Grapes

1. Introduction :

Grapes (*Vitis vinifera*) belonging to the Vitaceae family, originated in Western Asia and Europe. It was introduced to India by the Persian invaders in 1300 A. D. Grapes is a non-climacteric fruit that grows on the perennial and deciduous woody climbing vine. Grapes is a cross pollinated vine with simple, lobed, cut or toothed leaves (seldom compound) with racemes of greenish flowers, the fruit consisting of watery or fleshy pulp, stones and skin, four-seeded.

Grapes can be eaten as fresh or used for making jam, juice, jelly, vinegar, wine, grape seed extracts and grape seed oil. Approximately 71% of world grape production is used for wine, 27% as fresh fruit, and 2% as dried fruit. However, in India, 90% of the grape is used for table purpose, even though wine making has made strides. The rest of the grape is used mostly for raisin.

2. International scenario :

Grapes occupy a predominant position in terms of world fruit production, accounting for about 16% of the global fruit production. The total world production of grapes is estimated to be about 68.9 million tonnes, next only to citrus and bananas and is followed by apples. The major grape producing countries are Italy, France, Spain, U.S.A, Turkey, Argentina, Iran, Portugal, South Africa and Chile. The area and production of grapes in some of the major grape growing countries is given in Table 1.

Table 1. Area and Production of grapes in major producing countries (2006)

Name of the country	**Area ('000 ha)**	**Production ('000 t)**
Spain	1200.0	6401
France	842.0	6692
Italy	755.0	8325
India	60.2	1546
World	7399.5	68952

Source : FAOSTAT The world trade in fresh grapes during 2006 is to the extent of 32.60 lakh tonne valued at Rs.22979 crore.

3. National Scenario :

The annual production of fresh grapes in India during the year 2006-2007 was to the tune of 16.67 lakh tonne from an area of 63600 ha. India ranks first in productivity (25.69 t/ ha) against the world productivity of 9.32 t/ha and also in terms of highest recorded yield of 100 t/ha. Cultivation of grapes in the country is very much localized, being confined primarily to four states , viz., Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu, which together account for more than 90 percent of the area and production. The statewise area, production and productivity of grapes during is given in Table 2 below.

Table 2. State wise area, production and productivity of grapes (2006-07)

Sl. No.	State	Area ('000 ha)	Production ('000 t)	Productivity (t/ha)
1	Andhra Pradesh	2.50	51.80	20.72
2	Karnataka	10.80	199.00	18.43
3	Maharashtra	45.40	1284.20	28.29
4	Punjab	1.10	30.70	27.91
5	Tamilnadu	2.80	91.60	32.71
6	Other states	1.00	10.40	10.40
	All India	63.60	1667.70	26.22

Source : NHB database Grape exports from India started in the year 1991 with the initiation of economic liberalisation. The export of grapes during the year 2006-07 was of the order of about 85897 t (which amounted to only 5.1 % of total production) fetching an export earning of Rs. 301.92 crore. The major importers of Indian grapes are UK, Netherlands, Germany, USA, UAE, Saudi Arabia, Qatar, Oman, Bahrain, Sri Lanka, Bangladesh, Mauritius, Singapore and Hongkong. Out of the total exports, 90% is to the Middle East, 8% to the European Union and the rest to South East Asian countries. Though the harvesting season of grape in India starts from January and extends to October, the export season of grapes spans from January to April. During this period, South Africa and Israel are the main competitors. The export of fresh grapes from India during the last three years is given in Table 3.

Table 3. Export of Fresh Grapes from India

Sr. No.	Year	Quantity (t)	Value (Rs. in crore)
1	2004-05	39338	128.44
2	2005-06	54049	214.60
3	2006-07	85897	301.92

Source : DGCIS report Grape cultivation for export is mainly done as per EUREPGAP standards where the pesticide residues should be within permissible limit prescribed by European Union. Organic cultivation of grape is picking up in the grape growing areas. Being a new initiative, data on area and production of organic grapes are not available. As it is in a nascent stage, no

information is available with the Research Institutes and Grower's Association such as National Research Centre (NRC) for Grape and Maharashtra Grape Growers' Association.

4.Organic Farming :

Organic farming is a crop production method respecting the rules of the nature. It maximises the use of onfarm resources and minimises the use of off-farm resources. It is a farming system that seeks to avoid the use of chemical fertilisers and pesticides. In organic farming, entire system i.e. plant, animal, soil, water and micro-organisms are to be protected. The guidelines for organic farming is enclosed in **Annexure I**.

5.Organic Production of Grapes :

5.1Climate

The climatic factors such as temperature, occurrence of frost, rainfall and relative humidity play a vital role for commercial cultivation of grape. Generally grape requires a hot and dry climate. Regions with high rainfall and humidity is not conducive for grape cultivation. Hence the coastal districts of the state are not suitable for grape production. Grape is successfully grown in regions of Maharashtra with a temperature range of 150C to 400C and rainfall of 50 to 60 cm. The weather should be clear for about 3-4 months during the cropping period. Cloudy weather, high humidity low temperature and rain during flowering and berry development are detrimental as they promote spread of diseases.

5.2 Soil

Although grape can adapt to a variety of soils, it grows and performs best in deep medium-textured soils (loams and sandy loams) with good drainage and low salt content. Salinity is the major hindrance in the development of grapes. It grows well in soils with a pH range of 6.5 to 7.5.

5.3 Propagation

Development of salt resistant rootstocks like Dogridge and Salt Creek has given an impetus for area expansion under grape in saline areas. Most of the new vineyards are established on Dogridge rootstocks in the state of Maharashtra. The rootstocks are supplied by NRC Grapes, Maharashtra Grape Growers' Association etc. Some of the progressive farmers produce rootstocks for their own use and sale. The mother plants are available with NRC Grapes and farmers' field. The rootstocks are raised by planting hard wood cuttings on flat beds at desired spacing, depending upon the variety and method of training.

5.4 Varieties

The main varieties grown under organic cultivation in the state are Thompson Seedless, Sharad Seedless and Tas-A-Ganesh.

5.5 Spacing

Spacing varies with variety and soil fertility. Generally under organic cultivation, spacing of 2.5 m x 1.5 m, 2.75 m x 1.50 m and 3.0 m x 1.5 m are followed. For this model scheme, a spacing of 2.75 m x 1.50 m with a plant population of 2425 plants/ha is considered.

5.6 Land preparation

The land is prepared by ploughing it twice and harrowing it thrice.

5.7 Planting

Pits of 90 cm x 90 cm x 90 cm are dug and filled with soil and well decomposed FYM/Compost @ 55 t/ha. The pits are then irrigated in order to allow the soil to settle. Rectangular system of planting is adopted for growing grape.

5.8 Training

Training is an important operation in grapes. It helps to maintain the stature and spread of the vine and facilitates operations like pruning, intercultivation, spraying and harvesting. There are many systems of training. The common systems in India are Bower, Kniffin, Telephone, Trellis and Head system. Under the climatic conditions of Maharashtra, Bower and Trellis system has been found to be the best for commercial varieties like Thompson seedless, Sharad Seedless and Tas-A-Ganesh. In Bower system, a bower of 2.1 m height is erected using stone pillars as support and galvanized iron wire of 8 and 10 guage thickness for mesh. One vigorous growing shoot is selected by nipping off other shoots and this single shoot is allowed to grow up straight with the support of bamboo or plastic wire stake.

All the axillary shoots are pruned and the main growing shoot pinched off at 15 cm, below the pandal level. Two shoots arising below the cut area are allowed to grow in opposite direction on the wires overhead. These two shoots develop into main arms. On the main arms, side shoots are allowed to grow at regular intervals of 40 to 45 cm. These side shoots are called secondaries and tertiaries or canes from which fruiting spurs develop. The arms and secondaries form the permanent frame work of the vine.

The main arm should be trained towards East and West direction so as to reduce damage due to sunburn during summer months especially after February-March pruning. The entire space allocated for each vine is covered in a gradual manner by intermittent pinching of the primary arms and secondaries, not allowing them to grow more than 60 cm at a time. As they grow, the shoots are tied with jute twine and all tendrils are removed.

5.9 Pruning

Removal of any vegetative part in a vine is called pruning. It is a critical operation in grape cultivation. Therefore much care and precision needs to be exercised in pruning a vine. The main

objective of pruning grapevine is to increase productivity, facilitate interculture operations and maintain desired vine framework and vitality of the vine for consistent productivity. In organic grape cultivation, the vines are forced to undergo rest for about a month immediately after harvest.

This helps in storing the food material in the mature parts of the vine. The canes are cut back in April by keeping 1-2 buds which develop into canes in 4-5 months. The removal of dried canes is called ‘back pruning’ or ‘growth pruning’. In the month of September-October these canes are pruned for fruiting. This pruning is called ‘forward pruning’ or ‘winter pruning’. Vines, which have attained the age of one year can be subjected to this pruning.

5.10 Manuring

Manuring is done by applying FYM at the rate of 55 t/ha. Biofertilizers like Azatobacter, Phosphate Solubilizing Bacteria(PSB), Effective Microorganism (EM), Neem cake and vermiwash are being used to supplement the nutrient requirement of crop. Trichoderma, Azatobacter and PSB are applied at the rate of 25 g/plant. Neem cake is applied at the rate of 1.25 t/ha. Jeevamrut is prepared by adding 10 kg cow dung, 5 l cow urine, 2 kg black jaggery, 2 kg ground pulses powder, handful of bund soil in 200 l of water. The solution is kept for 2 to 7 days in shade for fermentation. During the fermentation, the solution is stirred daily. To improve the quality of grapes, a solution of sugar, humic acid and coconut water is sprayed at bud development stage.

5.11 Irrigation

A fully grown vine requires about 1000 l of water in winter and 2000 l in summer season immediately after pruning and application of fertilizer. Vines are given 2 to 3 summer irrigation at 3-4 days interval. During winter, an interval of 8-10 days is maintained between two irrigation. The vines are to be irrigated when the top 5 cm soil is dry in winter and 3.5 cm top soil is dry in summer. During berry development stage irrigations are given at weekly intervals and the same is withheld 10 days before harvesting to improve quality.

5.12 Weeding

In the vineyards, weeding is generally done mechanically. Frequent weeding is required to allow feeder roots to absorb the nutrients and moisture without any competition. Bullock drawn or tractor drawn implements can be used for inter-cultivation and weed control. Weeding is done 3-4 times in a year.

5.13 Shoot Pinching

Shoot pinching is a part of pruning mainly done to promote fruit bearing and regulate the current season’s growth. This is done when the main shoot attains 7-8 leaf stage. During pinching, the tip of the mature shoot is pinched by retaining only five nodes. As a result, the terminal bud

along with 1-2 laterals resumes growth. These laterals are called sub-canes. Buds up to the third node from the base on the sub-cane are observed to be bearing fruits.

5.14 Pests and Diseases

The major pests affecting the grape crop are flea beetles, thrips, mealy bugs and leaf hoppers. The major diseases are downy mildew, powdery mildew and anthracnose. The schedule of plant protection measures are given below:

Pest/disease	**Plant protection measures - Spraying of**
Downy mildew/ Powdery mildew	Trichoderma, 1% Bordeaux mixture + Dasparni arka + Gomutra<
Mealy bug	Cowdung urine
Thrips	Dasparni arka
Anthracnose	Solution of acacia leaves

The dasparni arka is prepared by adding 25 kg leaves of Neem and 2 kg leaves each of custard apple, Nirgudi, Kaner, Cotton, Papaya, Castor, Karanj, Gudwel, Drumstick in 200 l of water. In the solution, 5 to 10 l of gomutra and 2 kg of green chillies are added. The solution is kept for 15-20 days for fermentation. The stock solution is prepared by filteration through muslin cloth. The spraying is done by adding 5 l of stock solution in 200 l of water.

