield a red dye. The plant is common in the Himalaya.

6.7.6 Leaf dyes

***Indigofera tinctoria*:** Earlier, the shrub was extensively cultivated for the remarkable dye extracted from the leaves of the species. It was known as the king of dye stuff. The dye gives deep blue colour. It is widely used for its stability and strength of the colour (Mehta, 1981; Forest Utilization vol II).

***Lawsonia inermis*:** Commonly called as henna herb, it yields an orange coloured dye called as the henna dye. It gives a fast dye and is used for fabrics and leather. It is also used for dyeing hairs, nails and eyebrows (Mehta, 1981; Forest Utilization vol II).

6.7.7. Animal dyes

Animal dye is obtained from the lac insect (*Laccifer lacca*). It produces crimson red coloured dye. It once enjoyed wide commercial importance.

6.7 Summary

Tannins are polyphenolic compounds, made up of carbon, hydrogen and oxgen. Tannins brings about the following changes by their action on animals hides and skins- (a) they render the hides and skins resistant to decomposition; (b) they make them strong and flexible; and (c) they improve the wearing qualities of animal hides and skins. The process in which animal hides and skins are treated by tannins is known as tanning. It turns these raw products into leather. In India a large number of tanning materials are found which can be classified into wood tans, bark tans, fruit tans and leaf tans. Dyes are the name given to substances which are used to imparting colour and staining purposes. On the basis of origin dyes are classified into wood dyes, bark dyes, flower dyes, fruit dyes, root dyes, leaf dyes

and animal dyes. The cutch obtained from khair (*Acacia catechu*) tree heart wood is the main wood tans in India. Bark tans include *Acacia mearansii, Cassia auriculata, Acacia nilotica, Cassia fistula, Terminalis arjuna, Termenalia alata, Shorea robusta, Emblica officinalis* etc. Fruit tans include: *Acacia nilotica, Caesalpinia coriaria, Zizyphus xylopyrus, Embllica officinalis, Shorea robusta* etc. Leaf tannin includes *Anogeissus latifolia, Carissa spinarum* etc. But leaf tans are not of any importance from commercial point of view. Many of these species are of medicinal importance also thus facing the pressure of extraction from nature and need to be planted and regenerated to meet the industrial demand.

Terminal Questions

1. Differentiate between tannins and dyes and briefly write about their uses in different industries.
2. Provide a brief description of various plants and plant parts which yield tannins and dyes.
3. Give some examples of plants which yield tannin from fruits.
4. Give brief description of plants which yield tannin from wood bark.
5. What are the uses of tannins and dyes?
6. Give brief description about various dye yielding plant parts.
7. List some of the plants which yield both tannins and dye and also important for medicinal purposes.

References

Dwivedi, A.P. 1993. Forests: The Non-wood Resources. International Book Distributors, Dehradun. 352 pp

Indian Forest Utilization, Vol. (II). Forest Research Institute Press, Dehradun. 941 pp.

Khanbabaee Karamali and Ree Teunis van, 2001. Tannins: Classification and Definition. Natural Product Report (18) 641-649.

Mehta, T. 1981. Forest Utilization. International Book Distributors, Dehradun. 296 pp.

Unit 7 Oil Seeds

Unit Structure

7.1 Learning Objectives

After studying this unit, you should be able to:

- To know about important trees which yield edible and non edible oil from seeds.
- To develop an understanding of the major plant species including herbs, shrubs and tree that yield oils.
- To understand the importance of oil yielding plants.

7.2 Introduction

Natural oils and fats are mostly deposited in seeds and tissues of plants. These are compounds of glycerin with certain complex organic acids called fatty acids. These products are deposited in considerable quantities in seeds associated with starch, protein and nitrogenous substances. The seeds which have appreciable quantity of oils are crushed for obtaining oil and generally referred to as oil seeds.

Oils and fats are necessary for the survival and growth of both man and animals. Fats and oils can easily be distinguished on the basis of their physical state. Fats are solid or semi-solid at ordinary temperature. Oil is generally in liquid state and can turn into fat in cold conditions.

The present requirement of fatty oils in India is 15 million tonnes. Still there is a huge deficit in demand and production. This indicates that there will be a considerable shortage of oil seeds in the country in the coming years. In order to fulfill the oil seed requirement, India imports edible oil in a large quantity from different countries. Tree borne oilseed oilseed (TBO's) can solve the problem of oilseeds to some extent. Several species of trees such as *Diploknema butyraceae* (Cheura), *Prunus armenica* (Chulu), *Simmondsia chinensis* (Jojoba), *Pongamia pinnata* (Karanja) and Jatropha (shrub) are just a few tree species that yield oil. Tree borne oilseeds can be both edible and non-edible. Some of these seeds are edible and generally used for food in various forms. The non-edible oil finds uses in paints, soaps and substitute for diesel.

There are three methods for extracting vegetable oils from plants. The relevant part of the plant may be placed under pressure to "extract" the oil, giving an expressed oil. Oils may also be extracted from plants by dissolving parts of plants in water or another solvent. The solution may be separated from the plant material and concentrated, giving an extracted or leached oil. The mixture may also be separated by distilling the oil away from the plant

material. Oils extracted by this latter method are called essential oils. Essential oils often have different properties and uses than pressed or leached vegetable oils.

7.3 Important Tree Borne Oil Seeds

Several forest species yield oil seeds which are commercially important and are available in large quantities. These trees borne oil seeds are described below:

7.3.1 *Diploknema butryacea* (Cheura)

Cheura (*Diploknema butryacea*) belongs to the family sapotaceae and popularly known as Indian butter tree. It is also known as Phulwara, Fulwa, Pahari Mahua, Gophat in Kumaun region of Uttarakhand. Commercially, the Cheura oil extracted from the seeds, is marketed as Phulwara Ghee. Cheura is a native of Nepal and distributed from India through Nepal to Philippines and from Garhwal, Kumaun eastwards to Sikkim and Bhutan (Sub-Himalayan tracts and outer Himalayan ranges). It also occurs sporadically in tropical moist deciduous, semi-deciduous and evergreen forests of Andaman Islands. It is a fast growing tree and found in the elevation ranges between 400-1400 meters mainly along the sides of ravines and in shady valleys. The tree flowers in October- November at the age of 8-10 years. Its flowers are either white or yellow colour with a special fragrance. The fruits start ripening in June-July. Fruits are oval in shape and initially with green colour which turns light yellow after ripening during June-July. The weight of seed is 20% by weight of the fruit whereas the kernel weighs 76-80%. Seed and kernel contain 42-47% and 60-66% oil, respectively. Cheura oil is used as Ghee and butter which is known as 'Phulwara Ghee' for cooking and frying of vegetables and food. It is also eaten raw. Cheura butter is used for preparing medicines, ointment, candles, cream and other user-friendly products. Leaves of the tree are highly cherished as fodder by the cattle. Leaves of the tree are highly cherished as fodder by the cattle. (NOVOD Board Project Report 2010, Kumaun University, Nainital).

7.3.2 *Prunus armeniaca* (Wild Apricot)

The wild apricot (*Prunus armeniaca* Linn.) is an important tree of mid hills and dry temperate regions of the country and belongs to the family Rosaceae. In the Himalayan region of the country, local communities know it by different vernacular names viz. Chulli, Shara, Khurmani, Chulu, etc. The cultivated apricot has its origin in North-Eastern China, whereas, wild apricot appears to be indigenous to India. Wild apricot locally called Chullu is found in

the dry temperate region of North-Weastern Himalayas. Wild apricot fruits generally start maturing from last week of May and continue up to August end depending upon altitude and location. Change of surface colour, from green to yellow and fruit total sugar solids are considered as the best indices of maturity. The tree starts bearing fruits at the age of 4-5 years and continues to bear fruits for 50-60 years. The full bearing occurs at about 10-15 years when it yields about 85-100 kg. fruits per tree. The stone yield varies from 12-17 percent of fruits and the kernel yield ranges 3.14-4.81 kg/tree. The yield of a full- bearing well maintained plant tree varies from 120-150 kg. Kernel oil closely resembles almond oil thus it is used as an adulterant or a substitute for almond oil. Apricot kernels are cheaper and give higher yield of oil (0.8-1.6 percent) than bitter almond oil. The oil of the seed is also edible and is mixed with other edible oil like mustard oil. The oil fetches high cost in the cosmetic industry. It is also medicinal and used for joint pain. The strained baby foods from pulp are nutritious and a good source of calcium, phosphorus and iron. The oil of seed is edible and oil cake can be used as organic manure (NOVOD Board Project Report 2010, Kumaun University, Nainital).

7.3.3 *Simmondsia chinensis* (Jojoba)

Jojoba (pronounced as Ho-ho-ba) is a dioecious plant and is native to the Sonaran desert of Arizona, California and New Mexico. It was first introduced commercially in USA, South America, Mexico and Israel. Jojoba was first introduced in India around 1965. Jojoba plant belonging to family Simmondsiaceae, is an evergreen slow growing but long living (up to 150 years) desert shrub attaining a height of 3-5 meters. Leaves are simple, leathery, thick, opposite pubescent and evergreen. Jojoba plants start fruiting from fourth year of plantation and continue up to 150 years. Female flowers generally bloom in the month of December-January and seeds mature by the last week of May or first week of June. The seeds are generally elongated, slightly spherical and pointed. One kilogram Jojoba seed contains about 800-1200 seeds depending on their shape and size. The average seed yield of jojoba plantation from seedling is 50 gm/plant in 4th year and 1 kg./plant in 10th year with 2500 plant population/ ha, which increases substantially with the growth of plant and stabilizes in 14-15 years. The yield of plantation from cutting ranges from 250-300 gm/plant in 4th year and 3-5 kg./plant in 10th year with 1250 plant population per hectare. The oil is composed of almost entirely of esters of high molecular weight, straight chain mono-ethynelic acids and mono-ethynelic alcohol. Jojoba oil is a very rare as it is an extremely long (C36-C46) straight-

chain wax ester and not a triglyceride, making jojoba and its derivative jojoba esters more similar to sebum and whale oil than to traditional vegetable oils.

Jojoba oil is used for lubrication and cosmetics (mainly used as component of hair oil, shampoo and soap; potential use in face cream, sunscreen compound, lipsticks). It is used in Pharmaceuticals as suitable carrier of coating for some medicinal preparations; stabilizer of penicillin products; inhibitor to growth of tubercle bacilli; potential treatment for acne/ historical use as hair restorer. It may be used as cooking oil; low calorie additive for salad oil, vegetable oil and shortening. The oil is also used to prepare disinfectants, surfactants, detergents, lubricants, driers, emulsifiers, resins, plasticizers, protective coating, fibers, corrosion inhibitors and bases for creams and ointments. Oil is also used as polishing wax for floors, furniture and automobiles and when combined with other waxes it burns with bright, essentially smokeless flame; high melting point that may increase burning time of candle.

7.3.4 *Pongamia pinnata* (Karanja)

Karanja (*Pongamia pinnata* L Pierre) belongs to the family Leguminaceae and sub family Papilionaceae, is known by various local names in different states like Gaanug and Pungu in Andhra Pradesh, karanj in M.P. & U.P.

Karanja is a drought tolerant, semi-deciduous and leguminous tree. A medium sized globrous tree with a short bole and spreading crown upto 18 feet height or some times even more and 1.5 feet in girth, bark grayish green or brown, smooth or covered with tubercles, leaves compound, imparipinnate.

Karanja is believed to be originated in India and distributed throughout the country from the Ravi river eastward in the hills of South India up to elevation of about 1200 meters (4000 feet.) and in the Himalayas up to about 610 meters (2000 feet.).

White and purplish flower in axillary racemes appear in during April- July months. Trees raised through seedlings start fruiting at the age of 5-6 years. The yield of kernels per tree is reported between 8kg to 24 kg.

The seed collection is prolonged due to non-synchronization of flowering and fruiting. Therefore, one time harvesting is usually not possible. The collected pods are dried for 2-3 days in the sun. The kernels are separated from the shell manually by a wooden hammer or

manually operated decorticator. However, the electric decorticators of Karanja fruits have also been fabricated and are being used for efficient processing. The average seed yield of Karanja is about 40-90 qtl./ ha.(NOVOD Board, 2009).

Karanja kernels are reddish brittle in colour. The air dried kernels contain 19% moisture, 27-39% oil, 17.4% protein, 6.6% starch, 7.3% crude fibres and 2.3% ash. The kernels also contain mucilage (13.5%) and traces of essential oil. In addition, a complex amino acid globrin is also present.The seeds contain pongam oil, a bitter, red brown, thick, non-drying, non-edible oil, 27-39% by weight, which is used for tanning leather, soap, as a liniment to treat scabies, herpes, and rheumatism and as illuminating oil. It is also used for lubrication. Pongam oil showed inhibitory effects on Bacillus pulilus, Esherichia coli, Pseudomonas mangiferae, Salmonella typhi, Sarcina lutea, Staphylococcus albus, Staphylococcus aureus and Xanthomonas campestris.