5.15 Harvesting

Grape is harvested almost all the year round. If not all the varieties, one or the other variety is always available at any given time of the year. However, in Thompson Seedless and its clones, major part of the produce is harvested during March-April from the hot tropical region contributing to more than 70% of the total harvest.

5.16 Yield

An average yield of 15 -20 t/ha is obtained during the second and the third year onwards which increases upto 25 t/ha from the fourth year onwards. The economic life of grape is fifteen years and harvesting of fruits can be done upto an age of 15 years.

6. Linkages :

Marketing of grapes is done through APMC market located in taluka/district level or through direct purchase by vendors. There is great demand for grapes in the Indian market. However, marketing of organic grapes with distinct demarcation from non-organic grapes is not there so far. National Research Centre for Grapes, Pune has been involved in problem oriented research activities with respect to Grapes.

7. Financial Aspects :

7.1 Sale price

Although the farmers realise a sale price ranging between Rs. 10000/t to Rs. 15000/t of organic grape based on export or domestic markets, a conservative estimate of Rs. 12000/t is considered for this model.

7.2 Unit Cost

The unit cost estimated in this model scheme is Rs. 432400/- per ha, capitalised upto the second year. The break-up of unit cost is given in **Annexure II**.

7.3 Margin Money

The percentage of margin / down payment to cost of development prescribed is 5, 10 and 15 % for small, medium and large farmers respectively. The rest of the cost of development will be provided as bank loan. Margin considered in the present model is 10 %.

7.4 Bank Loan

Bank loan of 85 - 95 % shall be available from the financing institution. Bank loan considered in the model is 90%.

7.5 Rate of Interest

The rate of interest to be charged to the ultimate borrower would be guided by RBI guidelines issued from time to time. However, the ultimate lending rate has been considered as 12 % for working out the bankability of the model scheme.

7.6 Security

Banks are guided by RBI guidelines issued from time to time in this regard.

7.7 Financial Analysis Results of financial analysis are indicated below :

- NPW at 15% DF : Rs.345540
- BCR at 15% DF : 1.55 : 1
- IRR : 42.30%

The details of financial analysis is presented in **Annexures III-V**

7.8 Repayment

The bank loan with interest is repayable within seven years with one year grace period as shown in **Annexure-VI**. The interest deferred during the first year can be collected during the second year.

8. Conclusion :

In view of the above, it can be concluded that organic cultivation of grapes is a technically feasible, financially viable and bankable activity.

Tumeric

1. Introduction

Turmeric *(Curcuma longa L)*, the ancient and sacred spice of India known as 'Indian saffron' is an important commercial spice crop grown in India. It is used in diversified forms as a condiment, flavouring and colouring agent and as a principal ingredient in Indian culinary as curry powder. It has anti cancer and anti viral activities and hence finds use in the drug industry and cosmetic industry. 'Kum-kum', popular with every house wife, is also a by-product of turmeric. It finds a place in offerings on religious and ceremonial occasions. A type of starch is also being extracted from a particular type of turmeric. The increasing demand for natural products as food additives makes turmeric as ideal produce as a food colourant.

Turmeric is the dried rhizome of *Curcuma longa L*., a herbaceous perennial belonging to the family Zingiberaceae and a native of South Asia particularly India. The plant is propagated from rhizomes. The leaves are long, broad, lanceolate and bright green. The flowers are pale yellow and borne on dense spikes. The pseudostems are shorter than leaves. The rhizomes are ready for harvesting in about 7 to 9 months after planting.

2. International scenario

India is the largest producer, consumer and exporter of turmeric in the world. Other major producers are Thailand, other Southeast Asian countries, Central and Latin America and Taiwan. The global production of turmeric is around 11 lakh tonnes per annum. India dominates the world production scenario contributing 78 % followed by China(8%), Myanamr(4%) and Nigeria and Bangala Desh together contributing to 6% of the global production.

India is the global leader in value added products of turmeric and exports. Other major exporters are Thailand, other Southeast Asian countries, Central and Latin America and Taiwan. United Arab Emirates(UAE) is the major importer of turmeric from India accounting for 18% of the total exports followed by United States of America(USA)with 8%. The other leading importers are Bangaladesh, Japan, Sri Lanka, United Kingdom, Malaysia, South Africa, Netherland and Saudi Arabia. All these countries together account for 75% of the world imports and Asian

countries are the main suppliers to the entire world. The remaining 25% is met by Europe, North America and Central and Latin American countries. United States of America imports 97% of its turmeric requirement from India and the remaining portion from the Islands of the Pacific and Thailand. Out of the total global production UAE accounts for 18% of the imports, followed by USA(11%), Japan(9%), Srilanka,UK, Malaysia together accounting for 17%.

3. National scenario

The state wise total area and production of turmeric is given in Table 1.

Table 1. Statewise Area, production and productivity of turmeric in India (2005-06)

State	Area (ha)	Production (tonnes)	Productivity (tonnes/ha)
Andhra Pradesh	69,990	518,550	7.41
Tamil Nadu	25,970	143,358	5.52
Orissa	24,020	57,090	2.38
West Bengal	11,844	25,049	2.11
Assam	11,700	8,400	0.72
Maharashtra	6,760	8,427	1.25
Karnataka	5,410	26,380	4.88
Bihar	3,533	3,383	0.96
Kerala	3,384	8,237	2.43
Himachal Pradesh	1,640	1,140	0.70
Gujarat	1,400	16,510	11.79
Tripura	1,108	3,750	3.38
Uttar Pradesh	979	4,364	4.46
Meghalaya	850	9,000	10.59
Nagaland	850	9,000	10.59
Chhattisgarh	740	640	0.86
Madhya Pradesh	670	610	0.91
Sikkim	670	3,600	5.37
Uttarakhand	466	3,970	8.52
Arunachal Pradesh	427	1,631	3.82
Manipur	200	140	0.70
Mizoram	200	1,650	8.25
Andaman & Nicobar	92	642	6.98
Rajasthan	90	230	2.56
Jammu & Kashmir	12	12	1.00
TOTAL	173,005	855,763	4.95

Source : Spices Board

Indian turmeric is considered the best in the world market because of its high curcumin content. India exported 5150 tonnes of turmeric valued at Rs.164.80 crores during 2006-07. From India's total turmeric exports, 65% exported to UAE, USA, Japan, Srilanka, UK, and Malaysia. The institutional sector in the West buys ground turmeric and oleoresins, while dry turmeric is preferred by the industrial sector.

Turmeric is available in two seasons in India *i.e.*,February to May and August to October. The various varieties of turmeric that are traded in India are Allepey Finger (Kerala), Erode Turmeric (Tamil Nadu), Salem Turmeric (Tamil Nadu), Rajapore Turmeric (Maharashtra), Sangli Turmeric (Maharashtra), Nizamabad Bulb (Andhra Pradesh) *etc.* The major trading centers of turmeric are Nizamabad, Dugirala in Andhra Pradesn, Sangli in Maharshtra and Salem, Erode, Dharmapuri and Coimbatore in Tamil Nadu.

4. Organic farming :

Organic farming is a crop production method which encourages sustainable agriculture by enhancing the biological cycles in nature. It is targeted at producing healthy, nutritive, pollution free food maximising the use of on farm resources and minimising the use of off-farm resources. It seeks to avoid the use of chemical nutrients and pesticides. The guidelines for organic farming of spice crops is enclosed in Annexure I.

5. Organic production :

5.1 Climate and soil

Turmeric requires a warm and humid climate. It can be grown in diverse tropical conditions from sea level to 1500mm above MSL within a temperature range of 20-30°C with a rainfall of 1500 mm or more per annum or under irrigated conditions. Though turmeric thrives in different types of soil ranging from light black loam, red soils to clayey loams, rich loamy soils having natural drainage and irrigation facilities are the best. Turmeric cannot stand water stagnation or alkalinity.

Turmeric can be cultivated organically as an intercrop along with other crops provided that all the companion crops are also organically grown. In some areas, turmeric is grown as an intercrop with mango, jack and litchi and on the west coast with coconut and arecanut.

Often castor and pigeon pea are planted on the borders and on irrigation channels to provide shade

5.2 Rotation

Turmeric is grown in rotation with sugarcane, chilli, onion, garlic, elephant foot yam, vegetables, pulses, wheat, ragi and maize. It is cultivated as a subsidiary crop to ginger in some areas and in other areas with chilli and quick-growing vegetables.

5.3 Buffer zone

In order to cultivate turmeric organically a buffer zone of 25 to 50 feet shall be maintained if the neighbouing farms are non-organic. The produce from this zone shall not be treated as organic. Being an annual crop, turmeric requires a conversion period of two years.

5.4 Land preparation

While preparing the land, minimum tillage operations may be adopted. Beds of 15 cm height,1 m width and of convenient length may be prepared giving at least 50 cm spacing between beds. In the case of the irrigated crop, ridges and furrows are prepared and the rhizomes are planted in shallow pits on the top of the ridges. Spacing generally adopted is 45-60 cm between the ridges and 15-20 cm between the plants. Solarisation of beds is beneficial in checking the multiplication of pests and diseases causing organisms. The polythene sheets used for soil solarisation should be kept away safely after the work is completed.

5.5 Planting material

Carefully preserved seed rhizomes free from pests and diseases which are collected from organically cultivated farms should be used for planting. However, to begin with seed material from high yielding local varieties may be used in the absence of organically produced seeds. For sowing, both the mother - rhizomes and fingers are used. The fingers are cut into 4 - 5 cm long pieces, and the mother rhizomes are planted as such or split into two; each having at least one sound bud. The seed is sometimes sprouted under moist straw before sowing.

5.6 Varieties

A number of cultivars are available in the country and are known mostly by the name of the locality where they are cultivated. The cultivated varieties show considerable variation in size and colour of the rhizomes and curcumin content. More than 5 per cent curcumin content and lemon yellow, orange or orange yellow coloured turmeric powder are preferred in the international market. There are two dominant types of turmeric found on the world market: 'Madras', and 'Alleppey', both named after the regions of production in India. The orange-yellow flesh Alleppey turmeric is predominantly imported by the United States, where users prefer it as a spice and a food colorant. Alleppey turmeric contains about 3.5% to 5.5% volatile oils, and 4.0% to 7.0% curcumin. In contrast, the Madras type contains only 2% of volatile oils and 2% of curcumin. The Madras turmeric is preferred by the British and Middle Eastern markets for its more intense, brighter and lighter yellow color.

The Patna variety is noted for its deep colour. Of the two types cultivated in Maharashtra, 'Lokhandi' has bright coloured hard rhizomes and the other has light-coloured soft rhizomes. The

popular commercial varieties in Andhra Pradesh are 'Duggirala' of Guntur and 'Tekurpeta' which has long, stout, smooth and hard fingers. 'Kasturi Pasupa' of the Godavari Delta, the 'Armoor' type of the Nizamabad area and the 'Chaya Pasupa' are the other important varieties of Andhra Pradesh. In Orissa important varieties cultivated are Roma, Suroma, Ranga and Rasmi. Lakadong variety of ginger is grown in Meghalaya and this variety is popular for high curcumin content of 5 to 5.05%.

5.7 Planting

At the time of planting 25 g powdered neem cake mix well with soil is applied in each pit taken at a spacing of 20-25 cm within and between rows. Seed rhizomes may be put in shallow pits and covered with well rotten cattle manure or compost mixed with *Trichoderma* (10 gm compost inoculated with *Tricoderma*). A seed rate of 1000 kg rhizomes is required for planting one acre of land. As an intercrop in a fruit-garden seed rate may be as low as 125 - 200 kg per acre. Turmeric can be planted during April-July with the receipt of pre monsoon showers.