7.3.5 *Jatropha curcas* (Jatropha)

Jatropha belonging to Euphorbiaceae family is a fast growing shrub and commonly named as Ratanjyot, Jamalghota, Jangli arandi etc . It can be cultivated in tropical and subtropical regions of the country and even on waste lands. The oil extracted from seeds of Jatropha has been found a promising and commercially viable alternative to diesel, which is a renewable source of energy. Alternate fuels for diesel engines have become increasingly important due to diminishing petroleum reserves and awareness of the increased environmental consequences of emissions from petroleum- fuelled engines.

Jatropha is a native of South America and has a long history of its propagation by Portugese into Africa and Asia. It grows well throughout India. Andhra Pradesh, Gujarat, Rajasthan, Karnataka, Chhattisgarh, Uttarakhand, Tamil Nadu, Maharashtra, Orissa, North Eastern states are some of the promising states where it occurs in the vicinity of villages and towns as semi wild bush and is not browsed by cattle. It flowers between September-December and March-April. The fruiting extends from September to December. The fruits mature 2-4 months after flowering. The yield of seeds varies between 2.5 to 4 tonns/ha/yr from an establishment plantation and yield approximately 1 tonne oil/ha/yr. The seed resemble castor seed in shape but is smaller in size and dark in colour. Weight of the seed ranges 0.5-0.7g. and length 1-2cms. The seed contains moisture (6.6%), protein (18.02%), fat (38%), carbohydrates (17.98%), fiber (15.5%) and ash (4.5%). Besides, starch, sucrose,

dextrose, glutein, a free acid and an active lipase are also present. The oil is used as lubricants, soap and candle manufacturing. It has also been reported as hair growth stimulant and thus can be used as hair oil. In animals/ live stock, its application is useful against sores. It is used as a bio-diesel after trans-esterification. The information about species given here has been compiled from various sources (Diwedi, 1993; Mehta, 1981; Forest Utilization vol II, NOVOD Board, 2009).

7.3.6 *Actinodaphne angustifolia* (Pisa)

It is a medium sized evergreen tree, found in the Western ghats, Maharashtra and North Kanara; Orissa, Assam and Sikkim. It flowers during November to January. The flowers are yellowish in colour and visited by honey bees. Fruiting takes place during May-June. The fruits are ellipsoidal berry 0.8 to 1.3 cm long, red and pulpy when ripe and edible. Weight of one fruit is about 0.25 grams. In a dried fruit, the seed constitute 53.2 percent and skin and pulp 46.8 percent. Moisture content in fresh fruit is about 56 percent. Pulp and shell of the fruit yield an oil that contains unsaturated fatty acids. The oil content in the pulp and skin is reported to be 51.1 percent and 34.9 percent, respectively. The oil content in the kernel is 74.6 percent. Yield of fruit per tree is about 14 kg. Collection period continues for 15-20 days before the monsoon. The product is marketed as fruit.

7.3.7 *Azadirachta indica* (Neem)

It is a large sized evergreen tree, found almost throughout the country. The period of flowering varies with locality. Mostly, the tree flowers during February to April. Flowers are small, white, in clusters and fragrant. Fruiting takes place in the month of March and lingers up to May. Fruits ripe during May to August, fruits are green, ellipsoidal drupe, yellow when ripe. Yield of fruit per tree is 37-55 kg and seed yield per tree is about 40 percent of fruit yield. Kernels form 17 percent in depulped seed. The seeds are depulped by rubbing in water or by dumping them with soil/ ash followed by trampling. These are marketed in three forms viz., fresh/ dried fruit, depulped seed or kernels. Moisture content in commercial neem fruit is about 6 to 9 percent and after drying it reduces to 5 percent. Neem oil is used for preparing cosmetics (soap, shampoo, balms and creams, for example Margo soap), and is useful for skin care such as acne treatment, and keeping skin elasticity. Neem oil has been found to be an effective mosquito repellent. Neem oil is generally light to dark brown, bitter and has a rather strong odour that is said to combine the odours of peanut and garlic. It

comprises mainly triglycerides and large amounts of triterpenoid compounds, which are responsible for the bitter taste. It is hydrophobic in nature and in order to emulsify it in water for application purposes, it must be formulated with appropriate surfactants. Neem oil also contains steroids (campesterol, beta-sitosterol, stigmasterol) and a plethora of triterpenoids of which azadirachtin is the most well known and studied.

Decortication of fruits is necessary. For dried fruits, the yield is 70 percent shell, 25 percent kernel and for pulped seed the yield is obtained 2-5 months after the time of collection. Oil yield obtained from fruit, depulped seed and kernel in ghani and expeller.

7.3.8 Butea monosperma (Palash)

This medium-sized tree is commonly known as 'the flame of the forest' and occurs throughout the country in dry deciduous forests. It flowers during February- March. The flowers are bright, flaming, scarlet- orange, with black calyx and resembles the beak of parrot in shape. These are borne in closely packed bunches commercially known as tessu flowers. These are source of yellow colour used for dyes and flower dust is used in abir, a yellow powder used in Holi. Buds are dark brown, the canopy of flowers on the crown of the tree brings the name, 'Flame of the Forest'. Fruiting takes place during April to June. Fruit is one seeded pod, 15-20 cm long, 25.5 cm broad; pale green turning to yellowish brown with silver white colour when ripen. Kernels/ seeds have wormicidal and medicinal properties. They are reddish brown, flat, oval, kidney shaped at the apex. Oil content ranges between 17- 19 percent. Yield per tree is 1 kg seed (kernel). Pods collected in May-June are decorticated and marketed as kernel. Kernels yield 8 percent oil in expeller and 16-17 percent oil by solvent extraction.

7.3.9 *Hydnocarpus wightiana* (Maroti)

It occurs in tropical evergreen and tropical moist deciduous tropical forests of the country. It is a tall and large evergreen tree. It flowers during January-April. The flowers are white, solitary or racemes. Fruits ripe during July August-September. The fruits are globose or ovoid, 10 cm diameter having a thick- woody rind. Pulp forms 45 to 50 percent of the fruit. About 9-15 black conical seeds are embedded in the pulp. The seeds form 20 percent of the fruit. Yield of the fruit per tree is about 100 kg (20 kg seed). Kernels from 60-70 percent in the seed. Oil content is 63 percent in the kernel. Fruits are plucked by climbing up the tree or by inducing falling using long sticks with a sickle tied to it. Fruits are peeled by knife and

seeds are washed in water and dried in the sun. It is marketed in the form of seed. Seeds are decorticated by mallet, hammer or by decorticator. The kernels yield yield 43 percent oil in ghani, when crushed in oil expeller. and rotary and exported in zinc barrels from Kerala. (Diwedi, 1993)

7.3.10 *Listea umbrosa* (Chirandi)

It is evergreen shrub found in the Eastern Himalayan region, Khasi hills and Manipur. It is also found in deodar forests up to 2500 m elevation. It flowers during August to September. Fruiting takes place during October- November. Fruits are round having diameter 3 to 3.5 mm; pericarp, a thin pulpy layer, has 41 percent oil content. The oil from fruit is considerably different from kernel oil. The green fruit turns light red when dried and later to black. In dry fruit, oil content is 54.23 percent. In the de-pulped seed, shell constitute 17.87 percent and kernels constitutes 13.87 percent. Oil content in the seed is 56 percent. The oil content in the kernels is 70 percent. Yield per tree is 17 to 21 kg kernels.

Collection of fruits is done in the month of November-December. Bunches of fruits are plucked from tree and then fruits are separated and marketed as fruit. Crushing of the whole fruit is advisable. In expeller, the fruit gives 49 percent oil and kernels gives 60 percent oil.

7.3.11 Kokum (*Garcinia indica*)

The kokum tree is a slender, pyramid-shaped, evergreen tree with dropping branches. It is commonly known as kokum butter tree, mangosteen oil tree or brindonia tallow tree. It is originated from the tropical rain forests of the Western ghats of Kerala and Malaysia. Its cultivation is confined to the coastal hilly regions of Maharashtra and Goa states and known as Ratamba. It also flourished well on the lower slopes of the Nilgiri Hills. It flowers during December- January. Flowers pale yellow in colour, are borne either singly/solitary or in clusters. The seed oil is used in cosmetic industries. Yield potential ranges from 30 to 173 kg/tree/year with the productivity of 9.27 to 51.9 ton/ha.

7.3.12 Simarouba (*Simarouba glauca*)

It is an evergreen multiutility tree that grows up to 15 metre height with tap root system and cylindrical stem. It is commonly known as paradise tree. It grows well in the wastelands of Orissa, Karnataka, Gujarat, Andhra Pradesh, Bihar, Chhattisgarh and Tamil Nadu. The gestation period of the tree is 6-7 years and flowering occurs annually in December to

February. The tree starts bearing fruit after gestation period and stabilizes in next 4-5 years. The fruit is an etario with one to five fruitlets. Each well grown tree yields 15-30 kg nutlets equivalent to 2-5 to 5.0 kg oil. Seed contains 60-75% oil content. (NOVOD Board, 2009)

7.3.13 *Madhuca indica* syn. *M. latifolia* (Mahua)

It is a medium to large sized tree, found naturally wild in forests. It is common almost throughout India. Mahua tree flowers during the end of February and continues up to April; flowering takes place in clusters at the end of branches. Flowers are aromatic, with sweet scented petals (corolla). These are they fall on the ground shade on in the group which are collected for distillation and making country of liquor, for essential oil and they are eaten after cooked cooking . They are rich in sugar, vitamins and calcium. Flowers left after distillation are fed to animals and are considered to be a good animal feed.

Fruits appear in the month of April May-June, mature and fall during June to July September in the northern parts and August to September in the Southern parts of India. Fruits are fleshy, green berry, yellowish or orange brown, when ripe, 2.5 to 5 cm long (Troup,1921). There are two species e.g. *M. indica* and *M.latifolia*. Both the species of *Madhuca* are closely related and hardly make any differences in oil trade. Fruits of *Madhuca indica* are oblong and that of *M. longofolia* are ovoid and contains 1 to 4 shining seeds. These are eaten raw or cooked as a vegetable; essential oil is obtained by distillation (0.3 percent yield) has 22.72 percent ethyl cynemate; rind can be used for alcoholic fermentation. Kernel yield per tree is about 22 to 37 20 to 40 kg.

Kernels form 70 percent of the seed. In a single seed, two kernels of 2.5 x1.75 cm size are present. Oil content is 46 percent in *M. latifolia* and 53 percent in *M. longifolia* which are smaller in size.

Fallen fruits are collected by hand picking. The falling of fruit is induced by shaking the branches. Collection of fruits completes within 2 to 3 weeks. The outer rind is removed by hand and seeds are decorticated by beating with stone or hammer. Collection of seed is organized by forest tribal federation in some areas. The average collection of seed per person per day is about 20 kg.

The seed kernels are dried and cleaned before extraction of oil. The yield of oil obtained in ghani (local oil drilling machine) is 20-30 percent, in expeller 34-37 percent and in solvent extraction 40-43 percent. Residual oil in solvent extracted cake is only 1 percent. The

maximum protein content in the kernel is in the month of January, which declines thereafter, January and February are therefore, the best period for crushing seed kernels for good oil yield.

7.3.12 *Mangifera indica* (Mango)

Mango, (king of fruits) trees are cultivated at a large scale but also occurred wild or semi wild. It is a large evergreen tree valued mainly for its fruits. Flowering starts in the end of winter and beginning of spring. Fruits mature in April and May. There are several varieties of these species found in India. It has export value. Raw mangoes are used for preparing pickles, chutney, amchoor, etc. Ripe mango is a popular edible fruit all over the world. Skin and pulp constitute 80 85 percent. Fruits contain one seed in the pulpy fruit. It is generally thrown away after using the pulp. It consists of hard shell enclosing a kernel. Kernel forms 62 percent of the seed. Kernel is kidney shaped and dicotyledons are enclosed in a thin cover. Medicinally used as astringent and anthelmintic. Oil content in the kernel is 11 percent on moisture free basis.

Collection of seeds has been recently started in Maharashtra and Madhya Pradesh by a couple of parties and the seed collectors. The seeds are decorticated by stones and supplied as kernels by the collectors.

Collections of seeds and decortication in machines have been tried at some laboratories. However, to purchase kernels seems to be more practicable. The kernel starts deteriorating and turns back. Its immediate cooking and passing through expeller to convert it into a cake like form is advised so that the kernel is sterilized and the resultant cake can be stored safely, till it put to solvent extraction. It can be used as a cattle feed or manure.

7.3.13 *Mesua ferrea* (Nahor)

It is a large sized tree of evergreen and semi-evergreen forests. Flowering time is highly variable in India (July- January). Flowering period in the trees varies from place to place. Flowers are white, sweet scented, 7.5 to 10 cm in diameter, borne singly or in pairs at the end of branches. They are used for medicinal purpose as astringent, stomachic and expectorant. On distillation, flowers yield an essential oil. Stamens and flowers are used for stuffing pillows. Dried stamens and flowers are sold as ‘Nagkeshar’ used for ayurvedic medicine.

Fruiting period varies considerably. In West Bengal, it flowers between mid- July to September; in Assam, August to October; in Karnataka, May-July; in Kerala, December-January. Fruits are reddish, conical, hard and ovoid; rough and nearly woody about 7cm in diameter. Each fruit weighs about 45-63 50 to 60 gms. Fruits contain one round or 2 to 3 conical shining brown seeds. The outer cover is fibrous. Kernel forms about 36 percent of the fruit. They are roundish, yellow, slightly smaller than seed is about 70 to 80 percent. Fruits are hand picked from the ground or plucked from the tree with the help of a long handle sickle. Outer shell is removed by hand;

Collection is done during the rainy season season mostly coincides with torrential rain.

Seed is dried and decorticated by hand, mellet or decorticator. Drying of seed is necessary. Shell of the seed is decorticated by mallet or decorticator. To avoid infestation of pests, the insecticides, aldrex (0.1percent of seed) powder is first sprayed on the ground meant for storing the seed. While crushing in expeller, addition of some roughage like rice- bran helps the seed meal cake formation. Subsequently solvent extraction of the cake is necessary. Yield of oil is about 35- 40 percent.

7.3.14 *Salvadora oleoides* (Pilu)

It is a large shrub or small evergreen tree, found growing wild in arid and sandy areas. Flowering in the plant occurs during January to April March-April in North India and January to March in western part of India. Flowers are small, greenish yellow or greenish white, produced in clusters. Fruiting takes place in the month of May- June in western areas and in the month of June in central parts. Fruits are red-brown when ripe, globose drupe, diameter 0.5. The fruits of S.persica are bigger in size; sweet, edible and fed to cattle to increase milk yield. Yield of fresh fruits per tree is 10 to 13 15 kg or 2.5-3 2-3 kg dried fruit. Oil content is low generally below 20 percent 19 to 21 percent in the fruit and 34 percent in the seed. In Salvadora persica (Chhota pilu) yield of kernels is 60 percent in dried seed, 49 percent in dried fruit and oil content is 40 to 43 percent. Kernels are 1/2cm in diameter with dicotyledons enclosed in thin brittle shell. .(Diwedi, 1993)

Fruits are plucked from tree or felled by shaking the trees vigorously. Collection of unripe fruit should be avoided. Fruits are dried and separated from stems and pulped. Collection season extends for 15 to 20 days. The collection of fruits per person per day is 40 to 50 kg.

Fruits are sold as Mitha pilu or dal (Cotyledons). In case of *S.persica*; driage of fruits is 77 percent. *S. persica* fruits are manually depulped and decorticated by stone grinder.

About 40 percent kernel yield is obtained on decortications. S.persica is mostly collected for crushing. S.oleoides is difficult to decorticate due to pulp hence can go directly for crushing. Yield of oil in expeller is 39 percent from S.persica kernel. The oil yield from the unripe and the ripe fruits varies, it is generally higher close to 20 percent from the ripe fruits and generally below 13 percent from the unripe fruits. The oil yield from the ripe fruits of S.oleoides is 21 percent and from unripe ones is 15 percent.

7.3.15 *Schleichera oleosa* (Kusum)

Kusum is a large sized tree generally found mostly occurring in the deciduous forests of the India country. The tree flowers during spring season February-April. Flowers are minute, yellowish green, sessile and borne in dense clusters. They yield a dye and are a source of honey for bees. Fruiting takes place during June-July. The fruits are smooth or slightly prickly, globose or ovoid, hard skinned berry with a pointed tip; size: 1.25-2.5 cm, one celled, contains 1 or 2 irregularly ellipsoidal slightly compressed seeds with a thick brown seed coat, very little pulp, which is eaten for getting cooling effect. Kernels constitute 58-61 60-64 percent of nuts. They are 14 15 percent of the dried fruit, generally U shaped and soft. The oil content varies between 51 to 62 percent. Kernels are susceptible to fungal attack. Bunches of fruits are generally plucked by climbing the tree, before they fall down. They are depulped by rubbing in water and dried. Collection of seed per day per person is generally 7 to 11 kg. After decortications, kernels crushed in ghani give 25 to 27 percent oil in the first crushing and 2 to 5 percent after hot water sprinkling on the cake in the second crushed. Yield in expeller is about 36 percent. Kusum oil is used upto 15 percent in the manufacture of soap. The oil is mostly used by small soap units. It is resistant to rancidity and produces roughing action on skin; hence used only up to the said proportion.

7.3.16 *Shorea robusta* (Sal)

Sal is a large sized tree, found in forest areas in north, east and central parts of India along the Himalaya tract. The sal tree begins to fruit 25-30 years. Some estimates suggest that India has a potential to produce 1,80,000 tones of sal fat annually against current annual production of 6-9 thousand tones. The cotyledons of sal yield butter commonly known as sal butter. Sal trees flower during May-June. Flowering is profuse during May-June for some

years while it is not so in other years. Flowers are yellowish, small and profuse, suitable for honey bees. Fruits mature during July- August and have five wing likes sepals and one seed (Troup, 1921). Fruits are of the size, 9.75-16.5 cm to 6.8- 12.8 cm. Fruits consists of wings (20.8 percent), shell (12.8 percent) and kernels (66.4 percent).

Yield of the seed kernel per tree is about 5 kg. Kernels have 2 to 4 segments. Oil content varies between 14 to 20 percent and moisture content between 4.7 to 20.8 percent. For collection, fruits fallen down, forming a layer are swept together or hand picked. Collection per head per day is about 30 to 40 kg of fruits. The widely used process for decortications is by spreading the Sal fruit on dry hard ground and setting fire to it. Although an easy means of de winging the seeds. This is a risky process as sometimes fire affects the seed and the oil content is reduced. Burnt seeds are often rejected by the collection centers as are seeds that are mixed with sand or stones. To avoid the risk of burning decortications may be done by beating the seeds with a wooden stick, if the quantity is small or by mechanical means. (Pant, 2011) Wings are removed by burning or rubbing. Seeds are crushed under wooden plants for decortications. Period of collection continues for 3 to 4 weeks. Decorticated seeds give 61 percent kernel.

Fat is traditionally obtained by water rendering or crushing in expeller. Direct solvent extraction is not efficient. Maximum recovery of fat is obtained by the solvent extraction of cooked and flaked kernel, keeping the residual oil in cake to 0.7 percent. Food grade hexane used for solvent extraction and the yield of refined fat is 81 percent of the total fat.

7.3.17 *Tectona grandis* (Teak)

It is commercially valuable timber tree. The species occurs in moist and dry deciduous forests over a large area. In Uttarakhand plantations of teak have been raised in Shiwalik hills and Tarai that make a significant source of revenue to the Forest Department. It flowers in August- September and in wet conditions as early as April. Fruits ripen from November to February. The nuts are light in weight and 2000 to 3000 numbers weigh in 1 kg. Kernels yield 44.5 percent oil. Fruits fallen on the ground are collected. The calyces are removed by agitating the seeds in gunny bags and then by winnowing. The oil is useful for soap making. It promotes hair growth and is useful in scabies.

7.3.18 *Vateria indica* (Dhup)

It is handsome evergreen tree occurring in tropical evergreen and moist deciduous forests in Karnataka, Kerala and Tamil Nadu. The tree flowers during January to March. The flowers are fragrant, while in terminal corymbose panicles. Fruiting occurs during May-July. The fruits are oblong or round capsule, 6x4 cm in size, resemble sapota or chikoo in appearance. They are fleshy, 3 valved, 1 seeded, pale brown when ripe. The hard capsule has a 6 mm thick brown pericarp of semi-fibrous composition. Yield of fruit per tree is 400 to 500 kg. Good carp appears after every 3-5 years with 1-2 poor season and 1-2 average seasons in between. Yield of kernels from the fruit is 47 percent. Kernel weighs 55 grams and it is reddish white or green and has a thin brown covering. It is hard, brittle and aromatic. Oil content ranges between 19-27 percent. To avoid germination in the wet soil and infestation by worms, the fruit should be collected immediately after they fall on the ground. The fruits are decorticated by wooden mallet and kernels get broken and sterilized in the process. Kernels are dried and stored. Fat is extracted by water rendering in traditional method which is not economical. In improved method, kernels are disintegrated to 6.7 mm and put to expeller. The yield of oil is 6 to 9 percent. In solvent extraction, the oil yield is 10 to 12 percent.

7.3.19 *Aegle marmelos* (Bel)

It is a deciduous tree found wild in the sub-Himalayan tract, in central and southern parts of India. The seeds yield bitter fatty oil. The oil content in the seed is 11.9 percent. It include oleic acid and linoleic acid as dominant fatty acids. The oil is taken internally as a purgative in small doses.

7.3.20 *Anona squamosa* (Sitaphal)

It is a small evergreen tree, found almost throughout India. Seeds are smooth, oblong and many. Over dried kernels of seeds contain 30 percent oil. Composition of fatty acid in a seed shows oleic acid 18.1 percent, linoleic acid 55.2 percent, palmitic acid 14.7 percent, and stearic acid 10.7 percent. The oil obtained is used in making soaps.

7.3.21 *Argemone mexicana* (Satyanashi)

It is an annual herb, common in plains almost throughout the country. The seeds yield 22-36 percent of oil. Oil is non edible and bitter in taste. It is beneficial for skin diseases and

used externally. The oil is used as illuminant and lubricant. The oil cake can be used as a fertilizer. The seeds are considered to be of medicinal use.

7.3.22 *Bauhinia variegata* (Kachnar)

It is a medium sized tree found in the sub-Himalayan tract, dry forests throughout eastern, central and south India. Flowering takes place during summer and the seed (pods) ripen in winters. The seed comprises 20 percent of endocarp and 80 percent kernel. The seeds yield about 16.5 percent of pale yellow fatty oil. The oil can be used for making soap.

7.3.23 *Bombax ceiba* (Semal)

It is a lofty deciduous buttressed tree found sporadically in the mixed deciduous forests throughout the sub-Himalayan region and lower valleys. It is typical of the alluvial savannah type of forests. It is also found occurring in the sal forests. It is common in dry and moist mixed evergreen forests. The seeds of the tree yield a pale yellow oil. The oil compares favorably with the seeds of Ceiba pentandra. It is used in soap making and as an illuminant. It is used for edible purposes as a substitute for cotton seed oil.

7.3.24 *Cinnamomum camphora* (Kapoor)

It is a large evergreen tree, successfully cultivated in India. Camphor seeds yield an oil similar to coconut oil in properties and is suitable for soap making. Fatty acids present are 95 per lauric acid cent and 5 percent oleic acid.

7.3.25 *Holarrhena antidysentrica* (Kutaja)

It is a large shrub or a small deciduous tree, occurring almost throughout India in deciduous forests and open wastelands. It is gregarious in sub-Himalayan tract. The seeds yield a greenish yellow drying oil, with pungent odour and mild taste. It is used as an anthelmintic.

7.3.26 *Juglans regia* (Akhrot)

It is a large deciduous tree, which occurs in natural forests throughout high Himalayas and hills of Assam. The kernels yield a pale greenish yellow or almost colourless oil with pleasant odour. The oil is commonly called as walnut oil. It is used for edible purposes and in small quantity in making artists colours, printing links, varnishes and soap. Oil cake is rich in protein and is used as a cattle feed.

7.3.27 *Listea glutinosa* Syn. *L. chinensis* (Maida lakdi)

It is an evergreen shrub or tree, found almost throughout India, ascending up to an altitude of 1350 m in the outer Himalayas. The seeds yield about 35 percent of fat. Fat obtained possess strong aromatic odour and disagreeable taste. It is used to make candles, soaps and detergents.

7.3.28 *Mallotus philippensis* (Kamla, Rohini)

It is a shrub or a small evergreen tree, found almost throughout India, ascending up to 1500 m in outer Himalayas. The seed kernels yield a viscous, dark brown to pale yellow oil or semi-solid fat. The oil is used in the formation of hair fixers and ointments, useful in perfumery, and antioxidants. Seed cake is used as manure.

7.3.29 *Pinus gerardiana* (Chilgoza pine)

The tree attains a height generally between 10-25 m and is native It is a small to moderate sized tree found locally in the inner valleys of the north-west Himalayas. The seeds commercially called as Chilgoza neoza are edible contain edible kernels. The kernels are eaten raw or roasted. The kernels possess high fatty oil content which is yellow in colour and yield a transparent a clear pale yellow colour oil. The oil is used for dressing wounds and ulcers.