5.8 Cultural practices

Mulching the beds with green leaves is an important practice beneficial to this crop when planting is done on raised beds. This helps to enhance germination of seed rhizomes, prevents wash off of soil due to heavy rains, adds organic matter to the soil and conserves moisture during the dry period. Care may be taken to include a mix of leguminous crops with leaves rich in nitrogen content, phosphorus content like Acalypha weed and potassium content like Calotropis as mulch. The first mulching is to be done at the time of planting with green leaves @ 4-5 tonnes per acre. It is to be repeated again @ 2 tonnes / acre at 50th day after planting. Cow dung slurry may be poured on the bed after each mulching to enhance microbial activity and nutrient availability. Weeding may be carried out depending on the intensity of weed growth. Such materials may be used for mulching. Proper drainage channels are to be provided in the inter rows to drain off stagnant water.

5.9 Manuring

Turmeric needs heavy manuring. Application of well rotten cow dung or compost from own farm @2-3 tonne /acre may be given as basal dose while planting rhizomes in the pits. In addition, application of neem cake @ 0.8 tonnes/ acre is also desirable.

5.10 Plant protection

The underlying approach for pest and disease management under organic production is based on a range of preventive and other management strategies to minimize the incidence of pests and diseases. Regular field surveillance, adoption of phyto sanitary measures combined with understanding the life cycles of both pest and its predators will allow decisions to be made

regarding the need to intervene for managing the pest population.

5.10.1 Pests

If shoot borer incidence is noticed, such shoots may be cut open and larve picked out and destroyed. If necessary neem oil 0.5% may be sprayed at fortnightly intervals.

5.10.2 Diseases

No major disease is noticed in turmeric. Leaf spot and leaf blotch can be controlled by restricted use of Bordeaux mixture 1%. Application of Trichoderma at the time of planting can check the incidence of rhizome rot.

5.11 Harvesting and curing

The crop has to be harvested at the right maturity and is ready for harvesting in about 7 to 9 months after sowing depending upon the variety. The aromatic types mature in about 7 months, the intermediate types in about 8 months and the late types in about 9 months.

Usually the land is ploughed and the rhizomes are gathered by hand picking or the clumps are carefully lifted with a spade. Harvested rhizomes are cleaned of mud and other extraneous matter adhering to them. The average yield per acre is 8 -10 tonnes of green turmeric.

Fingers are separated from mother rhizomes. Mother rhizomes are usually kept as seed material. The green turmeric is cured for obtaining dry turmeric. Curing involves boiling of rhizomes in fresh water and drying it in the sun. No chemical should be used for processing. The cleaned rhizomes are boiled in copper or galvanized iron or earthen vessels, with water just enough to soak them. Boil till the fingers/mother rhizomes become soft. The cooked turmeric is taken out of the pan by lifting the troughs and draining the water into the pan itself. The same hot water in the pan can be used for boiling the next lot of raw turmeric which is already filled in the troughs. Alternatively, rhizomes may also be cooked using baskets with perforated bottom and sides. The mother rhizomes and the fingers are cured separately. The cooking of turmeric is to be done within 2-3 days after harvest.

The cooked fingers/mother rhizomes are spread on bamboo mats or cement floor under the sun for drying. The rhizomes are spread in 5-7 cm thick layers for desirable colour of the dried product. During night time the material should be heaped or covered. It may take 10-15 days for the rhizomes to become completely dry. Artificial drying using cross-flow hot air at a maximum temperature of 60°C is also found to give a satisfactory product. In the case of sliced turmeric, artificial drying has a clear advantage giving brighter coloured product than sun drying which

tends to suffer from surface bleaching. The recovery of dry product varies from 20-25% depending upon the variety and the location where the crop is grown. Dried turmeric has a poor appearance and rough dull colour outside the surface with scales and root bits. Smoothening and polishing the outer surface by manual or mechanical rubbing improves the appearance.

Manual polishing consists of rubbing the dried turmeric fingers on a hard surface. The improved method is by using hand-operated barrel or drum mounted on a central axis, the sides of which are made of expanded metal mesh. When the drum filled with turmeric is rotated, polishing is effected by abrasion of the surface against the mesh as well as by mutual rubbing against each other as they roll inside the drum. The turmeric is also polished in power-operated drums. The colour of the turmeric always attracts the buyers. In order to impart attractive yellow colour, turmeric suspension in water is added to the polishing drum in the last 10 minutes. When the rhizomes are uniformly coated with suspension they may be dried in the sun.

5.12 Preservation of seed

Rhizomes for seed are generally heaped under the shade of trees or in well-ventilated sheds and covered with turmeric leaves. Sometimes, the heap is plastered over with earth mixed with cow dung. The seed rhizomes can also be stored in pits with sawdust. The pits can be covered with wooden planks with one or two holes for aeration.

5.13 Yield

The yield of pure crop varies from 8000 to 10000 kg per acre. Under exceptionally favourable conditions, viz. abundant manuring and copious irrigation it may be as high as 12000 kg per acre.

6. Linkages :

Spices Board supports production, processing, certification and marketing of organic spices. Assistance is provided for organic cultivation of turmeric in select states. Spices Board has also programmes to encourage production of Lakadong turmeric in the North Eastern States. Spices Board has been designated as one of the agencies empowered to accredit certification agencies. Spices Board is also implementing the scheme for Export Oriented Production during the XI Plan where in assistance is being provided for promotion of organic turmeric under various programmes as indicated in **Annexure II**

7. Financial aspects :

7.1 Sale price

The farm gate price of cured turmeric has been considered at Rs.25/kg.

7.2 Cost of cultivation

The cost of cultivation for 1.0 acre organic turmeric cultivation is Rs 34800/- per acre. The detailed cost of cultivation is given in **Annexure -III.**

7.3 Margin

The percentage of margin / down payment to cost of development prescribed is 5, 10 and 15% for small, medium and large farmers respectively. The rest of the cost of development will be provided as bank loan. Margin considered in the present model is 10%.

7.4 Bank loan

Bank loan of 85 - 95 % shall be available from the financing institution. Bank loan considered in the model is 90%.

7.5 Rate of interest

The rate of interest to be charged to the ultimate borrower would be guided by RBI guidelines issued from time to time. However, the ultimate lending rate has been considered as 12 % for working out the bankability of the model scheme.

7.6 Security

Banks are guided by RBI guidelines issued from time to time in this regard.

8. Conclusion

The net income from organic cultivation and curing of turmeric is Rs. 23900/-. The activity is technically feasible, financially viable and bankable.

Notes

4

BAMBOO PLANTATION

You are required to select a site suitable for the plantation and establish a nursery in or close to the plantation. Now once you have established a plantation, you need to maintain and manage it intensively for culm or shoot production. The focus of this lesson is on serious cultivation and management of bamboo as a plantation crop. Important issues like the size and scale of plantation, density of plantation etc. will be discussed. Although bamboo has been cultivated in India for thousands of years, plantations raised for commercial reasons are of relatively recent origin. You will also learn the profitability of a bamboo plantation.

OBJECTIVES

After reading this lesson, you will be able to:

- establish a commercial bamboo plantation;
- identify the size and scale, spacing used in the plantation;
- execute steps and consideration for a good bamboo plantation.

4.1 PLANTATIONS

Let us first understand what a plantation is and how it is different from any piece of land where a plant is growing. A plantation is a plot of land on which serious cultivation of any preferred species is done regularly over a period, using high-quality inputs and scientific methods of cultivation and management.

Plantations (Fig. 4.1) provide various opportunities as follows:

Notes

1. They ensure optimal use of land.
2. They affect economies in the purchase of planting material and inputs such as fertilizers.
3. They enable planned irrigation systems.
4. They ensure best use of labor for planting, maintenance and harvesting operations.

Fig. 4.1: Bamboo plantation

The objective of a plantation is generally to maximize yield, and profit. There is thus a strong commercial orientation to plantations.

In some cases, however, plantations may be established without a primary commercial purpose like for other purposes of steadying soil and its renewal, and also reclamation of wasteland.

4.2 BAMBOO PLANTATIONS

Bamboo holds great potential to be a commercial crop (Fig. 4.1a). With increasing demand for bamboo-based products due to several reasons, bamboo is a good crop for commercial plantations, for many reasons:

1. Bamboo can be grown in a wide variety of soil and climatic conditions.
2. Once clump maturity has been attained, bamboo can be harvested every year and can provide regular returns.

Notes

3. Harvesting of bamboo can be staggered – either brought forward or delayed – to cater to the fluctuations in market demand.

4. Bamboo plantations have comparatively few requirements of labor and maintenance. The demand for bamboo in the market is increasing due to its ecological acceptability, ease of growing, short rotations to harvest, and multifarious uses, from handicrafts to engineered products.

Fig. 4.1a: Commercial bamboo plantation

The bamboo-based industry would require a continuous supply of raw material. Thus, a bamboo plantation will be the source of raw material to the industry. Therefore, commercial bamboo plantations may need to be established:

- to maximize the yield of bamboo culms
- to produce a mix of bamboo culms and shoots
- to maximize biomass production

The basic principles of establishing a plantation will remain the same in all cases. However, there can be certain changes depending on its product focus. These changes include choice of species, spacing, input intensity and content, harvesting technique and, most importantly, clump management.

Notes

4.2.1 Can raising Bamboo Plantations be a Profitable Activity?

A well-managed mature plantation can yield 25-30 tonnes of culms per hectare or we can say that 5–6 culms per clump of medium diameter bamboo can be obtained, i.e. 2500–3000 culms per hectare (Fig. 4.2).There is demand of bamboo in bulk to meet the needs of large-scale users. Pulping units and paper mills also have high demand for bamboo (air dried, i.e. moisture levels of 12–15% in large quantities at rates varying from Rs. 800–Rs. 1,300 per tonnes.

Fig. 4.2: A Commercial bamboo plant

Bamboo can also be sold by the piece (culm). The price it gets is generally higher than when sold in bulk. Culms sold by the piece must be of good quality and nature to attract a higher price. The price per culm varies across the country in retail markets, ranging from Rs. 25 to Rs. 80. It increases with distance from growing areas. There is a growing demand for high-quality and mature bamboo from architects and builders. For good-quality bamboo, such users are ready to pay between Rs. 40 to Rs. 80 and higher per culm. Manufacturers of bamboo boards and composite material also require large quantities of good-quality bamboo.

4.3 SIZE AND SCALE OF BAMBOO PLANTATION

A bamboo plantation can be established on lands ranging in area from half an acre to a couple of hundred acres. Most commercial plantations fall into one of these size-categories:

- Large (over 20 acres / 8 hectares) and
- Small (5 to 20 acres / 2-8 hectares).

Notes

The decision on the size of plantation will depend on the following factors:

- Land availability
- Investment capital
- Availability of labor and other inputs
- Management capacity
- Market demand for bamboo culms or shoots.

INTEXT QUESTIONS 4.1

1. Fill in the blanks

   (a) The price per culm in the market ranges from .....

   (b) Air dried bamboo has high demand in ..... industry.

   (c) Apart from profit, bamboo plantation can also be used for ..... of wasteland.

2. State whether True or False

   (a) The objective of a plantation is to increase yield and production but not profit.

   (b) Bamboo plantation requires comparatively less labor.

   (c) Bamboo can be grown as a useful agro-forestry species with certain precautions.

   (d) On clump maturity, bamboo can be harvested every year regularly as individual culms without creating 'ugly' gaps in the canopy in contrast to tree felling.

4.4 PLANTING OF BAMBOO

Placing the planting material in previously prepared pits is an important activity. It signifies the initiation of a bamboo plantation.