7.3.30 *Prinsepia utilis* (Bhekal)

It is a thorny shrub found distributed in the Himalayas, from 1600-2500m elevation hills of Assam and Nilgiris. The seed kernels yield semi-drying pale yellow fatty oil. It is used for cooking and as illuminant. It is also used for hydrogenation and soap making. It is applied externally in rheumatism and pains resulting from over fatigue.

7.3.31 *Sapindus mukorossi* (Ritha)

It is a medium to large sized deciduous tree. It is a native of south India and is common commonly found up to 1200m on coasts and in open forests at low elevations. Seeds are pea sized, enclosed in blackish smooth hard endocarp. The kernels yield an oil, which can be used as a source of oleic and arachidic acids or as a hard oil in soap making.

7.3.32 *Terminalia bellerica* (Beheda)

It is a middle sized tree found throughout the dry deciduous forests. The seed kernels on extraction with petroleum ether yield clear bright yellow fatty oil. The oil is non-edible and is used in manufacture of soaps. When mixed with groundnut oil it gives better foaming and detergency. The yield of oil is about 36 percent. The oil is good for hairs. It is also used in rheumatism.

7.3.33 Terminalia chebula (Harar)

It is a medium sized tree found in the deciduous forests of India. The seed kernel on extraction yields yellow fatty oil. The oil content is about 35 percent oil. The oil is said to be toxic in nature.

7.4 Summary

Natural oils and fats are found in seeds of various plant species. These are glycerin compounds with complex fatty acids. In plants the oil is present in cellular tissues. The seed having good quantity of oils are generally referred as oil seeds. In India at present the total requirement of oil seeds is about 15 million tons but there is huge gap in demand and supply. Tree borne oilseeds are both edible and non edible and also has certain medicinal properties. The non edible oils are used in paints, soaps and as bio-fuel. Tree borne oilseeds can solve the problem of oilseeds. The major oilseed species includes Cheura (*Diploknema butyracea*), Wild Apricot (*Prunus armenica*), Jojoba (*Simmondsia chinensis*), Karanja (*Pongamia pinnata*) etc. These trees could be a significant source of income for the marginal farmers and attempts should be made to plant and conserve these trees.

Terminal Questions

1. Write briefly about various important oil seed bearing tree species and their industrial importance.
2. List out oil seed bearing tree species of Uttarakhand and their distribution?
3. Write short notes on the following:
    i. Cheura
    ii. Wild apricot
    iii. Neem

iv. Mahua

4. Give some examples of oil yielding plants useful for medicinal purposes.
5. Describe few methods of oil extraction from the seeds.

References

Dwivedi A.P. 1993. Forests: the non-wood Resources.IBD, Dehradun .352pp

Indian forest utilization, volume (II).FRI Press, Dehradun.941pp.

Mehta,T. 1981. Forest Utilization. IBD, Dehradun.296pp.

Integrated development of wild apricot and Cheura, Project Report 2010 submitted by Department of Forestry, Kumaun University, Nainital to National Oilseed and Vegetable oils Development Board.

Troup, R.S. 1921. Silviculture of Indian Trees. Vol I-IV.

Kureel, R.S., Gupta, A.K. and Pandey, A. 2009. "Simarouba"; A potential tree borne oilseed foredible oil. Booklet published by National Oilseed and Vegetable Oils Development Board. Ministry of Agriculture, Govt. of India.

Kureel, R.S., Gupta, A.K. and Pandey, A. 2009. "Kokum"; A potential tree borne oilseed for edible oil. Booklet published by National Oilseed and Vegetable Oils DevelopmentBoard. Ministry of Agriculture, Govt. of India.

Pant, G.C. 2011. Livelihood generation from Sal seeds, Lichens and Yarsa Gambu in KumaunHimalaya. Ph. D. Thesis, Department of Forest & Environmental Science, Kumaun`University, Nainital, Uttarakhand, India.

Unit 8 Gums, Resins and Oleo-Resins

Unit Structure

8.1 Learning Objectives

After studying this unit, you should be able to:

- To differentiate between gums, resins and oleoresins.
- To classify the resins and gums depending upon their purity or mixture with essential oils gums etc.
- To develop an understanding about the major plants that yield resins and gums.
- To develop an understanding about the significance of the gum and resin yielding plants in the industrial and economic development.

8.2 Introduction

Among the forest products of India gums and resins occupy an important place. These natural products have been known to man from time immemorial. Gum Arabic was used by the Egyptians as early as 2000 B.C. Balsams, myrrh and frankincense are frequently referred to in the old Testament and these have been in use in India and China for religious purposes from ancient times. They were in great demand in ancient Egypt for embalming the dead and for use in cosmetics. There are several species in India that yields resins and

gums. Generally gums and resins are plant exudations which may occur naturally or due to some injury in the plant parts. Although mostly of plant origin an important resin lac is obtained by secretions of minute insects *Laccifer lacca* (Indian Forest Utilization, 1972). . Gums are supposed to be the result of disintegration of internal tissues in which cellulose is decomposed into more or less viscous substance through a process called gummosis, which exudes from cracks and wounds of the stems. The species of genus pine are the most common resin yielding species. In small hill state like Uttarakhand where resin is collected from Pine trees (*Pinus roxburghii*), the revenue to the state forest department was Rs. 453 million in 2005-06.

The secretion of toxic resinous compounds is regarded as a defense against a wide range of herbivores, insects, and pathogens; while the volatile phenolic compounds may attract benefactors such as parasitoids or predators of the herbivores that attack the plant.

8.3 Resins

A resin is a hydrocarbon secretion of many plants particularly coniferous trees. It is valued for its chemical constituents and uses, such as varnishes and adhesives, as an important source of raw materials for organic synthesis. Resins consist primarily of secondary metabolites or compounds that apparently play no role in the primary physiology of a plant. While some scientists view resins only as waste products, their protective benefits to the plant are widely documented. The toxic resinous compounds may confound a wide range of herbivores, insects, and pathogens; while the volatile phenolic compounds may attract benefactors such as parasitoids or predators of the herbivores that attack the plant.

The resin produced by most plants is a viscous liquid, composed mainly of volatile fluid terpenes, with lesser components of dissolved non-volatile solids which make resin thick and sticky. Some resins also contain a high proportion of resin acids. Resinous secretion occurs in special cavities or passages in a wide variety of plants. The mode of resin formation or its utility to the plants is little understood. Presumably resins originate through reduction and polymerization of carbohydrates. They may also represent exudation products of various essential oils. They normally ooze out through the bark, hardening on exposure. Commercial resins are collected from artificial wounds or fossils material. Unlike gums, resins are insoluble in water but are more or less soluble in ordinary reagents such as ether, alcohol and turpentine. They are brittle, amorphous and more or less transparent and burn

with a smoky flame when ignited. Though widespread in nature, only a few families of plants are commercially important as source of resin; these include Anacardiaceae, Burseraceae, Dipterocarpus, Guttiferae, Hamamelidaceae, Leguminosae, Liliaceae, Pinaceae, Styraceae and Umbelliferae.

The classification of resins is in a chaotic condition. The resins occur both in the pure or nearly pure state, and in mixture with essential oils, gums and the like. Resins are mainly distinguished into three types: (i) hard resins, (ii) oleo-resins and (iii) gum-resins. The classification of the resins has been given following Indian Forest Utilization, 1972, Dwivedi, 1993 and Mehta, 1981.

8.3.1 Hard resins

These contain only a little, if any, essential oil. They are usually solid, more or less transparent, brittle substances with no particular odour or taste. They constitute the best sources of varnishes. The most important commercial resins, such as copals and dammars, belong to this class.

(a) Copals: It comprise a considerable group of resins of recent, semi-fossil and fossil origin, found in many tropical and subtropical countries. They contain almost no oil and yield a hard and elastic varnish, much used for outdoor work.

(b) Dammar: This is the Malay term for all gums and resins that exude from cracks or cuts and solidify upon exposure to the air, but used commercially as it designates a group of varnish resin obtained from Indian or East Indian trees belonging to the families Dipterocarpaceae and Burseraceae (Mehta, 1981).

(c) Amber: This is a fossil resin found principally on the shores of the Baltic Sea. The principal source was now extinct Pinus succinifera. Amber is an exceedingly hard and brittle substance. The larger and finer pieces are used for jwellery, beads, trinkets, cigar holders, etc., and the smaller pieces and waste form carving for varnish (Mehta, 1981).

(d) Lacquer: This is a natural varnish exuded by Rhus verniciflua, a native of China. When applied, the varnish rapidly hardens in a moist atmosphere owing, in part, to oxidation.

(e) Sandarac: This is a soft, pale- yellow resin obtained from Callitris quadrivalvis, a small tree of Northern Africa. Some Australian species of Callitris also yield sandarac. It is hard, white, spirit varnish, useful for coating labels, negatives, leather and metals.

(f) Mastic: This is derived from Pistacia lentiscus, a small tree of the Mediterranean region. Mastic yields a pale varnish used for coating metals and pictures, both oils and water colours. It is one of the most expensive and high- grade resins with many other uses (Mehta, 1981).

8.3.2 Oleo-resin

It contains a considerable amount of essential oils in addition to resinous materials and consequently they are more or less liquid in form. They have a distinct aroma or flavor. Among the oleo-resins are included the turpentine, the balsams and elemis. The distinction between these groups is very slight and often confusing (Indian Forest Utilization, 1972). Different oleo-resins are mentioned below:

(a) Turpentine: Turpentine are oleo-resins obtained almost exclusively from coniferous trees. For commercial purposes crude turpentine is obtained by tapping the trees. On distillation turpentine yield the essential oil or spirits of turpentine and rosin. The turpentine industry is one of the major industries based on forest products in India. Turpentine and rosin are produced in many European countries and in the United States, Indo-China etc (Mehta, 1981).

(b) Balsams: Balsams are oleo-resins that contain benzoic or cinnamic acid and so are highly aromatic. The name is usually applied to same substances like Canada balsam which is true turpentine. True balsam contains much less oil than the turpentine. They yield essential oils on distillation. Balsam of Peru is obtained from *Myroxylon pereirae,* a tree of Central America. It is used in perfumes as a fixative for heavier odours. It is also used in medicine.

There are several other oleo-resins which do not belong to either the turpentine or balsams. Among these may be Copaiba and elemi.

8.3.2Gum-Resins

Gum- resins, are mixture of both gums and resins and combine the characteristics of both groups. They also contain small amount of essential oils. They are usually produced by plants of dry arid regions, specially species of Umbelliferae and Burseraceae. These plants are abundant in Iran and Afganistan. Important gum-resins include gambage, asafoetida, galbanum, myrrh and frankincense (Indian Forest Utilization, 1972) and detailed as follows:

(a) Gambage: This is a hard, brittle, yellow gum-resin produced by several species of *Garcinia,* especially *G. hanburyi* of Siam and Indo-China and *G. morella* of India. It is used to colour golden lacquers, as a water colour pigments, and in medicine (Mehta, 1981).

(b) Asafoetida: The sources of asafetida are *Ferula asafoetida* and allied species found in Iran and Afganistan. The gum-resin exude from the roots when the stem is cut off. It has a powerful odour and a bitter acrid taste due to sulphur compounds present in the essential oil. It is used throughout the East for flavoring curries, sauces and other food products and as a drug (Mehta, 1981).

(c) Galbanum: A gum- resin excreted from the lower part of stems of *Ferula galbaniflua.* It has a tenacious and powerful aromatic odour. It is used in medicine.

(d) Myrrh: One of the oldest and most valuable of the gum-resins derived from *Commiphora myrrh,* a large shrub or small tree of Ethiopia, Somaliland and Arabia (Mehta, 1981).

(e) Frankincense: A fragrant gum-resin obtained from the stems of species of *Boswellia,* especially *B. carterii,* native to north-eastern Africa and Southern coast of Arabia. Its principal use is as incense in Roman Catholic and Greek churches.

One more category, which constitutes 75% of resins used, is unsaturated polyester resin. Ion exchange resin is another important class with application in water purification and catalysis of organic reactions.

Synthetic resins are materials with similar properties to natural resins—viscous liquids capable of hardening. They are typically manufactured by esterification or soaping of organic compounds. The classic variety is epoxy resin, manufactured through polymerization-polyaddition or polycondensation reactions, used as a thermo set polymer for adhesives and composites. Epoxy resin is two times stronger than concrete, seamless and waterproof. Accordingly, it has been mainly in use for industrial flooring purposes since the 1960s. Since 2000, however, epoxy and polyurethane resins are used in interiors as well, mainly in Western Europe. Use of natural resins in paints, varnishes and lacquers, in particular, has suffered as cheaper, synthetic chemicals have become available. Others, especially the soft resins and balsams, are used as sources of fragrances and pharmaceuticals, usually after preparation of a suitable solvent extract or distillation of a volatile oil.

The hard transparent resins, such as the copals, dammars, mastic and sandarac, are principally used for varnishes and cement, while the softer odoriferous oleo-resins

(frankincense, elemi, turpentine, copaiba) and gum resins containing essential oils (ammoniacum, asafoetida, gamboge, myrrh, and scammony) are more largely used for therapeutic purposes and incense. Resin in the form of rosin is applied to the bows of stringed instruments (e.g. violin, rebec, erhu, sarangi, etc), because of its quality for adding friction to the hair. Ballet dancers may apply crushed rosin to their shoes to increase grip on a slippery floor.

Resin has also been used as a medium for sculpture by artists such as Eva Hesse, and in other types of art work. In the early 1990s, most bowling ball manufacturers started adding resin particles to the covers of bowling balls. Resin makes a bowling ball tackier than it would otherwise be, increasing its ability to hook into the pins at an angle and (with correct technique) making strikes easier to achieve. Resins used to be much more commonly utilized in industry, e.g. in the production of oil paints and varnishes or to waterproof ships. These days their industrial uses have largely been diminished in favour of synthetic substitutes. Some resins have powerful medicinal properties that have long been utilized in herbal medicine, but others can be toxic. For example resins derived from certain plants of the *Artemisia* family or from the *Cypress* contain thujone, which is a known neurotoxin.

Agathis is the most tropical of all conifers. The copal-yielding species are very tall trees, up to 60 m high, often with a near-cylindrical bole. However, there can be some variation in the characters of the living tree, as well as the ecological conditions under which it occurs. It is grown widely as a timber tree on Java (over 100 000 ha) and other parts of Indonesia. Recent research in Indonesia and the Philippines has shown that thick-barked *Agathis* yields significantly more resin than thin-barked trees (in one study in Indonesia, almost nine times as much), and that tapping in the morning and at the side of the tree which maximizes the length of time that sunlight falls on it is beneficial to resin yields

Important resin yielding plants in India are as follows:

Salai (*Boswellia serrata*): It is a large sized tree, generally found in dry deciduous forests. For taking out the resin, the bark is shaved off from the trunk in fully grown trees at a height of generally 0.75 meters above the ground. The phloem which contains resins canal and ducts are exposed for exudation of resin. The blaze so made is freshened after every fourth and fifth day to facilitate resin exudation. The first collection is made after one or two weeks of making the blaze. Freshening of the blaze is done from time to time and the original blaze

is gradually widen to tap the resin in larger quantities. It hardens in four days and it is golden in colour and transparent in nature. The tapping is done during December to June every year. It closes on the onset of monsoon (Dwivedi, 1993).

Black dammer (*Canarium strictum*): This tree is a large deciduous tree, generally occurs as an associate of moist deciduous forests in Karnataka. It is found up to an elevation of about 1500 meters in the Western Ghats. The resin is tapped from these trees and vertical incisions are made in strips at about 1.8 meters from the ground. Generally, a fire is lit in the ground near the base of the tree to damage the outer layer of the bark. The resin begins to flow from this portion of the stem and lasts for about six months each year usually from November to April up to about 10 years. The resin is generally translucent and bright shining in colour. It is used in caulking boats, making varnishes and bottling wax. It is also used as a substitute for Burgundy pitch in plasters (Dwivedi, 1993).

Guggal (*Commiphora mukul*): It is a large sized shrub or small tree generally found in dry and rocky areas of Rajasthan, Gujarat, Maharashtra, Karnataka and adjoining states. The resin obtained from this tree is known as guggal gum or Indian myrrh in the trade. For harvesting the resin oblique incisions 7 to 10 cm apart are made with sharp instrument into the bark of the stem. The milky liquid exudes from the incisions. The colour become darker as it thickens. Each tree yields about one kg of resin each year. The resin is aromatic in taste and balsamic in colour. It is used as an incense and as a mixture in the preparation of perfumes. It is also used in the preparation of certain medicines. Other species, *C. berryi, C. caudata* and *C. roxburghii* also exude resins.

Gurjan (*Dipterocarpus turbinatus*): It is large sized tree found in the moist tropical forests of Assam and the Andaman Islands. The trunk exude an oleoresin commercially known as the gurjan oil. About 1 m from the ground, a cone shaped cavity is made on the trunk of the tree and fire is lighted to char the cut surface. After sometime, the oleoresin starts flowing out which is removed periodically. An average tree yields about 10 kg of oleoresin in one season i.e., from November to May. This oleoresin is used in lithographic inks, providing an anticorrosive coating to iron, for the preservation of timber and bamboo, for caulking boats, in preparation of varnishes. It also finds use as a medicine (Dwivedi, 1993)..

Chir Pine (*Pinus roxburghii*): The Chir Pine (*Pinus roxburghii*) named after William Roxburgh, is a pine native to the Himalaya. It is a large evergreen tree reaching 30-50 m

with a trunk diameter of up to 2 m, exceptionally 3 m. The range extends from northern Pakistan, Jammu and Kashmir, Punjab, Himachal Pradesh, Uttarakhand, Sikkim and Nepal to Bhutan. It generally occurs at lower altitudes than other pines in the Himalaya, from 500-2000 m, occasionally up to 2,300 metres (7,500 ft). The other Himalayan pines are Blue Pine, Bhutan White Pine, Chinese White Pine, Chilgoza Pine and Sikang Pine. Chir pine is widely planted for timber in its native area, being one of the most important trees in forestry in northern Pakistan, India and Nepal. It is also occasionally used as an ornamental tree, planted in parks and gardens in hot dry areas. In Uttarakhand this tree is tapped intensively for resin. On distillation, the resin yieds an essential oil, commonly known as turpentine, and non-volatile rosin. The proportion of rosin and turpentine oil in Chir Pine is 75% and 22%, respectively with 3% losses, etc. The turpentine is chiefly used as a solvent in pharmaceutical preparations, perfume industry, in manufacture of synthetic pine oil, disinfectants, insecticides and denaturants. It is one of the most important basic raw materials for the synthesis of terpene chemicals which are used in a wide variety of industries such as adhesives, paper and rubber, etc. Chir Pine rosin is principally used in paper, soap, cosmetics, paint, varnish, rubber and polish industries. Besides these, other uses include, manufacture of linoleum, explosives, insecticides and disinfectants, as a flux in soldering, in brewing and in mineral beneficiation as a frothing agent. Presently, India imports resin which is far superior in quality as well as cheaper than the indigenous one. Quality of resin depends on the pinene content. Imported resin contains 75-95% pinene, whereas Chir Pine resin contains only about 25% pinene.

Old Chir Pine trees which die from fire or drying out undergo some metamorphosis in their wood due to the crystallization of the resin inside the heart wood. This makes the wood become brightly colored (various shades from translucent yellow to dark red) and very aromatic with a brittle, glassy feel. This form of wood known as *Jhukti/Chhilka* by the locals is very easy to ignite (it never gets wet or waterlogged) fires and even used for lighting, as a small piece of this burn for a long time (owing to the high resin content). Of all the conifer species in Uttarakhand, only this one seems to be ideal for that purpose. Another use of this tree is made extensively for its dried needles those are collected from the forest floor to form a dense carpet underneath the cattle beds mostly during winter to provide warmth to the cattle. This material when mixed with animal dung and urine is allowed to decompose in compost pits and applied to the criopfileds to replenish soil fertility. The green needles are

also used to make tiny hand brooms. For local building purposes, the wood of this tree is the least preferred, as it is the weakest and most prone to decay when compared with other conifers. However, in most low altitude regions, there is no other choice, except for Chir Pine the clear boles of which are used for making rafters and furniture as the wood is soft and easily worked out.

Chilgoza Pine (*Pinus gerardiana*): *Pinus gerardiana*, known as the Chilgoza Pine**,** is a pine native to the northwestern Himalaya in eastern Afghanistan, Pakistan, and northwest India, growing at elevations between 1800-3350 m. It often occurs in association with Blue Pine (*Pinus wallichiana*) and Deodar (*Cedrus deodara*). The trees are 10-25 m tall and approx. 127 cm dbh with usually deep, wide and open crowns with long, erect branches. The seeds (pine nuts) are 17-23 mm long and 5-7 mm broad, with a thin shell and a rudimentary wing. Chilgoza Pine is well known for its edible seeds, rich in carbohydrates and proteins. The seeds are sold as dry-fruits by the name "Chilghoza". In Afghanistan, this species is cultivated for its edible seed, and efforts are underway to expand its economic utilization in India. Elsewhere, native populations are ruthlessly exploited, with typically 100% of cones harvested. As a consequence, there is virtually no natural regeneration of this species except in that very small fraction of its range (about 5%) where the species is inaccessible to significant human exploitation. Besides, Chilgoza pine is also a good soil binder, which ultimately checks the soil erosion. Though it has not been exploited commercially for oleoresin, owing to its limited distribution and to avoid destruction of the trees in order to get more valuable nuts, yet there is plenty of scope for resin extraction once large areas will be under this species. Reckless cone extraction and almost complete lack of natural regeneration have led Chilgoza pine to brink of extinction, which deserves immediate attention for genetic conservation and improvement. The Himachal Pradesh State Forest Department has tried artificial regeneration of Chilgoza Pine at many places. However, performance of seedlings was found to be very poor.

The seed is eaten as dry fruit chilgoza. The seed is also anodyne and stimulant. The oil obtained from the seeds is used as a dressing on wounds and ulcers; it is also used externally in the treatment of head diseases. The turpentine obtained from the resin of all pine trees is antiseptic, diuretic, rubefacient and vermifuge. It is a valuable remedy used internally in the treatment of kidney and bladder complaints and is used both internally and as a rub and steam bath in the treatment of rheumatic affections. It is also very beneficial to

the respiratory system and so is useful in treating diseases of the mucous membranes and respiratory complaints such as coughs, colds, influenza and TB. Externally it is a very beneficial treatment for a variety of skin complaints, wounds, sores, burns, boils etc and is used in the form of liniment plasters, poultices, herbal steam baths and inhalers.

Oleo-resins are present in the tissues of all species of pines, but these are often not present in sufficient quantity to make their extraction economically worthwhile. The resins are obtained by tapping the trunk, or by destructive distillation of the wood. In general, trees from warmer areas of distribution give the higher yields. Turpentine consists of an average of 20% of the oleo-resin and is separated by distillation. Turpentine has a wide range of uses including as a solvent for waxes etc, for making varnish, medicinal etc. Rosin is the substance left after turpentine is removed. This is used by violinists on their bows and also in making sealing wax, varnish etc. Pitch can also be obtained from the resin and is used for waterproofing, as a wood preservative etc.

Blue pine (*Pinus wallichiana*): Blue pine forests occur in moist valleys at elevations above 2000m in the middle Himalayas. These trees are generally found mixed with deodar.

Khasi pine (*Pinus kesiya*): It grows in Garo, Khasi and Naga hills in North-eastern states between the elevations of 1000-2000 m.

Tropical pines: Some of the tropical Pines introduced in the country viz. *Pinus caribaea, Pinus illiottii, Pinus petula*, etc., also yield oleoresin similar to that yielded by Chir pine.

8.4 Gums

Gums are substances that are either water soluble or can absorb water - they are not soluble in oil. Chemically they are complex polysaccharides (Carbohydrates). True gums are formed as a result of disintegration of internal plant tissues, chiefly decomposition of cellulose, through a process known as gummosis. Gums are soluble in water or can at least imbibe quantities of water and swell in the process, but are usually insoluble in common organic solvents such as alcohol and ether and in various oils. On heating they decompose completely without melting usually showing charring.

Gums either derive from the resinous sap or from the endosperm of certain seeds, e.g., Guar Gum, which is derived from the seeds of *Cyamopsis tetragonolubus*, an African herbaceous plant of the pea family. Gums are widely used as emulsifying and thickening agents in the

food industry, but they also find uses in other industries, from pharmacy to cosmetics and skin care products, to the manufacture of inks, paper, water colours and even the adhesive on the back of stamps. Water soluble gums also play an important role in a healthy diet as they are able to bind endotoxins and help to excrete them by adding bulk to the stool. *Psyllium* seed - a well known dietary supplement often used for minor constipation is a prime example of this action. Some sea weeds also yield gums, e.g., agar agar is well known and widely used in cooking as a thickener.

In India, there are a large number of species, mostly trees, which exude gums. Some of these are of local or limited interest, while a few are used extensively all over India and also enter the export trade of the country. The most important are;

8.4.1 *Acacia* gums

The acacia gums, largely known as gum arabic are derived from several species of genus *Acacia*. The bulk of the gum from indigenous sources is utilized locally. The gum Arabic available in the market is often a mixture largely of the gums of *Acacia* species and small quantities of the gums of *Anogeissus latifolia, Feronia limonia,* etc. This mixture is used as such for various purposes. The following are important Indian species of *Acacia* yielding gum:

***Acacia catechu* (khair):** This tree is well known as the source of katha and cutch and occurs in many places in India. The gum from this tree, though darker in colour, is of good quality and is regarded as a better substitute for true gum Arabic than babul gum. The tears may be as large as 3 cm in diameter and pale yellow to dark amber in colour. It is not collected separately and is generally mixed up with other Acacia gums. No gum is formed during the rainy season when the trees are in flower and fruit. With the onset of the dry season as indicated by the withering and falling of the leaves, the gums oozes out freely from injured areas in the trunk and branches.