Planting should be done in the early hours of the morning. The planting material should be stored in a convenient and shaded part of the plantation site. If natural shade is not available, arrangements should be made for temporary cover. Planting should be completed in a short period of time and, as far as possible, should be

Notes

undertaken simultaneously. After the first year, further planting may be needed to cover gaps due to mortality (death) of plants (also called gap-filling in the plantation).

4.4.1 Spacing (Planting Density)

The spacing to be followed while planting bamboo will depend on many factors like the species to be planted, the primary objective of the plantation, local climate and soil conditions. The size and physical dimensions of the species to be planted are an important for planting density.

Higher densities (i.e. closer spacing) are appropriate for small-sized bamboos and lower densities (i.e. more spaced out) are appropriate for larger-sized bamboos.

If the plants are spaced too far apart, the plantation will suffer from canopy exposure, loss of soil moisture through evaporation, and competition from weeds and other vegetation. An unduly dense plantation will lead to bamboo plants competing amongst themselves for light, space, soil moisture and nutrients.

If your main objective of the plantation is to have steady supply of culm, the following guides to spacing may be followed:

- For medium-dia., thick-walled species, 5×5 meter^2 spacing. This requires 400 clumps per hectare, or 160 clumps per acre. This spacing is good for *Bambusa tulda*, *Bambusa nutans*, *Dendrocalamus asper* and *Dendrocalamus brandisii*. Under well-managed conditions it can go up to 6×6 or 7×7 meter^2 (Fig. 4.3).

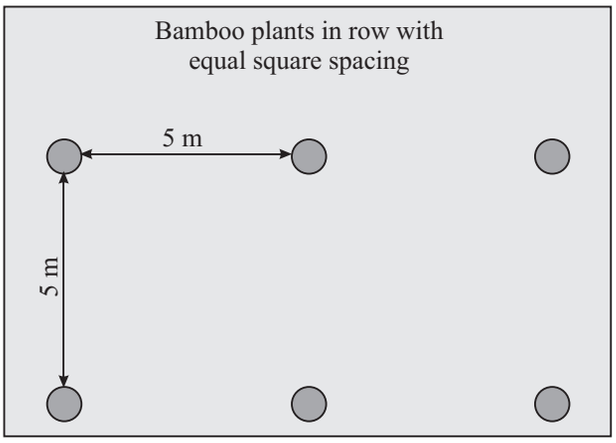

Fig. 4.3: Plant spacing formedium dia. thick walled species

- For smaller species, like *Ochlandra travancorica* 4×4 meter^2 spacing will be enough. This requires 625 plants per hectare.

Notes

- For larger species like *Dendrocalamus hamiltonii*, the spacing can be 7 × 7 meter^2, or 204 plants per hectare. For *Dendrocalamus giganteus* this can go up to even 10 × 10 meter^2, or 100 plants per hectare.

If your primary objective is soil stabilization, smaller spacing of even 3 × 3 meter^2 (1111 plants per hectare) will suffice. However, if your objective is erosion control along river banks or landslide/avalanche protection, the spacing can be 3 × 3 meter^2 or even 2.5 × 2.5 meter^2. In such cases, bamboo (1111 to 1600 plants) can be interspersed with appropriate, fast-growing timber species.

4.4.2 Trench cum Bund Method of Spacing

The trench cum bund method (Fig. 4.4) of spacing involves planting bamboo on 1 meter wide and 50 cm high bunds (heap of soil). The bunds are prepared by digging trenches and heaping the dug-out soil. The distance from the centre of one bund to that of the next on a 5 × 5-metre plantation should be 5 meters.

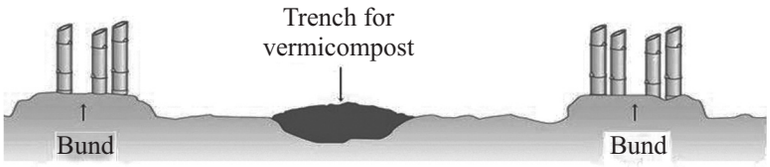

Fig. 4.4: Trench cum bund, trench method of spacing

Bunds and trenches should be prepared sufficiently in advance so as to stabilize them before planting is taken up. The trench cum bund method has several advantages. Bamboo planted on bunds with a base of well-worked soil, turned over from the trenches, will grow well. In subsequent years, more soil can be dug out of the trenches and heaped or mounded around the bamboo clumps.

The method facilitates mounding as the plants grow. The trenches can be used for irrigation, or for preparing vermicompost.

The initial cost of establishing a plantation using this method may be slightly high compared to conventional planting. This cost is however likely to be more than recovered in subsequent mounding and management operations, and through improved productivity.

4.4.3 Triangular Spacing Method

For commercial plantations, raised for culm, timber or for shoot, staggered planting in a triangular grid is recommended. This involves digging pits in alternating rows in the same line, with the row in the middle consisting of pits placed at the centre point of the preceding row (Fig. 4.5).

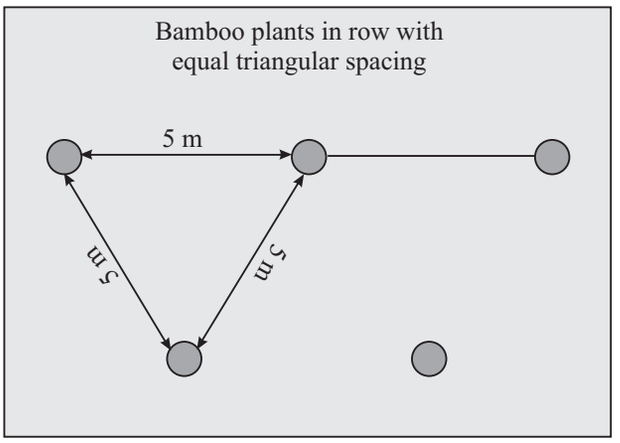

Fig. 4.5: Triangular spacing method

This allows for optimum utilization of land area and maximizes the space available to each clump. At the same time, it ensures a uniform distance between rows of plants, which can be used for intercropping and vermicomposting, and allows for easy passage.

4.5 PITS

After clearing the land and before digging the pits, you should identify the pit sites by using a measuring tape to ensure the desired spacing. It is then marked with wooden or bamboo sticks at the spot that will be the centre of the pit. The pit should be deep enough to ensure that the roots of the plants get enough space after the planting material is placed in it.

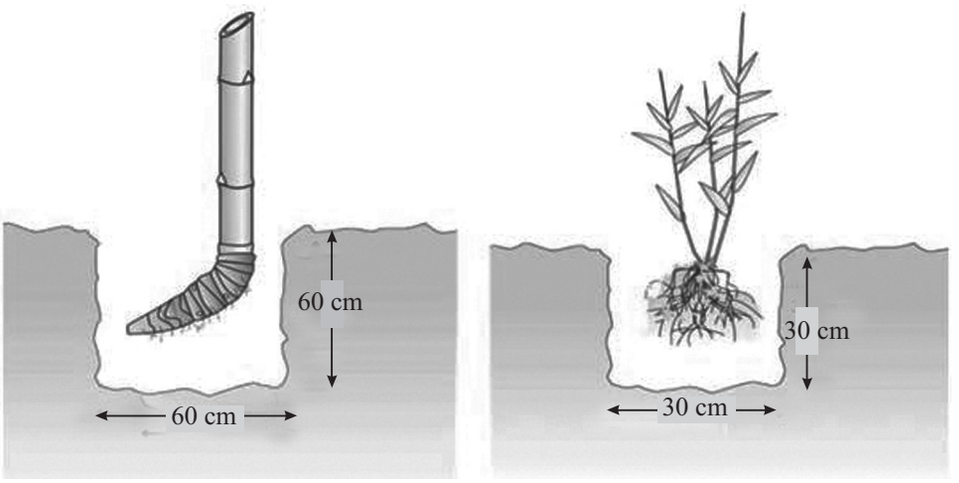

Fig. 4.6: Pits used for bamboo plantation/planting

Notes

A thumb rule is, 'the larger the pit, the better the growth of rhizomes'. But this must be done seeing the cost-effectiveness. Offsets and rhizomes should be planted in pits measuring $60 \times 60 \times 60$ to $100 \times 100 \times 100$ centimeter^3 (Fig. 4.6). Pits should be dug much before the rainy season. Pits should be spaced according to the requirement of the bamboo species or the management objective of the plantation.

You should take care of certain points while planting the bamboo to minimize the risks of failure. They are as follows:

- Thoroughly turn the soil in the pits a few days before planting.
- Remove weeds and competing vegetation within a radius of 3–4 feet from the pit.
- For a pit size of $60 \times 60 \times 60$ centimeters^3, mix the soil with one basket (5 kg) of farmyard manure (FYM), 100 grams urea, 100 grams super phosphate and 50 grams muriate of potash (MoP). Nitrogen in the ammonium form increases water uptake, resulting in faster growth.
- Place the plant vertically in the pit, ensuring that the roots do not get cramped but remain free flowing.
- Level the pit with the soil mixed with manure.
- After planting, irrigate with 12–20 liters of water, depending on the prevailing climatic conditions. This will provide the needed moisture to the rhizome and roots and compact the loose soil around the plant.
- Repeat the watering the next day, moderating the quantity of water. For the next 10 weeks, provide water if there is no rain or little rain, at daily intervals initially. Later it can be extended to once in three days.

INTEXT QUESTIONS 4.2

1. Fill in the blanks

   (a) Digging a ..... can prevent spreading of bamboo to other adjacent area.

   (b) ..... density in planting bamboo is appropriate for large sized bamboos.

   (c) For commercial plantation for culm timber ..... method of spacing is recommended.

   (d) Pits for planting should be dug much before ..... season.

Notes

WHAT YOU HAVE LEARNT

Let us recapitulate and list the salient points we have learnt through this lesson:

- Plantation is a plot of land where intensive cultivation of one species is done for commercial purposes.
- The objective of plantation is to maximize yield and profit.
- Bamboo is a good option for commercial plantation.
- Bamboo has high demand in market both in bulk as well as loose.
- A bamboo plantation can yield upto 23-30 MT of culm per hectare (Internationally, yields even as high as 50 MT/Ha are obtained).
- In bulk, bamboo is sold from Rs. 800-1300 per tonne.
- Loose bamboo culm can fetch Rs. 25 to 80 per culm.
- Size of the plantation can range from large scale (over 20 acres) to small scale (5-20 acres).
- The scale depends on many factors like availability of land, capital, labor and other inputs.
- Planting of material is initiation of a bamboo plantation. It should be done in early morning and the planting material should be stored in shade.
- Spacing between individual plants is very important. The spacing depends on type of bamboo species, other climatic and soil conditions.
- For proper spacing Trench-cum-Bund, Trench Method or Triangular spacing methods can be used.
- For planting the bamboo, pits are dug at desired spacing.
- The pit should be deep enough to provide proper space for the roots. The larger the pits, the better growth of the rhizomes and better will be the yield.
- After planting, they should be irrigated completely, and water should not be scarce at least for 10 weeks.

TERMINAL EXERCISE

1. What do you understand by the term plantation? Write 3 important goals achieved by plantation.
2. List the factors on which the size of bamboo plantation depends.

Notes

3. Do you think bamboo plantation is a profitable activity? Discuss.
4. What factors determine the size and scale of the bamboo plantation?
5. Why spacing is important in plantation? Describe the various methods for determining the proper spacing?
6. Discuss the role of pits in bamboo plantation?
7. What important considerations should be taken in establishing a plantation to minimize the risk of failure?

ANSWERS TO INTEXT QUESTIONS

4.1

1. (a) Rs. 25 to 80 (b) Paper (c) Reclamation
2. (a) False (b) True (c) False (d) True

4.2

1. (a) Trench (b) Lesser (c) Triangular (d) Rainy

Key Learning Outcomes

- Establish and manage a commercial bamboo plantation efficiently.