***Acacia modesta*:** This tree yields a fair quantity of a gum which is highly valued in indigenous medicine and also in calico-printing.

***Acacia nilotica*:** This tree is widely distributed throughout India, especially in the drier localities. It forms the main source of the Indian “gum Arabic”, rightly called the babul gum. This gum is commercially important in the internal trade. Babul gum is generally considered inferior to true gum arabic obtained from *A. senegal,* especially for medicinal purposes. Gum

arabic from *A. senegal* is a pale to orange-brown coloured solid, which breaks with a glassy fracture. The best grades are in the form of whole, round tears, orange-brown in colour and with a matt surface texture; in the broken, kibbled state the pieces are much paler and have a glassy appearance. Gum from *A. seyal* (gum talha) is more friable than the hard tears produced by *A. senegal* and is rarely found as whole lumps in export consignments.

Gum arabic is a complex, slightly acidic polysaccharide. The precise chemical and molecular structure differs according to the botanical origin of the gum, and these differences are reflected in some of the analytical properties of the gum. As a result, the functional properties and uses to which gum arabic can be put (and its commercial value) are also very dependent on its origin. Unlike some other gums such as tragacanth, locust bean and the seaweed gums, gum arabic is very soluble in water and forms solutions over a wide range of concentrations without becoming highly viscous. The combination of high solubility in water and low viscosity confers on gum arabic its highly valued emulsifying, stabilizing, thickening and suspending properties. Despite some substitution of gum arabic by cheaper alternatives, brought about in the past by shortages of supply and high prices, it has remained the most important of the exudate gums and in some applications it has technical advantages which make it difficult to substitute completely. Its uses fall into three main areas: food, pharmaceutical and technical. Gum arabic's use in pharmaceuticals has been displaced in many of its applications by modified starches and celluloses. However, it still finds some use in tablet manufacture, where it functions as a binding agent or as a coating prior to sugar coating, and it is also used as a suspending and emulsifying agent, sometimes in combination with other gums. Other technical uses include ceramics, where gum arabic helps to strengthen the clay, certain types of inks, and pyrotechnics. Use in textiles, paints and adhesives (including the traditional office glue and postage stamps) has decreased to very low levels in recent years, at least in Western markets.

***Acacia Senegal*:** This tree yields the true gum arabic. It is small throny tree, 3-4.5 m in height and 30-60 cm in girth, found in Punjab, Himachal Pradesh and the northern Aravalli hills and other parts of Rajasthan. It is abundant in the arid tracts of North Africa, particularly in Sudan, from where world supplies are drawn. It has been an article of commerce since the first century of the Christian era.

8.4.2 *Anogeissus latifolia* (dhaura)

This is a large tree found in the dry deciduous forests, almost throughout India. It is the source of the so-called ghatti gum. The tears are round or vermicular, opaque externally and transparent internally, and almost free from cracks. The colour varies from whitish yellow to amber. It is sometimes brown because of impurities. Factors which affect the colour are the proximity of the tear to the bark and the length of time it has remained on the tree before collection, since tannins in the bark darken the gum tears. This gum is said to be superior to babul gum in colour. It is partly soluble in water, forming a colourless mucilage. The gum is a substitute for gum arabic and is used for calico-printing, pharmaceutical purposes and sizing paper. In recent years, it has been used in the petroleum industry as a drilling mud conditioner and in the explosive industries as a preferential water-absorbent or desiccant. It is also used in ceramics and foods.

8.4.3 *Bauhinia retusa* (semal)

This is a tree found in many parts of India and is often tapped for the gum known as semal gond, in parts of Himalayan foothills (Siwaliks) and elsewhere. There is always a good local demand for this gum which resembles gum arabic. It is eaten by the poor people and is also used for sizing cloth and paper and for water proofing terraced roofs. It can also be used as an efficient binder in the manufacture of charcoal briquettes, either alone or in conjunction with other binders of starchy nature.

8.4.3 *Cochlospermum religiosum*

This tree, which is found in many parts of the country, yields a gum by exudation from the fibrous, deeply- furrowed bark. The gum is similar to gum karaya in appearance and properties. It is known as katira gum or hog gum and is used as a substitute for gum tragacanth. Katira gum and gum karaya are in great demand for export for use in cigar paste and in ice-cream industry. Katira gum is used as a substitute for gum tragacanth in calico-printing and leather-dressing. The gum is sweetish, cooling and sedative and is useful in coughs.

8.4.4 *Lannea coromandelica* (jhingan)

This is a moderate to large- sized deciduous tree, found throughout the greater part of India up to 1,500 m in the sub-Himalayan tracts. A mucilaginous gum, called jhingan gum, exudes

from wounds and cracks in the bark. The gum is tapped in North India from March till the onset of rains, by making shallow cuts in the bark. The yield is about 5kg per tree in the first year, decreasing to 1 kg after 5 years, when the tree is given rest. The gum occurs in round tears or colourless angular fragments like gum arabic. Fresh gum is soluble in water, forming thin mucilage with good adhesive properties. It is used in calico- printing, paper and cloth sizing and inferior varnishes and for preserving fishing nets. It is also used in confectionary. Small quantities are exported.

8.4.5 *Pterocarpus marsupium* (bijasal)

This is a large tree, distributed in central and southern India. It is source of an important gum, the kino of the Indian Pharmacopoeia and the officinal kino of the British Pharmacopoeia. The blood red or ruby-coloured, astringent gum exudes from the bark. It is valuable medicine in cases of diarrhea and dysentery. There is a considerable demand for the kino gum for export much of it going to Europe.

8.4.6 *Sterculia urens*

This tree is common in India in the tropical deciduous forests, mostly in dry and rocky areas. It is the source of an important gum known in the trade as “gum karaya” or “katira gum”. It belongs to the tragacanth group of gums that swell to jelly like masses in water, but are not actually soluble in it. Gum karaya is commonly used as substitute for gum tragacanth; in some properties e.g., viscosity, the former is even superior to the latter and has the added attraction of being lower in cost.

In world trade two kinds of gums play an important role, viz. gum arabic and gum tragacanth. The term gum arabic is used with varying degrees of precision by different groups of people. In the context of its use as a food additive the most recent international specification, published by FAO (FAO, 1990), defines gum arabic as the "dried exudation obtained from the stems and branches of *Acacia senegal* (L) Willdenow or closely related species". The specification then proceeds to give limits for certain parameters which have been selected to try and ensure that only gum from *A. senegal* (and closely related species) satisfies the specification. The need for such legislation arises from the need to assure the public on safety grounds that there are no hazards associated with ingestion of gum arabic; gum arabic which complies with the definition and specifications has been tested and shown to be safe to consume.

8.5 Summary

A resin is a hydrocarbon secretion of many plants particularly coniferous trees. It is valued for its chemical constituents and uses, such as varnishes and adhesives, as an important source of raw materials for organic synthesis. The resins occur both in the pure or nearly pure state, and in mixture with essential oils, gums and the like. Resins are mainly distinguished into three types, hard resins, oleo-resins and gum-resins. The important resin yielding plant species are *Boswellia serrata*, *Canarium strictum, Commiphora mukul, Dipterocarpus turbinatus, Pinus roxburghii, Pinus gerardiana* etc. Gums are substances that are either water soluble or can absorb water - they are not soluble in oil. Chemically they are complex polysaccharides (Carbohydrates). Gums either derived from the resinous sap or from the endosperm of certain seeds, e.g. like Guar Gum, which is derived from the seeds of *Cyamopsis tetragonolubus*, an African herbaceous plant of the pea family. The two important types of gum found in India i.e., Gum arabic and gum tragacanth. The important gum yielding plant species are *Acacia spp., Anogeissus latifolia, Bauhinia retusa, Cochlospermum religiosum, Lannea coromandelica, Pterocarpus marsupium, Sterculia urens* etc.

Terminal Questions

1. Differentiate between gum and resins and oleoresins.
2. Describe the various uses of gum, resin and oleoresins.
3. Describe various gum yielding major plant species.
4. Write in detail about Chir Pine, a resin yielding plant of Uttarakhand.
5. Differentiate between gum arabic and gum trgacanth.
6. Describe some common method of extraction of gums and resins with some examples.
7. Describe the industrial, medicinal and other uses of resin.

References

Indian forest utilization, volume (II).FOREST Research Institute Press, Dehradun.941 pp.

Dwivedi A.P. 1993. Forests: the non-wood Resources. International Book Distributors, Dehradun. 352 pp.

Mehta, T. 1981. Forest Utilization. International Book Distributors, Dehradun. 296pp.

Unit 9 Edible Fruit Plants

Unit Structure

9.1 Learning Objectives

After studying this unit, you should be able to:

- Understand the wild edible plants of Himalayan region
- Know the indigenous uses of wild edible plants

9.2 Introduction

Non wood forest products (NWFPs) have emerged as a vital income-generating and source of employment for rural poor in all parts of the world. There are about 600 species of wild

edible fruit plants found in India. In the Indian Himalaya alone 675 wild edible plant species are found, out of them 344 occur in the west Himalaya. Despite this diversity of wild edibles, limited attempt have been made to assess the status of their occurrence and availability, harvesting trends, and the potential of wild edibles to generate income. In the present section we have tried to document in detail the most promising edible plants that occur in the Himalayan region. A brief description of the other important wild edible plants has also been discussed in brief.

9.3 Important Wild Edible Plants

9.3.1 *Myrica esculenta* (Kaphal)

Myrica esculenta (local name Kaphal), known for edible fruit is a potential income-generating species in the sub-Himalayan region. *M esculenta* is a medium-sized, dioecious, evergreen tree widely distributed between 900–2100 m asl in the Indian Himalaya from Ravi eastward to Assam, Khasi, Jantia, Naga, and the Lushi Hills and extending to Malaya, Singapore, China, and Japan (Osmaston 1927). This species is well known for its edible fruit and other by products, and has emerged as a potential income generating species in Uttarakhand. The popularity of the species can be judged from the fact that local people of the region can earn over Rs. 14.00 lakh/ season from selling the fruits of the species. The bark of *M. esculenta* yields tannin, which is used commercially as tanning and dyeing material. The bark of the plant is astringent carminative and antiseptic. In Khasi hills the bark of this species is used as a fish poison. The species is known for its unique medicinal and industrial uses. Myriconol has been isolated from stem bark, which has lesser toxicity than related rotenone. The bark also contains yellow colouring substances in the form of glycoside, quercitin, β-sitosterol taraxerol and trirterpindiol. Glutamine and aspargine are reported to the principle amino acids in *Myrica* species.

The species of *Myrica* are recognized for their nitrogen fixing capacity (Becking 1977; Benson and Silverster, 1993; Muckun *et al.* 1993). The ecological importance of genus *Myrica* is of being non-leguminous angiosperm, nodulated by *Frankia* spp. Nodulation of *Myrica gale* has been studied well. This species is used as fodder in some parts of Uttarakhand and Himachal Pradesh. The species is extensively used as a fuel throughout the hilly region. The wood has high density with the highest biomass/ ash ratio amongst some of its associated woody species like *Alnus nepalensis*, *Aesculus indica* and *Juglans*

regia etc. the species competes well with other species in its fuel wood value index equaling almost with *Quercus semecarpifolia*.

9.3.2 *Diploknema butyracea* (Cheura)

Cheura (*Diploknema butyracea*) belongs to the family Sapotaceae and popularly known as Indian Butter Tree which is mainly found in Uttarakhand state. This multipurpose tree is also known as Phulwara, Fulwa, Pahari Mahua, Gophat or Indian Butter Tree in Kumaun region of Uttarakhand state. It is a medium size deciduous tree with straight trunk attaining a height of 15-22 m and girth 1.5-1.8m, but in Andaman Islands, it reaches a height of 21-36 m and the girth of 1.5- 2.4 m. Commercially, the Cheura oil extracted from the seeds is marketed as Phulwara Ghee. Cheura is a native of Nepal and distributed from India through Nepal to Philippines and from Uttarakhand eastwards to Sikkim and Bhutan (Sub-Himalayan tracts and outer Himalayan ranges). It also occurs sporadically in tropical moist deciduous, semi-deciduous and evergreen forests of Andaman Islands. It is a fast growing tree borne oilseed and found in the elevation ranges between 400-1400 meters mainly along the sides of ravines and in shady valleys.