Model Profile for 1.0 ha Cashew Cultivation

1. Introduction

Cashew (*Anacardium occidentale*), a native of Brazil, was introduced in India during the later half of the Sixteenth Century for the purpose of afforestation and soil conservation. From its humble beginning as a crop intended to check soil erosion, cashew has emerged as a major foreign exchange earner next only to tea and coffee. Cashew nut is one of the important nuts grown in the world and ranked first. Among various nuts such as hazelnuts, almonds, etc., cashew nut enjoys an unenviable position and it is an unavoidable snack in all important social functions especially in the western countries.

2. Scope for Cashew Cultivation and its National Importance

Commercial cultivation of cashew is taken up in eight states of our country mainly in west and eastern coast viz., Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra, Orissa, Tamilnadu and West Bengal. In addition, cashew is also grown in few pockets of Assam, Chhattisgarh, Gujarat, Meghalaya, Nagaland and Tripura. India has an area of 9.53 lakh ha (2010-11) under cashew with an estimated annual production of about 6.74 lakh tonnes of raw cashew nut. India is the third largest producer and exporter of cashew in the world next only to Vietnam and Nigeria. It is the second largest consumer of cashew and also the biggest processor with highest acreage under the crop. The current cashew production of the country accounts for 23.0% of the global production. A large number of small and marginal farmers, especially living on the coastal belts of India, depend on cashew for their livelihood. Nearly 2.00 lakh workers, more than 90% of whom are women, are directly employed in cashew processing factories which are concentrated mostly in Kerala, Andhra Pradesh and Maharashtra. It is estimated that nearly two million people are involved, directly and indirectly in cashew cultivation, processing and marketing.

Cashew cultivation is taken up in small and marginal holdings and as more than 70% of the cashew area is under this category, cashew plays an important role in the development of small and marginal farmers.

3. Technical Requirements of Cashew Cultivation

3.1 Soil

The general notion is that "cashew is very modest in its soil requirements and can adapt itself to varying soil conditions without impairing productivity". While Cashew can be grown in poor soils, its performance would be much better on good soils. The best soils for cashew are deep and well-drained sandy loams without a hard pan. Cashew also thrives on pure sandy soils, although mineral deficiencies are more likely to occur. Water stagnation and flooding are not congenial for cashew. Heavy clay soils with poor drainage and soils with pH more than 8.0 are not suitable for cashew cultivation. Excessive alkaline and saline soils also do not support its growth. Red sandy loam, lateritic soils and coastal sands with slightly acidic pH are best for cashew.

3.2 Climate

Cashew is a tropical plant and can thrive even at high temperatures. Young plants are sensitive to frost. The distribution of cashew is restricted to altitudes upto 700 m above mean sea level where the temperature does not fall below 20°C for prolonged period. Areas where the temperatures range from 20 to 30°C with an annual precipitation of 1000 - 2000 mm are ideal for cashew growing. However, temperatures above 36°C between the flowering and fruiting period could adversely affect the fruit setting and retention. Heavy rainfall, evenly distributed throughout the year is not favourable though the trees may grow and sometimes set fruit. Cashew needs a climate with a well-defined dry season of at least four months to produce the best yields. Coincidence of excessive rainfall and high relative humidity with flowering may result in flower/fruit drop and heavy incidence of fungal diseases.

3.3 Varieties

The research programmes on crop improvement had resulted in identification of elite materials with yield potential ranging between 20-25 kg of nuts per tree. Several varieties have been released by the different co-ordinating centres of Indian Council of Agricultural Research (ICAR). All the Agricultural Universities and Research Centres have established bud wood bank with the released varieties of respective centres for further multiplication and distribution. The cashew varieties recommended for different states are given in the Table 1.

State	Variety
Andhra Pradesh	BPP 4, BPP 6, BPP 8
Karnataka	Chintamani 1, Chintamani 2, Dhana (H – 1608), NRCC Selection 2, Bhaskara, Ullal 1, Ullal 3, Ullal 4, UN 50, Vengurla 4 &Vengurla 7
Kerala	Dhana, K 22-1, Madakkathara 1, Madakkathara 2, Kanaka, Amrutha and Priyanka
Madhya Pradesh	T No. 40 &Vengurla - 4
Maharashtra	Vengurla 1, Vengurla 4, Vengurla 6 &Vengurla 7

Goa	Goa 1, Goa 2, Vengurla 1, Vengurla 4, Vengurla 6 &Vengurla 7
Orissa	Bhubaneswar 1, BPP 8 &Dhana
Tamil Nadu	VRI 1 & VRI 5
West Bengal	Jhargram 1 & BPP 8

3.4 Planting material

Cashew is a cross pollinated crop and exhibits wide variation in respect of nut, apple and yield of seedling progenies. Therefore, vegetative propagation has been advocated to mitigate this problem. Air layering has been quite successful but survival percentage is low and it has been reported that the plantations raised from air layers are more susceptible to drought and the life of such plantation is shorter as compared to that of grafted or seedling ones. The anchorage has also been observed to be poor, especially in cyclone prone areas. Epicotyl grafting and softwood grafting are found to be successful because it is easy to produce large number of grafts in a short time. The percentage of field establishment is also reported to be high with these grafts. Adequate thrust has been given to produce enough planting material through these standardised techniques by the ICAR (through the Directorate of Cashew Research, its sub-stations, Agricultural Universities and State Departments of Horticulture/Agriculture), to meet the growing demand. Production of cashew planting material is one of the economic activities in most of the states. The planting material is raised in these nurseries within a year. The farmers can purchase planting material from these nurseries but care should be taken that the planting material is purchased from authentic and certified nurseries. The supplier should have the details like age of the plant, variety of the cashew, rootstock used etc. and the same should be mentioned in the bill/ cash receipt.

3.5 Preparation of Land

The land should be ploughed thoroughly and levelled in case of agricultural lands. In case of forestlands, the jungle should be cleared well in advance and the debris burnt. After clearing the jungles, land is to be terraced or bunds constructed on sloppy land. In order to ensure better moisture conservation, soil trenches are dug across the contours. The cost of land preparation will vary depending upon the type and method of soil working. Nowadays, use of JCB for soil working is most popular; hence a provision for use of soil working is made in the model. The land preparation work should be completed prior to the onset of monsoon season i.e. during May – June.

3.6 Layout

Cashew trees are generally planted with a spacing of 7 to 9 meters adopting square system. A spacing of 7.5 m X 7.5 m (175 plants/ ha) or 8 m X 8 m (156 plants/ ha) is recommended. High density planting of cashew at a closer spacing of 4 m X 4 m (625 plants/ ha) in the beginning and thinning out

in stages to maintain a final spacing of 8 m X 8 m in the tenth year is also recommended. This enables higher returns during initial years. In case of sloppy lands, the triangular system of planting is recommended to accommodate 15 per cent more plants without affecting the growth and development of the trees. In undulating areas, the planting should preferably be done along the contours, with cradle pits or trenches provided at requisite spacing in a staggered manner to arrest soil erosion and help moisture conservation.

3.7 Digging and filling of pits

The work of digging of pits has to be completed much in advance (May – June). Cashew can be planted in pits of 60cm x 60cm x 60cm size in soils with normal strata. In hard lateritic soils, pits of 1m x 1m x 1m size are recommended. The top soil and sub-soil are kept separately and allowed to wither under sun. It helps in migration of termites and ants. Burning of the debris and forest wastes inside the pits before planting is advantageous. The pits are then filled with topsoil mixed with farmyard manure or compost (5 kg) or poultry manure (2 kg) and rock phosphate (200 g). In order to mitigate soil borne diseases, BHC @ 100g/ pit is also added to the soil mixture.

3.8 Planting

The grafted plants obtained from the superior mother plant are usually planted at the onset of monsoon. It is essential to provide stakes and temporary shade with the locally available materials wherever necessary (especially in the South West aspects in case of forest plantation) to reduce the mortality rate and achieve quicker establishment. If the monsoon rains are inadequate, one or two pot irrigation can be done during the initial stages to ensure establishment.

3.9 Mulching

The cashew is generally planted on the wastelands and hence availability of soil moisture is always low, hence, mulching is essential. Mulching with black polythene is beneficial to increase the growth and yield of cashew. However, locally available materials like green or dry grass or weeds can be utilized for mulching the basins. Small pebbles or stones can also be used for mulching of the basin. The plastic or stone mulch does not improve soil health but ensures better moisture retention in the soil and also prevents attack of soil borne insects and pests.

3.10 Manuring and fertilization

In our country, application of manures and fertilizers is very limited in the case of Cashew. In order to get better yield, it is essential to maintain adequate N:P:K ratio in the soil. Application of 10-15 kg of farmyard manure per plant is recommended to ensure adequate organic matter in the soil. The fertilizers recommended for a mature cashew tree are 500 g N (1.1 kg urea), 125 g P_2O_5 (750 g Single

Super Phosphate and 125 g K_2O (200 g muriate of potash). The nutritional requirements and the quantity of fertilizer per plant are given in Table 2.

Table 2. Nutritional requirements and recommended fertilizer doses for cashew

Age	Urea (g)	SSP (g)	MOP (g)
1 st Year	**375**	**275**	**75**
2 nd year	**750**	**525**	**150**
3 rd year	**1100**	**750**	**200**

The ideal time for application of fertilizer is immediately after the cessation of heavy rains. Fertilisers should be applied in a circular trench along the drip line. Before application of fertilizer it should be ensured that there is adequate soil moisture. The fertilizers should be applied in two split doses during pre-monsoon (May – June) and post monsoon (September – October) season. However, in the case of single application, it should be done during post monsoon season (September – October) when adequate soil moisture is available. In sandy and laterite soils, soils of sloppy land and in heavy rainfall zones, the fertilizer application should be done in a circular trench of 25 cm width and 15 cm depth at 1.5m from the tree trunk. In red loamy soils and in low rainfall areas (east coast), the fertilizers should be applied in circular bands at a distance of 0.5m, 0.7m, 1.0m and 1.5m away from the trunk during first, second, third and fourth year onwards of planting, respectively.

3.11 Weeding

Weeding with a light digging should preferably be done before the end of rainy reason. Hoeing, cutting the weeds off underground is more effective than slashing. Chemical weeding has not been of any importance until now, however it may be considered as an alternative, where wages are high or where there is shortage of labour. Initially, Agrodar-96 (2, 4 –D) @4ml/litre of water and subsequently Gramaxone @5ml/litre of water is sprayed. Approximately, 400 litre/ha (160 litre/acre) of solution is required per spray. The spray is again repeated in the post monsoon season.

3.12 Inter-cropping

Tall growing intercrops like certain varieties of sorghum and millet should not be encouraged between young cashew, as they provide too much shade. Leguminous crops such as groundnut and beans are very suitable for inter cropping. Besides the annual crops, arid zone fruit crops having less canopy especially annona, phalsa, etc., can be thought of, depending on the suitability. Cultivation of horse gram, cowpea, groundnut etc is recommended as inter-crops in cashew. Inter cropping cashew, *Casuarina* and coconut are popular.

3.13 Cover cropping

Leguminous cover enriches soil with the plant nutrients and adds organic matter, prevent soil erosion and conserves moisture. The seeds of these cover crops may be sown in the beginning of rainy season. The seed beds of 30cm X 30cm size are prepared in the interspace in slopes by loosening soil and mixing a little quantity of compost. The seeds of these crops are sown in the beds and covered with a thin layer of soil. The seeds should be soaked in the water for six hours before sowing.

3.14 Training and Pruning

During first year of planting, the sprouts coming from the rootstock should be removed frequently to ensure better health of the plant. These sprouts eat up valuable plant nutrition and also cause death of grafted scion allowing only rootstock to grow. Initial, training and pruning of cashew plants during first 3-4 years is essential for providing proper shape to the trees. The trees are shaped by removing lower branches and water shoots coming from the base during first 3-4 years. Thereafter, little or no pruning is necessary. The plant should be allowed to grow by maintaining a single stem up to 0.75-1.0 m from the ground level. Weak and criss-cross branches are also chopped off. In order to avoid lodging of the plant by wind, proper staking of plant is essential. After 4-5 years, the main stem is detopped to a height of 4-5 m from the ground level. Thereafter, regular removal of dried/ dead wood, criss-cross branches and water shoots once in 2-3 year is done to keep the plant healthy. The training and pruning of cashew plants is done during August – September. The cut surfaces are smeared with Bordeaux paste.

The flowers appearing during first and second year of planting should be removed (de-blossoming) and plants should be allowed to bear fruits only after third year.

3.15 Top working

Better management practices may increase the yields marginally but boosting cashew production 3-4 folds in a short span of time is perhaps possible only by "genetic transformation" of the existing plantations with high yielding varieties. It is reported that this genetic transformation can be effected through top working. The rejuvenation of unthrift cashew plantations through top working involves beheading of trees, allowing juvenile shoots to start-out and taking up of in-situ grafting using procured scions of high yielding varieties. Periods from November to March and February to June have been found to be ideal for beheading and in-situ grafting respectively. It has been observed that the top worked trees within a period of two years have not only put forth a canopy of 3-4 m in diameter and 5-6 m in height (as that of 8-10 year old trees) but also have given an yield of 3 to 5 kg nuts per tree in their first bearing itself.

3.16 Pests and Diseases

3.16.1 Pests

It is observed that there are about 30 species of insects infesting cashew. Out of these tea mosquito, flower thrips, stem and root borer and fruit and nut borer are the major pests, which are reported to cause around 30% loss in yield.

Tea Mosquito

The nymphs and the adults of tea mosquito (*Helopeltis spp*.) suck sap on the tender leaves, shoots and inflorescence and even young nuts and apples. The saliva of the insect is very toxic, which causes blistering at the site of infestation. Severe attack on the young shoots cause dieback. Attacked inflorescence usually can be recognised from a distance by their scorched appearance. Tea mosquito population builds up during the beginning of the rainy season, when the cashew tree is full of new flush.

Tea mosquito can be controlled by spraying carbaryl 0.1.% or phosalone 0.07% or dimethoate 0.05%. Spraying should be done thrice, first at the time of flushing, second at early flowering and third at the time of fruit set.

Thrips

Both nymphs and adults suck and scrape at the underside of the leaves, mainly along main veins, causing yellowish patches, latter turning grey, giving the leaves a silvery appearance. The thrips are more active during the dry season. 0.05% monocrotophos or 0.1% carbaryl are very effective for controlling thrips.

Stem and Root Borers

The young white grubs bore into the fresh tissues of the bark of the trunk and roots and feed on the subsequent subepidermal tissues and make tunnels in irregular directions. Due to severe damage to the vascular tissue the sap flow is arrested and the stem is weakened. The characteristic symptoms of damage include the presence of small holes in the collar region, gummosis, yellowing and shedding of the leaves and drying of the twigs. Once the plant is infested complete control of this pest is very difficult. However, prophylactic measures for its control can be adopted with 0.1% BHC swabbing twice a year, once in April-May and the second application during November.

Fruit and Nut Borers

The young caterpillar bores through the apple and nut causing deformity and /or loss of kernel weight. Spraying of monocrotophos - 0.05% concentration at flowering and fruit setting is recommended.

3.16.2 Diseases

Fortunately cashew crop does not have any serious disease problem except the powdery mildew caused by a fungus, which affects the young twigs and inflorescence and makes it wither. This disease generally appears when the weather becomes cloudy. Control can be obtained by dusting with 2% sulphur W.P.

3.17 Harvesting and Yield

Cashew plants start bearing after three years of planting and reach full bearing during tenth year and continue giving remunerative yields for another 20 years. The cashew nuts are harvested during February – May. Normally, harvesting consists of picking of nuts that have dropped to the ground after maturing. However, if the apples are also used for making jam, juice, syrup, Fenni, etc., the fruit has to be harvested before it falls naturally. The cashew apples are removed and the nuts are dried in sun for 2-3 days to bring the moisture level from 25 per cent to 9 per cent. The maturity of the cashew nut is tested by floatation method. The mature nuts sink in water while the immature/ unfilled ones float. The nuts are collected at weekly intervals from the farm during the harvesting season. During that period the land should be clean in order to facilitate collection of cashew. Plantations of unknown origin or seedling progenies with conventional methods of cultivation yield less than one kg of raw nuts per tree. However, there is a chance to increase the yield up to 4 to 5 kg per tree with the adoption of improved production techniques, over a period of 4 to 5 years. In new plantations, with the use of elite planting material coupled with a package of improved agronomic practices, a yield of 8-10 kg per tree could be achieved.

3.18 Marketing

Marketing of raw cashew is not a problem in view of the fact that our raw material production is considerably low (around 6.74 lakh t) when compared to the processing capacity of our existing factories (around 7.0 lakh t developed so far). The raw cashew nuts fetch a price of Rs.65-70 per kg in the internal market.

3.19 Processing

The processing of cashew involves the following steps :

- Preliminary cleaning
- Roasting
- Shelling and separation

- Drying

- Peeling

Preliminary cleaning of cashew nuts is done by manual picking of large objects and by sieving. The cleaned cashew nut is roasted in open pan or earthen ware or rotary cylinder or hot oil bath. The first two methods are simple and cheap, but they are time consuming and lead to poor recovery of CNSL (Cashew Nut Shell Liquid). The rotary cylinder method is more hygienic and efficient, but a major portion of the CNSL would be lost. The hot oil bath process combines good roasting and recovery of shell liquid. The cleaned cashew nuts are placed in wire baskets and immersed in a tank containing CNSL, boiling at a constant temperature of about 180-200°C for about 60 to 90 seconds. The CNSL in the tank should be stirred continuously to avoid local overheating and excessive polymerization and clogging. However, the hot oil bath processing is costlier, and is resorted to only by a few processors. The most common method adopted is roasting by rotary cylinder method. After roasting, the shells are removed and the nuts extracted manually. In manual shelling, recovery of whole kernels is more compared to the mechanical shelling. The kernels are dried in hot air chambers which facilitates peeling of the outer coating or testa. To prevent breakage, the kernels are to be handled very carefully, as they are brittle at this stage. The shelling percentage of cashew varies between 20-25.

3.20 Grading and Packing

Grading is done for export purposes based on "counts" or number of kernels per pound. Sound kernels are named as "wholes" and broken ones as "splits". The wholes are again classified as whole white kernels, whole scorched kernels, whole dessert kernels (a) and whole dessert kernels (b). The splits are also further graded into white pieces, scorched pieces, dessert pieces (a) and dessert pieces (b) based on certain physical characters. The wholes are packed in several grades viz., 210, 240, 280, 320, 400, 459 and 500; the popular grade is 320. The specifications for graded kernels are that they should be fully developed, ivory white in colour and should be free from insect damage and black and brown spots. Packing is done in time by Vita pack method (exhausting the air inside the packing tin, pumping in carbon dioxide and sealing).

The techno-economic parameters for the model project are detailed in **Annexure I.**

4. Financial Viability and Bankability

4.1 Project Cost

The cashew tree starts bearing during third year but the income is not sufficient to cover the expenses. Hence, the cost of development upto fourth year is capitalized. The project cost estimated for one ha of cashew plantation is Rs.83800/- and the details are presented in **Annexure II.**

4.2 Margin Money

The margin money / down payment prescribed are 5 %, 10 % and 15% for small, medium and other farmers respectively. The rest of the cost of development will be provided as bank loan. However, in the present model, 10 % of the unit cost i.e. Rs.8400/ha has been considered as margin money.

4.3 Bank Loan

Bank loan of 85 - 95 % of the total cost of development shall be available from the financing institution. Bank loan considered in the model is 90%. It works out to Rs.75400/ha in the model.

4.4 Rate of interest

Banks are free to decide the rate of interest within the overall RBI guidelines issued from time to time. However, the ultimate lending rate has been considered as 12 % for working out the bankability of the model project.

4.5 Security

Banks are guided by RBI guidelines issued from time to time in this regard

4.6 Financial Analysis

Financial analysis was carried out for one hectare of cashew cultivation. For financial analysis, the income was assessed on a conservative basis. The productivity of a ten year old cashew tree is considered at 9 kg of nuts per tree. The detailed calculation of project's income and expenditure has been indicated in **Annexure III.** IRR, NPW and BCR for the model works out to 44 %, Rs. 1,39,588/- and 1.66 respectively and the details are given in **Annexure IV**.

4.7 Repayment period of loan

Based on the cash flow the detailed repayment schedule has been worked out and furnished in the **Annexure V**. The repayment period works out to nine years including three years grace period for repayment of principal.

5. Conclusion

Cashewnut cultivation is a technically feasible, financially viable and bankable activity in the areas identified suitable for it based on agro-climatic conditions.

Annexure I : Techno-economic parameters

Spacing	7.5 m x 7.5 m
Varieties	Vengurla 4, 6 & 7
Planting Material	Grafts
Plant Population (plants/ha)	178
Land preparation (Rs./ha)	5000.00
Labour (Rs./manday)	200.00
Planting material (Rs./plant)	20.00
Farm Yard Manure (Rs./MT)	1200.00
Urea (Rs./kg)	5.70
Single Super Phosphate (Rs./kg)	5.80
Muriate of Potash(Rs./kg)	16.60
Plant protection material (Rs./litre)	300.00
Sale price of Cashewnut (Rs./kg)	65.00

Annexure II : Project Cost

(Amount in Rs.)

Items	Year				Total
	1	2	3	4	
Land preparation	5000	0	0	0	5000
Digging and filling up of pits	3000	0	0	0	3000
Plant material	4100	0	0	0	4100
Planting and staking	1000	0	0	0	1000
Cost of FYM	3600	3600	4800	4800	16800
Cost of fertilizers	900	1700	2500	2500	7600
Manures & fertilizers application	1400	1400	1600	2000	6400
Irrigation	2000	2000	2400	3000	9400
Plant protection measures	1500	1500	2400	3000	8400
Appl. of plant protection	600	600	800	2000	4000
Interculture	1600	1600	2000	2400	7600
Intercropping	4000	0	0	0	4000
Live fencing	3500	0	0	0	3500
Harvesting	0	0	1000	2000	3000
TOTAL	32200	12400	17500	21700	83800
Rounded off	32200	12400	17500	21700	83800
Margin Money					**8400**
Bank Loan					**75400**

Annexure III : Income - Expenditure Statement

(Amount in Rs.)

Items	Year							
	3	4	5	6	7	8	9	10
Income								
Yield (kg/plant)	1	3	5	6	7	8	8.5	9
Yield (kg/acre)	178	534	890	1068	1246	1424	1513	1602
Income	11570	34710	57850	69420	80990	92560	98345	104130
Expenditure								
Cost of FYM	2000	2000	2000	2000	2000	2000	2000	2000
Cost of fertilizers	2731	2731	2731	2731	2731	2731	2731	2731
Manures & fertilizers application	1600	2000	2000	2000	2000	2000	2000	2000
Irrigation	2400	3000	3000	3000	3000	3000	3000	3000
Plant protection measures	2400	3000	3600	3600	3600	3600	3600	3600
Appl. of plant protection	800	2000	2000	2000	2000	2000	2000	2000
Interculture	2000	2400	2400	2400	2400	2400	2400	2400
Harvesting	1000	2000	2400	2400	2400	2400	2400	2400
Total Expenditure	14931	19131	20131	20131	20131	20131	20131	20131
Rounded off	15000	19000	20000	20000	20000	20000	20000	20000
Surplus	-3430	15710	37850	49420	60990	72560	78345	84130

Annexure IV : Financial Analysis

(Amount in Rs.)