Cheura starts flowering in the months of October- November at the age of 8-10 years. Its flowers are either white or yellow colour with a special fragrance. Generally, an alternate bearing has been observed in this tree. The fruits start ripening in June-July. Fruits are oval in shape and initially with green colour which turns light yellow after ripening during June-July. Fruits are harvested during second week of June till July end. Ripened Cheura fruits with grey and light blackish in colour are harvested manually either by hand or locally made bamboo stick. Average fruit yield per annum is about 100-250 kg/tree. The fruits are eaten and are sweet. Cheura is used as food, fodder and medicines in Kumaun hills and called Kalp- Vriksha. Its flowers are rich source of sugar and utilized for preparation of Gur (juggery) like products and for fermentation (alcohol). Cheura products are usually handled by the local farming community in Kumaun and are used mostly for household consumption. The price of the fruit is determined by the dryness of the fruit. Dried fruit fetches a higher price to a raw fruit. Large and fleshy Cheura fruits are considered of good quality. Some of the consumers of the Kumaun region of Uttarakhand have been using Cheura ghee since decades are habituated in the consumption of ghee (NOVOD Report 2002).

9.3.3 *Prunus armeniaca* (Wild Apricot)

The wild apricot (*Prunus armeniaca*) is an important tree borne oilseed crop of mid hills and dry temperate regions of the country. In the Himalayan region, local communities known it by different vernacular names viz. ”Chulli”, “Shara”, “Khurmani”,”Chulu” etc.

The cultivated apricot has its origin in North-Eastern China, whereas, wild apricot appears to be indigenous to India. Wild apricot locally called Chullu is found in the dry temperate region of Uttarakhand. The Chullu tree is about 10-15 m tall with a reddish brown bark. Leaves are ovate to round, approximately 5-9 cm long. Flowers are solitary, white or pinkish about 2.5 cm across, borne singly and appearing much in advance of the foliage. Fruits are around 1.5-4.0 cm across or more and hairy when young but nearly smooth skinned at maturity. The appearances of the ripened fruits are yellowish with light red cheek and nearly glabrous. The flesh is yellow or yellowish orange to firm and sweet. Stone is smooth with a thickened furrowed edge. It starts bearing fruits at the age of 4-5 years and continues to bear well for 50-60 years. The full bearing occurs at about 10-15 years when it yields about 85-100 kg. fruits per tree. The stone yield varies from 12-17 percent of fruits and the kernel yield ranges 3.14 - 4.81 kg/tree. The yield of a full- bearing well maintained plant tree varies from 120-150 kg (NOVOD report, 2006).

Wild apricot fruits generally start maturing during from last week of May and continue up to August end depending upon altitude and location. They are harvested manually by shaking the tree branches and no mechanical harvesting is practiced. Change of surface colour, from full bloom to harvesting and fruit total sugar solids are considered as the best indices of maturity. Fully ripened fruits are harvested for freezing, canning and drying. The fruits should be harvested in morning hours and direct exposure of fruits to sun should be avoided during grading and packaging tree. Apricot is a good source of sugars and vitamin A and contains appreciable amounts of thiamine and iron. Fresh Indian wild apricots yield 86% of edible matter. The wild apricot fruits yield 22-38% percent kernels, which may be sweet or bitter depending on the type. Sweet kernels resemble almonds in taste and are used as its substitute in pastes and confectionery and can be added to apricot jams.

The wild apricot is unfit for table purpose due to high acids and low sugars. It is not processed for any commercial product at present although studies for preparation of sauces and chutney from this fruit have given quite encouraging results. The major portion of the crop

pulp is utilized by the tribals in Himachal Pradesh and Uttarakhand for the preparation of distilled alcoholic liquor. The fruits are highly perishable and can be preserved in a number of ways. They are frozen, candied or made into a paste. In some countries, fruit pulp is cooked and thinly spread on cloth and then rolled and dried and it constitutes an important food. A number of products are prepared from fruits of apricot. Its fruits mixed with those of cultivated types are utilized in Himachal Pradesh in production of number of products like apricot jam, apricot nectar and apricot papad. The strained baby food from pulp is nutritious and a good source of calcium, phosphorus and iron. The oil of seed is edible and oil cake can be used as organic manure.

9.3.4 *Embilica officinalis* (Aola)

Aola (*Embilica officinalis)* belongs to family *Euphobiaceae.* It is native to India and also known as Indian gooseberry. This is a small to medium sized deciduous tree, 8-18 meters high with thin light grey bark, leaves are light green having the appearance of pinnate leaves; flowers are greenish yellow, in axillary fascicles, unisexual, males numerous on short slender pedicels, females few, subsessile, ovary 3-celled; fruits globose, fleshy, pale yellow with six obscure vertical furrows enclosing six trigonous seeds in 2-seeded 3 crustaceous cocci. The tree is found throughout India, the sea-coast districts and on hill slopes up to 200 meters, also cultivated in plains. The fruits are sour, astringent, bitter, acrid, sweet, cooling, anodyne, ophthalmic, carminative, digestive, stomachic, laxative, alterant, aphrodisiac, rejuvenative, diuretic, antipyretic and tonic. They are useful in vitiated conditions of tridosha, diabetes, cough, asthma, bronchitis, cephalalgia, ophthalmopathy, dyspepsia, colic, flatulence, hyperacidity, peptic ulcer, erysipelas, skin diseases, leprosy, haematogenesis, inflammations, anemia, emaciation, hepatopathy, jaundice, strangury, diarrhoea, dysentery, hemorrhages, leucorrhoea, menorrhagia, cardiac disorders, intermittent fevers and greyness of hair.

Aola fruit has been used as valuable ingredient of various medicines in India and abroad. Aola is highly nutritious and is an important dietary source of vitamin C, minerals and amino acids which is resistant to storage and heat damage due to cooking. The edible fruit tissue contains protein concentration 3-fold and ascorbic acid concentration 160-fold compared to that of the apple. The fruit also contains considerably higher concentration of most minerals and amino acids than apples. Glutamic acid, proline, aspartic acid, alanine, and lysine are

29.6%, 14.6%, 8.1%, 5.4% and 5.3%, respectively of the total amino acids. The pulpy portion of fruit, dried and freed from the nuts contains gallic acid 1.32%, tannin, sugar 36.10%; gum 13.75%; albumin 13.08%; crude cellulose 17.08%; mineral matter 4.12% and moisture 3.83%. Aola fruit ash contains chromium, 2.5 ppm; zinc 4 ppm; and copper, 3 ppm.

A small to medium sized deciduous tree, 8-18 meters height with thin light grey bark exfoliating in small thin irregular flakes, leaves are simple, subsessile, closely set along the branchlets, light green having the appearance of pinnate leaves; flowers are greenish yellow, in axillary fascicles, unisexual, males numerous on short slender pedicels, females few, subsessile, ovary 3-celled; fruits globose, fleshy, pale yellow with six obscure vertical furrows enclosing six trigonous seeds in 2-seeded 3 crustaceous cocci. Found throughout India, the sea-coast districts and on hill slopes upto 200 meters, also cultivated in plains. The fruits are sour, astringent, bitter, acrid, sweet, cooling, anodyne, ophthalmic,carminative,digestive, stomachic, laxative, alterant, aphrodisiac, rejuvenative, diuretic,antipyretic and tonic. They are useful in vitiated conditions of tridosha, diabetes, cough, asthma, bronchitis, cephalalgia, ophthalmopathy, dyspepsia, colic, flatulence, hyperacidity, peptic ulcer,erysipelas, skin diseases, leprosy, haematogenesis, inflammations, anemia, emaciation, hepatopathy, jaundice, strangury, diarrhoea, dysentery, hemorrhages, leucorrhoea, menorrhagia, cardiac disorders, intermittent fevers and greyness of hair1-6. Amla is becoming increasingly well known for its unusually high levels of Vitamin C, which is resistant to storage and heat damage due to cooking.

Emblica officinalis is effective in the treatment of amlapitta (peptic ulcer) and in dyspepsia. The fruits exhibit hypolipiadaemic and antiatherosclerotic effects in rabbits and rats. The fruit extract has antimutagenic activity on certain directly acting mutagens in some strains of *Salmonella typhimurium*. The extract of Aola also has antimicrobial properties. Amlaki is an antioxidant with free radical scavenging properties which may be due to the presence of high levels of super oxide dismutase.

9.3.5 *Pyrus pashia* (Indian wild Pear)

Indian wild Pear (*Pyrus pashia)* belongs to family Rosaceae. The cultivation of the pear in cool temperate climates extends to the remotest antiquity, and there is evidence of its use as a food since prehistoric times. Many traces of it have been found in the Swiss lake-dwellings. Pears are native to coastal and mildly temperate regions of the Old World, from

Western Europe and North Africa east right across Asia. They are medium sized trees, reaching 10–17 m tall, often with a tall, narrow crown; a few species are shrubby. The leaves are 2–12 cm long, glossy green to densely silvery-hairy, broad oval to narrow lanceolate in shape. Most pears are deciduous, but one or two species in southeast Asia are evergreen. Most are cold-hardy, withstanding temperatures between −25 °C and −40 °C in winter, except for the evergreen species, which only tolerate temperatures down to about −15 °C. The flowers are white, rarely tinted yellow or pink, 2–4 cm diameter, and have five petals. Flowering takes place in March–April and fruiting in August–September. Like that of the related apple, the pear fruit is a pome, in most wild species 1–4 cm diameter, but in some cultivated forms up to 18 cm long and 8 cm broad; the shape varies in most species from oblate or globose, to the classic pyriform 'pear-shape' of the European Pear with an elongated basal portion and a bulbous end. The pear is very similar to the apple in cultivation, propagation and pollination. Pears and apples cannot always be distinguished by the form of the fruit; some pears look very much like some apples. One major difference is that the flesh of pear fruit contains stone cells (also called "grit"). Another interesting difference is that apples, when placed carefully in water, will float; pears will sink. Fruits are eaten raw. The fruit is usually bletted, but even then it is not sweet. Tasty when fully ripe, even when dried. The fully ripe fruit has a reasonable flavour and, when bletted, is sweet and very pleasant. A mature tree yields about 45kg of fruit per year. The fruit contains about 6.8% sugars, 3.7% protein, 1% ash, 0.4% pectin. Vitamin C is very low, about 1.2 mg per 100g. The juice of the ripe fruit is used in the treatment of diarrhea. Wood - compact fine grained, hard, durable, liable to split and warp during seasoning. Used for small implements, walking sticks and fuel.

9.3.6 *Pinus gerardiana* (Chilgoza Pine)

Pinus gerardiana, known as the Chilgoza Pine**,** is a pine native to the northwestern Himalaya in eastern Afghanistan, Pakistan, and northwest India, growing at elevations between 1800-3350 m. It often occurs in association with Blue Pine (*Pinus wallichiana*) and Deodar Cedar (*Cedrus deodara*). It belongs to family Pinaceae. The trees are 10-20 m tall with usually deep, wide and open crowns with long, erect branches. Trees with a girth of up to 4 meters (approx. 127 cm dbh) are reported. The branchlets are smooth and olive-green. The leaves are needle-like, in fascicles of 3, 6-10 cm long, spreading stiffly. The cones are 10-18 cm

long, 9-11 cm wide when open, with wrinkled, reflexed apophyses and an umbo curved inward at the base. The seeds (pine nuts) are 17-23 mm long and 5-7 mm broad, with a thin shell and a rudimentary wing. Chilgoza Pine is well known for its edible seeds, rich in carbohydrates and proteins. The seeds are sold as dry-fruits by the name "Chilghoza". The seed is eaten as dry fruit chilgoza. The seed is also anodyne and stimulant. The oil obtained from the seeds is used as a dressing on wounds and ulcers; it is also used externally in the treatment of head diseases. The turpentine obtained from the resin of all pine trees is antiseptic, diuretic, rubefacient and vermifuge. It is a valuable remedy used internally in the treatment of kidney and bladder complaints and is used both internally and as a rub and steam bath in the treatment of rheumatic affections. It is also very beneficial to the respiratory system and so is useful in treating diseases of the mucous membranes and respiratory complaints such as coughs, colds, influenza and TB. Externally it is a very beneficial treatment for a variety of skin complaints, wounds, sores, burns, boils etc. and is used in the form of liniment plasters, poultices, herbal steam baths and inhalers.

In Afghanistan, this species is cultivated for its edible seed, and efforts are underway to expand its economic utilization in India. Elsewhere, native populations are ruthlessly exploited, with typically 100% of cones harvested. This harvest pressure is driven by subsistence and for the economic benefits that it provides. As a consequence, there is virtually no natural regeneration of this species except in that very small fraction of its range (about 5%) where the species is inaccessible to significant human exploitation. Besides, Chilgoza pine is also a good soil binder, which ultimately checks the soil erosion in dry temperate zones, where it grows. Though it has not been exploited commercially for oleoresin, owing to its limited distribution and to avoid destruction of the trees in order to get more valuable nuts, yet there is plenty of scope for resin extraction once large areas will be under this species. Reckless cone extraction and almost complete lack of natural regeneration have led Chilgoza pine to brink of extinction, which deserves immediate attention for genetic conservation and improvement. This species is listed as lower risk, near threatened. Overcutting, and intensive grazing causing poor regeneration, may result in the extinction of this pine species. The Himachal Pradesh State Forest Department has tried artificial regeneration of Chilgoza Pine at many places. However, performance of seedlings was found to be very poor.