Items	Year											
	1	2	3	4	5	6	7	8	9	10	11	12
Cost of investment	32200	12400	17500	21700	0	0	0	0	0	0	0	0
Maintenance cost	0	0	0	0	21700	21700	21700	21700	21700	21700	21700	21700
Total cost	32200	12400	17500	21700	21700	21700	21700	21700	21700	21700	21700	21700
Benefits	0	0	11570	34710	57850	69420	80990	92560	98345	104130	104130	104130
Net Benefit	-32200	-12400	-5930	13010	36150	47720	59290	70860	76645	82430	82430	82430
D F at 15%	0.87	0.756	0.658	0.572	0.497	0.432	0.375	0.327	0.284	0.247	0.215	1.23
Disc. cost	-28014	-9374	-3902	7442	17967	20615	22234	23171	21767	20360	17722	101389
Disc. benefits	0	0	7613	19854	28751	29989	30371	30267	27930	25720	22388	128080
Net discounted benefits	-28014	-9374	3711.1	12412	10785	9374.4	8138	7095.9	6163	5359.9	4665.5	26691
NPW	139588											
BCR	1.66	: 1										
IRR	44%											

Annexure V : Loan Repayment Schedule

(Amount in Rs.)

Year	Loan O/s at the beginning of the year	Interest@12.0%	Gross surplus	Repayment		Total outgo	Net surplus	Loan O/s at the end of the year
				Principal	Interest			
1	28980	3478	10000	0	3478	0	3478	6522
2	40140	4817	10000	0	4817	0	4817	5183
3	55890	6707	10000	0	6707	0	6707	3293
4	75420	9050	34710	10000	9050	0	19050	15660
5	65420	7850	36150	15000	7850	0	22850	13300
6	50420	6050	47720	20000	6050	0	26050	21670
7	30420	3650	59290	30420	3650	0	34070	25220

* Income from intercrop taken into account for first 3 years

1. Introduction

Sugarcane is a most important cash crop of India. It involves less risk and farmers are assured up to some extent about return even in adverse condition. Sugarcane provides raw material for the second largest agro-based industry after textile. The sugar industry is an instrumental in generating the sizable employment in the rural sector directly and through its ancillary units. It is estimated that about 50 million farmers and their dependents are engaged in the cultivation of sugarcane and about 0.5 million skilled and unskilled workers are engaged in sugar factories and its allied industries. The sugar industry in India has been a focal point for socio-economic development in the rural areas by mobilizing rural resources, generating employment and enhancing farm income.

There are 716 installed sugar factories (Co-operative-326, Private-347 & Public-43) in the country as on 31.01.2016, with sufficient crushing capacity to produce around 330 lakh MT of sugar.

2. Major Sugarcane Growing States

Sugarcane is grown in various states in subtropical and tropical regions of the country. Main sugarcane growing States are:

a) **Sub Tropical**: Uttar Pradesh, Uttarakhand, Haryana, Punjab, Bihar with an annual rainfall of 180 to 2000 mm. The climate ranges from humid, moist sub-humid and dry sub-humid to cold arid, semiarid and arid.

b) **Tropical region**: Karnataka, Tamil Nadu, Maharashtra, Andhra Pradesh, Gujarat, Madhya Pradesh with an annual rainfall of 602 to 3640 mm having moist to dry sub-humid and semi-arid to dry semi-arid climates.

3. Important regions/ zones for sugarcane cultivation in India:

Broadly there are two distinct agro-climatic regions of sugarcane cultivation in India, viz., tropical and subtropical. Tropical region shared about 45% and 55% of the total sugarcane area and production in the country, respectively. Sub-tropical region accounted for about 55% and 45% of total area and production of sugarcane, respectively.

3.1 Tropical Sugarcane region

The tropical sugarcane region includes the states of Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat, Madhya Pradesh, Goa, Pondicherry and Kerala. The coastal areas of A.P. and Tamil Nadu have high sugarcane productivity. Floods, water logging and diseases such as red rot are the main problems. In the tropical region climatic conditions are more favourable for its growth. It is cultivated with better package of practices and higher irrigation levels. The growing season is long with more equitable and favourable conditions without serious weather extremes. Being a tropical country, the agro-climatic conditions of tropical India favour higher sugarcane and sugar yields. The tropical region contributes about 55 per cent to the total cane production in the country. The average cane yields of the major states of the region including Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh and Gujarat is around 80 tonnes per hectare. Maharashtra and the adjoining area of Karnataka, Gujarat and A.P. record higher sugar recovery. Long hours of sunshine, cool nights with clear skies and the latitudinal position of this area are highly favourable for sugar accumulation. Moisture stress during the early part of the cane growths mostly during March to June is a major constraint in the state of Maharashtra & other part of region lacking perennial source of irrigation.

3.2 Sub-tropical sugarcane region

Around 55 per cent of total cane area in the country is in the sub-tropics. U.P, Bihar, Haryana and Punjab comes under this region. Extremes of climate is the characteristic feature of this region. During April to June, the weather is very hot and dry. July to October is rainy season accounting for most of the rainfall from South-West monsoon rains. December and January are the very cold months temperature touching sub-zero levels in many places. November to March are cool months with clear sky. The cane yield is lower in the subtropics due to various reasons viz., short growing season, high temperature disparity besides other factors like moisture stress, pest and disease problem, floods and water logging and very poor ratoons. The average yield of the four major states (U.P, Bihar, Punjab and Haryana) is around 60 tonnes per hectare. However, there is considerable potential to be exploited.

4. Area, Production & Yield of Sugarcane

Area, production & yield of sugarcane in major States during last 6 years & current year is at **Annexure I.** State wise normal area, production & yield of sugarcane is at **Annexure II.** Area, production & yield of major sugarcane countries during 2010 to 2014 is at **Annexure III.**

5. Varieties:- The ruling varieties of sugarcane in different States are given as under:

Andhra Pradesh:

Early varieties: Co.6907, 84A125, 81A99, 83A30, 85A261, 87A298, Co.8014, 86V96, 91V83.

Mid-late Varieties: COA7607, CO8021, COT.8201, Co7805, COV92102 (83V15), 83V288.

Late varieties: Co.7219, CoR8001, 87A380, Co7706

Bihar: Bo 99, CoP 9301, CoSe 98231, CoS 8436, Cos 95255, Bo 102, Bo 91, Bo 110, CoP 9206, CoSe 95422, CoSe 92423, UP 9530.

Gujarat: Co 86002, Co 86032, CoSi 95071, Co 86249, CoN 05072.

Haryana: CoJ 64, CoS 8436, CoS 88230, CoS 767.

Karnataka: Co 94012, CoC 671, Co 92020, Co 8014, Co 86032, Co 62175, Co 8371, Co 740, Co 8011.

Maharashtra: CoC 671, Co 86032, Co 8011, Co 94012, CoM 265, Co 92005.

Odisha: Co 62175, CoA 89085, Co 87A298, Co86V96

Punjab: CoJ 85, CoJ 88, CoS8436, CoH 119, Co89003.

Tamil Nadu: Co 94012, Co 94010, CoC 24.

Uttar Pradesh: CoS 8436, Coj 64, CoS88230, CoS 98231, CoS 767, CoS 8432, CoPt 90223, CoS 92423, CoS97264, CoLk 8102.

Uttrakhand: CoS 8436, CoS 88230, Cos 767, CoS 97264, CoSe 92423

6. Temperature requirement for different growth stages of sugarcane

S.No	Critical Stages of sugarcane	Max. Temp. (^{o}C)	Min. Temp. (^{o}C)	Relative Humidity (%)
1	Germination	32.0	20.0	-
2	Tillering	35.0	18.0	-
3	Grand growth	30.0	14.0	80.85
4	Ripening	30.0	20.0	50-55

7. Soil: Heavy soils with good drainage are preferred for sugarcane cultivation, though it grows well on medium & light-textured soils also with assured irrigation. Soils with 0.5-0.6 % carbon content & pH 6.5 to 7.5 are most suitable for sugarcane growth. In northern India, it is cultivated largely on the loams & clay loams of Gangetic & other alluviums, and in peninsular India, it is grown on brown or reddish loams, laterites and black cotton soils.

8. State and season wise time of sowing and harvesting

Sugarcane take generally one year to mature in sub tropical states (U.P., Punjab, Haryana, Bihar etc.) called "Eksali" however in some tropical states it matures in 18 months (Andhra Pradesh, Karnataka, Maharashtra etc.) called "Adsali". In India, the planting seasons of sugarcane in different States is given at **Annexure-IV.**

9. Method of planting: Sugarcane can be planted as per the recommendation for the region i.e. Autumn Planting (15 Sept. to Oct.) and Spring Planting (Feb. to March). Improved method of planting should be adopted like, deep furrow, trench methods, ring pit method and paired row method instead of furrow system.

10. Seeding technologies

Seed rate: Seed rate in sugarcane varies from region to region. Generally higher seed rate are used in north western India (Punjab, Haryana and Rajasthan) because of the lower germination percent and also adverse climatic condition (very hot weather with desiccating winds) during tillering phase. A northern region seed rate generally varies from 40,000 to 60,000 three budded setts per hectares while in southern region it range between 25,000 to 40,000 three budded setts.

Row spacing: Effect of row spacing from 45 to 120 cm has been tried on growth, yield and quality of sugarcane. Optimum inter rows spacing range between 60-100 cm under different situation and location.

Depth: About 80% of the sugarcane roots go up to a depth 60 cm. Hence deep ploughing of sugarcane fields is necessary. Initially one or two deep ploughings with tractor drawn disc plough or mould board plough or animal drawn mould board plough have to be done at least to a depth of 30 cm. This has to be followed by ploughing with other light tillage implements.

11. Water management

In sugarcane, maintenance of optimum soil moisture during all stages of crop growth is one of the essential requisites for obtaining high yield. The crop should, therefore, be grown in areas of well-distributed rainfall or under assured and adequate irrigation. In tropical India, total water requirement of the crop for optimum growth varies from 2000 to 3000 mm inclusive of rainfall. The requirement of an adsali crop is proportionately higher (3200 to 3500 mm). In sub-tropical India, the water requirement is 1400-1800 mm.

In tropical area, irrigations are to be given once in 7 days during germination phase (1 –35 days after planting), once in 10 days during tillering phase (36 – 100 days after planting), again once in 7 days during grand growth phase (101 – 270 days after planting)

and once in 15 days during maturity phase (271 days after planting up to harvest) adjusting it to the rain fall pattern of the area. About 30 to 40 irrigations are needed. About 250 tonnes of water is needed to produce one tonne of sugarcane. Methods like alternate furrow irrigation, drip irrigation and trash mulching could be of use to economize irrigation water during water scarcity periods. Foliar spraying of a solution containing 2.5% urea and 2.5% muriate of potash 3 or 4 times at fortnightly intervals during drought periods would help to reduce the impact of drought on the crop. Critical stages are those during which sugarcane is affected severely due to water stress and the loss cannot be restituted by adequate water supply at later stages. These stages are: sprouting (germination), formative stage or tillering, ripening and initiation of sprouting in ratoons. In case of limited water availability, one may sustain sugarcane productivity by irrigating at critical stages of growth.

12. Fertilizer Requirement

The nitrogen requirement of sugarcane depends upon the soil & climate. It ranges from 150 kg/ha in Uttar Pradesh to 270 kg/ha in Tamil Nadu and 300 to 500 kg/ha in Maharashtra & Karnataka. Nitrogen is given in the form of urea applied one-third at planting & the remaining two-thirds in 2 equal splits at tillering & at the commencement of grand growth stage. The fertilizers may also be applied as basal dose through diammonium phosphate to supply full P & part of N.