9.3.7 *Rubus ellipticus*

Rubus is a large genus of flowering plants in the rose family, Rosaceae, subfamily Rosoideae. Raspberries, blackberries, and dewberries are common, widely distributed members of the genus. Most of these plants have woody stems with prickles like roses; spines, bristles, and gland-tipped hairs. The blackberries, as well as various other *Rubus* species with mounding or rambling growth habits, are often called brambles. It is a prickly bramble with long arching stems, 13 ft long. Leaf compound with 3 leaflets, thick, hairy, terminal leaflet 3 inches long by 2.5 inches wide. Flowers white in terminal clusters. Fruit yellow, 0.3 inches long. Among the different Himalayan species of *Rubus*, *R. ellipticus* (Yellow Himalayan Raspberry) is a native to India and South Asia. This shrub, growing up to 2 m tall is clothed with prickles and reddish hairs. The alternate leaves are compound with three round to blunt leaflets 5-10 cm long. The flowers are small, white with five petals. The fruit is a round yellow cluster of druplets easily detaching from the receptacle. Flowering occurs in February-April followed by fruiting. The prickly shrub invades native forests principally in pig-disturbed habitats. The plant has underground shoots that contribute to its spread and allow it to rapidly regenerate following a fire. The fruits are edible and frugivorous birds spread the seeds. A purple to dull blue dye is obtained from the fruit.

The plant is astringent and febrifuge. A decoction of the root, combined with *Girardinia diversifolia* root and the bark of *Lagerstroemia parviflora*, is used in the treatment of fever. The juice of the root is used in the treatment of fever, gastric troubles, diarrhoea and dysentery. A paste of the roots is applied externally to wounds. Both the roots and the young shoots are considered to be a good treatment for colic. The leaf buds, combined with *Centella asiatica* and *Cynodon dactylon*, are pounded to a juice and used in the treatment of peptic ulcers. The juice of the fruit is used in the treatment of fever, colic, coughs and sore throat. The inner bark is used in Tibetan medicine, it is said to have a sweet and sour flavour plus a heating potency. A renal tonic and antidiuretic, it is used in the treatment of weakening of the senses, vaginal/seminal discharge, polyuria and micturation during sleep.

The plant is grown to deter soil erosion and is good for soil conservation. It is easily grown in a good well-drained loamy soil in sun or semi-shade. This plant is cultivated for its edible fruit in southern U.S.A. The fruit is sometime sold in local markets in the Himalayas. Another species of *Rubus (Rubus lasciocarpus)* is a large, rambling, throny shrub upto 3 m high and

2.5 cm in diameter, met within the temperate Himalayas from Kashmir to Sikkim at 1,200-3,000m. It also occurs in the Western Ghat at higher elevations from Kanara southwards. The fruit is dark purple or blackish, round, 0.8-1.3 cm in diameter. It resembles blackberry and is very palatable (Mehta, 1981).

9.3.8 *Aegle marmelos* (Bael)

This is a small to medium sized thorny tree. It is wild in the sub-Himalayan tract, and central and south India; it is often planted all over the plains and foot hills. The fruit is woody, grey or yellowish, round, 5 - 17.5 cm in diameter, containing numerous seeds embedded in a mass of sweet, orange coloured aromatic pulp. The ripe fruit is sweet and cooling. It is used in the form of *sherbet* or for making jams and preserves (Dwivedi, 1993)..

9.3.9 *Agave Americana* (Century plant)

This plant is a native of America, found in India only as an ornamental plant in gardens. On cutting of the young flower head, a large quantity of juice is obtained. This, when fermented yields *pulque*, the national drink of Mexico; the distilled spirit is known as *mescal*. In times of scarcity, the flowering stalk and the pulp of the lower part of the leaf are used as food.

9.3.10 *Anthocephalus cadamba* (Kadam)

This is large tree occurs in the sub- Himalayan tract from Nepal eastwards to Assam and in the south in the Northern Circars and Western Ghats. A spirit is distilled from the flowers. The ripe fruits are edible.

9.3.11 *Artocarpus heterphyllus* (Kathal)

This is a large evergreen tree found wild in the forests of the Western Ghats, but is cultivated more or less throughout India. The fruit is large, oval, tubercled, 0.3-0.6 m long by 0.2-0.4 m broad, hanging by stalk from the trunk and larger branches. It is actually an aggregation of the fruit produced by a number of flowers. The individual fruits are often called flakes, which consists of a seed surrounded by a pulpy mass of luscious tissue. Unripe jack fruit is used as a vegetable or made into pickles. The ripe fruit is eaten or made into preserves. The seed is eaten as a vegetable or roasted and eaten as such (Dwivedi, 1993).

9.3.12 *Artocarpus lakoocha* (Lakooch)

This is a large deciduous tree, found in the outer hills of Kumaun and in Sikkim, Assam, Bihar, Orissa, Madhya Pradesh, The Western Ghats and The Andamans. The unripe fruits are made into pickles. The ripe fruit, which has a sweetish taste, is eaten.

9.3.13 *Bauhinia vahlii*

This is a gigantic climber abundantly distributed in the sub-Himalayan region upto 900 m and also found in Assam, Madhya Pradesh and Bihar. The seeds are eaten raw or fried. When ripe they taste like cashew-nuts. The roots are boiled and eaten like potato in times of scarcity.

9.3.14 *Bauhinia variegata*

This is a moderate- sized deciduous tree, found in the sub-Himalayan tract from Jhelum eastward, as also in dry deciduous forests of eastern, central and southern India. It ascends to 1,200 m, preferring low hills. It is also cultivated as an ornamental tree. The flower buds and leaf buds are edible as vegetable.

9.3.15 *Diospyros melanoxylon* (Coromandel ebony)

This is a medium sized to large tree, up to 1.8m in girth and 15m high, occurring in the Indian Peninsula, extending northwards to parts of Madhya Pradesh, Orissa and Bihar. The fruit is globose, 2.5- 4.0 cm in diameter. The fruit contains a sweetish- astringent pulp which is much relished by the local population.

9.3.16 *Juglans regia* (Walnut)

This is a large deciduous tree, found in the temperate Himalayas from Kashmir to Bhutan at 900-3000 m and extensively cultivated in the region. The fruit is ellipsoidal about 5 cm long with a green leathery aromatic fruit-coat enclosing a 2- valved woody nut inside which is the edible kernel. The wild variety has a very small kernel and is rarely eaten. The fruits of cultivated varieties contain large kernels which from an important article of diet of the local people. A sweet oil expressed form the kernels is used for culinary purpose in the hills.

9.3.17 *Madhuca indica* (Mahua)

This is a large deciduous tree. It is found all over India in deciduous forests and is often planted in Central and Northern India. The oil extracted from the kernels of the fruit is largely used in Central and Southern India for culinary purposes and as a cheap substitute for ghee. The fruit is sometimes eaten. The succulent flowers are eaten raw or cooked and are also made into sweetmeats. Average annual yield of flowers per tree is about 100 kilograms. It is estimated that some 25,000 tonnes are gathered in India every year. A spirit distilled from the flowers is consumed by the local people. Alcohol is also made from the flowers on a large scale.

9.3.18 *Madhuca longifolia*

This is a large tree found in the forests of peninsular India from the Konkan southwards to Kerala and in the Anamalais and the Circars at low elevations. The uses of flowers, fruits and seeds are the same as for *M. indica*. The tree is often cultivated in parts of Tamil Nadu.

9.3.19 *Mangifera indica* (Mango)

This is a large evergreen tree found in moist forests of southern India and elsewhere. It is also extensively cultivated as an avenue tree and in gardens and near villages up to 1,200 m elevation. The fruits are ovoid, 5-15 cm long, fleshy, compressed, containing a hard and fibrous stone. The mango is one of the most important and popular fruits of India and is consumed both ripe and unripe in many different ways not only as a delicacy but also as a food. It is extensively cultivated in orchards, with numerous named varieties. The mango kernel is also used as a food in times of scarcity. Ripe fruits of the wild mango, found in the forests of southern India, are not edible; tender fruits are, however, much in demand for pickling.

9.3.20 Morchella esculenta (Morel)

This is fleshy fungus is abundantly found in Kashmir, as also in Chamba, Kangra and elsewhere in Himachal Pradesh and parts of Uttarakhand. This is most important among the Indian edible fungi. It is eaten in curries and pulaos, fresh or dried.

9.3.21 *Syzygium cumini* (Black plum)

This is a large evergreen tree, found all over India and is often planted as an avenue tree or in gardens. The fruit, which is sub acid and rather astringent, is largely eaten by all classes of people. It improves in taste when shaken with a little salt. A wine resembling port in taste and colour is prepared from the fruits. Vinegar is also manufactured.

9.3.22 *Tamarindus indica* (Imli)

This is a large tree cultivated throughout tropical India. It is self-sown in waste places and in forest lands all over the Peninsula. The acid pulp of the ripe fruit is used extensively as an ingredient in food preparation throughout India. It can also be used for making jams and syrups. The seeds with the outer coat removed, contain starch and can be eaten after boiling or roasting. Commercial starch is made from the seeds. The flowers and tender leaves are made into curries and chutneys.

9.3.23 *Zizyphus nummularia*

This is a gregarious, tomentose, throny shrub, occasionally growing into a small tree 4.5 m high and 15 cm in girth. It is found in the arid and dry regions of Punjab, Rajasthan and the Peninsula. The ripe fruits are eaten. The seeds are soaked in water and the decoction strained and drunk as a cooling beverage and as a great thirst-quencher.

9.3.24 *Ziziphus oenoplia*

This is a straggling or climbing thorny shrub, found very commonly throughout the hotter parts of India from the Punjab and N.W. Himalayas to Assam and South India. The fruits are small, black, round, about 0.6 cm in diameter, with a stone inside. The sweet, somewhat acid, fruits are eaten locally.

9.4 Summary

There are several wild edible plant species found world wide. In India 600 species of wild edibles are found and still more are discovered gradually. Of the 675 wild edible plant species in the Indian Himalaya, 344 occur in the west Himalaya. The important wild edible fruit plants are *Myrica esculenta*, *Prunus armeniaca, Diploknema butyracea, Embilica officinalis*, *Pinus gerardiana*, *Pyrus pashia, Rubus ellipticus* etc. All species have their own food and medicinal value. These species can be instrumental in enhancing the livelihood

options in the Himalayan region. However, most of these species are facing the danger of their over-exploitation from the nature. Attempts are therefore required to increase their population in wild and also cultivating them in wasteland.

Terminal Question

1. Give a brief description of wild edible fruit plants found in India.
2. Describe in detail the characteristics and importance of any five of the wild edible fruit plants found in Uttarakhand.
3. How can the wild fruit plants useful for poverty alleviation of rural people?
4. Describe the nutritious and medicinal value of some important wild fruit plants of India.

References

Dwivedi A.P. 1993. Forests: the non-wood Resources.IBD, Dehradun .352pp

Indian forest utilization, volume (II).FRI Press, Dehradun.941pp

Osmaston, A.E. (1927). A Forest Flora of Kumaun. International Book Distributer, Dehradun.

Becking, J.H. (1977). Dinitrogen- fixing association in higher plants other than legume. In Hardy, R.W.F. and Sibber, W.S. (eds). A treatise on denitrogen fixation, sec.3 (Biology), Wiley-Inter Science, New York.

Shah, S. (2005). Regeneration and nursery techniques of *Myrica esculenta.* Ph.D. Thesis, Kumaun University, Nainital.

Benson, D.R. and Silverster, W.B. (1993). Biology of Frankia strains actinomycete symbionts of actinorhizal plants. Icrobiological Review, 57:293-319

Muckun, I.R.; McNaughton, S.J.; Raynal, D.J. and Loepold,D.J. (1993). Comparative foliage and twig chemistry of co-occurring Myrica gale and Chamaedaphne calyculata. Canadian Journal of Botany, 71: 129-135.

NOVOD Report (2002). Natural Resource assessment and regeneration status of Diploknema butyracea. Submitted by Department of Forestry, Kumaun University, Nainital

NOVOD Report (2006) National Network on integrated development of Wild apricot and Cheura. Submitted by Department of Forestry, Kumaun University, Nainital

Dwivedi A.P. 1993. Forests: the Non-wood Resources. IBD, Dehradun .352pp

Mehta,T. 1981. Forest Utilization. IBD, Dehradun.296pp.