The phosphorous is required at 40-60 kg of P_2O_5/ha. The response of sugarcane to potassium has been obtained only in localized pockets of light soils. Nowadays deficiency of sulphur is constantly increasing in Indian soils & it has become a limiting factor in sugarcane culture. In marginally deficient soils, the application of 40-60 kg S/ha has been found to be useful. 20-30 kg $ZnSo_4$/ha and FYM/Compost of 10 tonnes/ha may be applied.

13. Weed Management in Pure Crop of Sugarcane

i. Spray Atrazine 2 kg or Oxyflurofen 750 ml/ha mixed in 500 ltr. of water as pre emergence herbicide on the 3rd day of planting, using deflector or fan type nozzle.
ii. If pre-emergence spray is not carried out, go in for post-emergence spray of Grammaxone 2.5 litre + 2,4-D sodium salt 2.5 kg/ha in 500 litre of water on 21st day of planting.
iii. If the parasitic weed striga is a problem, post-emergence application of 2,4-D sodium salt @ 1.25 kg/ha in 500 litre of water/ha may be done. 2, 4-D spraying should be avoided when neighbouring crop is cotton or bhendi.
iv. Apply 20% urea also for the control of striga as direct spray.
v. Pre- plant application of glyphosate at 2.0 kg/ha along with 2% ammonium sulphate at 21 days before planting of sugarcane followed by post emergence direct spraying of glyphosate at 2.0 kg/ha along with 2% ammonium sulphate with a special hood on 30 DAP suppressed the nut sedges *(Cyperus rotundas*) and provided weed free environment.
vi. If herbicide is not applied work the junior-hoe along the ridges on 25, 55 and 85 days after planting for removal of weeds and proper stirring.
vii. Remove the weeds along the furrows with hand hoe. Otherwise operate power tiller fitted with tynes for intercultivation.

Weed management in Sugarcane intercropping system

Pre-emergence application of Thiobencarb @ 1.25 kg ai/ha under intercropping system in Sugarcane with Soybean, blackgram or groundnut gives effective weed control.

14. Sugarcane prevailing cropping system in India:

Cropping system for Sub tropical	Cropping system for Tropical region
Paddy- Autumn Sugarcane-ratoon-wheat	Bajra-Sugarcane(pre-seasonal)-Ratoon-wheat
Greengram- Autumn Sugarcane-ratoon-wheat	Paddy-Sugarcane-Ratoon- Finger millet
Maize- Autumn Sugarcane-ratoon-wheat	Paddy-Sugarcane-Ratoon- Wheat
Kharif Crops-Potato-Spring Sugarcane-ratoon-Wheat	Paddy-Sugarcane-Ratoon- gingelly
Kharif Crops-Mustard-Spring Sugarcane-ratoon-Wheat	Paddy-Sugarcane-Ratoon- urd.
Kharif Crops-Pea/Coriander-Spring Sugarcane-ratoon-Wheat	Cotton-Sugarcane-Ratoon–wheat
Kharif Crops-Wheat-late Planted Sugarcane-ratoon-Wheat	Sugarcane-Ratoon-Kharif rice-Winter rice.

15. Constraints in sugarcane cultivation

a) **Sub-tropical Region**: Long winters, low Sun shine hours, high temperature disparity, lack of early maturing high sucrose varieties, poor ratoon management, late planting, water logging, imbalance use of fertilizer, incidence of disease and pests, inadequate availability of quality seed, etc.

b) **Tropical Region:** Lack of irrigation in many states, inadequate availability of quality seed, incidence of disease and pests, poor ratoon management, etc.

16. Strategies for increasing production and productivity of sugarcane

Sugarcane is long duration crop maturing in 12-14 months. The planting method vary place to place, therefore, the states has to encourage optimum use of water & space. Due to long crop duration inter cropping is a major tool to enhance higher returns to the farmers. The main strategies for increasing production and productivity of sugarcane in the country are as under:

i. Popularization of new varieties by providing support for breeder seed production.
ii. Thrust for transfer of technologies through demonstration and training of farmers and extension workers.
iii. Production of quality planting materials including tissue culture plantlets.

iv. Training to the field functionary & farmers for popularizing various technology including Ratoon Management

v. Demonstration on intercropping

vi. Establishment of bio-agent and tiusse culture labs.

vii. The states have flexibility to take support for sugarcane development for any recommended / proven technology /inputs under RKVY.

17. Researchable and Developmental issues:

Following are the major researchable issues:

i. Development of high yielding & high sugar varieties.

ii. Area specific package of practices for popularizing the intercropping module in sugarcane based cropping system.

iii. Assessment and refinement of agro-techniques for sustainable farming system and management of sugarcane under late planting situation.

iv. Development of module for controlling shoot borers, pyrilla, white grub and mealy bug in sugarcane.

v. Designing, developing, sugarcane harvester suited in Indian conditions particularly economical for small holdings.

Developmental issue:

i. Strengthening of seed production programme.

ii. Cluster approach in Transfer of Technology with modern tools.

18. Technical interventions under Promotion

- On Farm Water Management (OFWM) component of National Mission for Sustainable Agriculture (NMSA) provided support for propagation of micro irrigation system like drip irrigation/rain-gun sprinkler and adoption of improved method of irrigation i.e. furrow and skip furrow irrigation instead of flood irrigation in crops including sugarcane.
- Strengthening of seed production programme through tissue culture, single eye bud and poly bag technology, chip bud method, etc under NFSM.
- Introduction of partial mechanization so as to reduce cost of cultivation under Government of India schemes.
- Popularization of inter-cropping of sugarcane with wheat, oilseeds, vegetables, pulses, etc.

- Transfer of innovative bud chip technology through demonstration on the farmers field, training etc.

19. SUGARCANE DEVELOPMENT PROGRAMMES

a) Background of Sugarcane Schemes:

The Department of Agriculture, Cooperation & Farmers Welfare has implemented sugarcane development programme under Centrally Sponsored scheme of Sustainable Development of Sugarcane Based Cropping System (SUBACS) under the Macro Management Mode in Agriculture (MMA) scheme upto 2012-13. The Scheme was shifted under Rashtriya Krishi Vikas Yojana (RKVY) during 2013-14.

b) National Food Security Mission - Commercial Crops ((NFSM-CC) - Sugarcane

From 2014-15, Government has approved implementation of sugarcane development programme under NFSM-CC in 13 States (Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Tamil Nadu, Telengana, Uttar Pradesh and Uttarakhand). Under this scheme thrust has been given on transfer of technology through frontline demonstrations and training in order to extend benefits to the farmers. From 2015-16, NFSM is being implemented on sharing basis between Government of India and States on 60:40 basis for general category states & 90:10 basis for North East & hilly states. However, the Central Agencies are funded 100% by GOI. Pattern of Assistance under NFSM-CC-Sugarcane is at **Annexure-V**. Allocation of funds under NFSM-Sugarcane is at **Annexure-VI**.

20. Products and by- products of Sugarcane

Sugarcane based Sugar industry is one of the largest and important industry in tropical and sub tropical countries of the world. The Sugarcane plant offers a huge potential, not only as the sucrose of a very important food but also as a source of energy and valuable commercial products from fermentation and chemical synthesis. Sugarcane processing is focused on the production of cane sugar from sugarcane. Sugarcane is considered as one of the best converters of solar energy into biomass and Sugar. Sugarcane is a rich source of food (Sucrose, jiggery and syrups), fiber (cellulose), fodder (green top, bagasse, molasses) fuel and chemicals (Bagasse molasses & alcohol). During the process of sugar production, the main by product of cane sugar industry are Bagasse, Molasses and Press mud. The other co-products and by products of less commercial value are Green leaves, green tops, trash,

Boiler ash and effluents generated by sugar industry and distillery. There are many other industries which are based on sugarcane by diversification and utilization of co-products and by products of the sugar industry, instead of merely depending on production of sugar. Thus the effort should be for integral utilization of sugarcane, its co products and by products to produce many value added products, to derive maximum benefits from sugarcane crop.

Ethanol from Sugarcane

The major source of ethanol production in the country is via sugarcane-sugar-molasses route. This provides better economy by sale of sugar and molasses becomes the by-product of the sugar. A tonne of sugarcane produces 100 kg. sugar as well as 40 kg. molasses; the latter will produce about 10 litres of ethanol. On the other hand, one tonne sugarcane will produce 72-75 litres of ethanol. Likewise, a tonne of molasses produces about 220-250 litres of ethanol.

The 10% blending requires about 266.50 crore litres of Ethanol. If this Ethanol is produced directly from cane juice, around 5.08 lakh ha area under sugarcane is needed. In case (as the case today in the country) Ethanol is produced from molasses route, about 38.07 lakh ha sugarcane area is needed. Under molasses route, it will not affect sugar production as molasses is byproduct during production of sugar.

21. SUGARCANE PRICING POLICY OF THE GOVERNMENT

- For every sugar season, the Central Government fixes the Fair and Remunerative Price (FRP) of sugarcane (earlier called Statutory Minimum Price) having regard to the factors mentioned in clause 3(1) of the Sugarcane (control) Order, 1966, based on the recommendations of the Commission for Agricultural Costs and Prices (CACP) and after consultations with State Governments and other stake-holders.
- The FRP is a benchmark guaranteed price of sugarcane determined by the Central Government below which no sugar mill can purchase sugarcane from cane growers.
- However, the State Governments of States viz. Punjab, Haryana, U.P, Uttarakhand, and Tamil Nadu announce the State Advised Prices (SAP) which is normally higher than the FRP.
- Fixing of SAP at a price higher than FRP compounds the problem of cane price arrears.

- The following table indicates the FRP over the years:-

Sugar Season	FRP in Rs per quintal
2009-10	129
2010-11	139
2011-12	145
2012-13	170
2013-14	210
2014-15	220
2015-16	230
2016-17	230

22. Statistics on sugar

Production, Export, Import & Recovery (%) of Sugar during 2010-11 to 2014-15

Sugar Season (Oct-Sept)	Production of sugar (lakh tonnes)	Export (lakh tonnes)	Import (lakh tonnes)	Sugar Recovery (%)
2010-11	243.50	28.14	3.65	10.17
2011-12	263.43	36.74	1.886	10.25
2012-13	251.83	12.02	17.12	10.03
2013-14	245.54	26.85	10.788	10.23
2014-15	284.63	24.32	12.82	10.37

(Source: Website of Department of Food & Public Distribution, Data on sugar recovery (%) has been taken from website of IISR, Lucknow)

Ex-Mill & Retail Prices of Non-Levy Sugar

Sugar Season (Oct-Sept)	Range of Ex-Mill Prices of sugar (Rs per quintal)	Range of retail Prices of sugar (Rs per kg)
2009-10	2500-4400	25.00-47.00
2010-11	2350-3090	28.00-34.00
2011-12	2540-3735	31.17-43.70
2012-13	2810-3685	32.74-41.00
2013-14	2420-3300	31.00-36.00
2014-15	2050-2860	29.35-35.87
2015-16 (upto March, 2016)	2350-3500	30.55-34.64

(Source: Website of Department of Food & Public Distribution)

Export of sugar to Top 5 countries from India

Country	Unit	Qty	Oct'15 to Sep'16 Value (INR)
MYANMAR	TON	1436289	39792400513
SOMALIA	TON	458633	13118551910
SUDAN	TON	391134	11180187807
DJIBOUTI	TON	207674	6115085538
SRI LANKA	TON	188928	5228528512

Import of sugar from Top 5 countries to India

Country	Unit	Qty	Oct'15 to Sep'16 Value (INR)
BRAZIL	TON	1900986	44930352819
U S A	TON	328	115599163
GERMANY	TON	319	96111692
FRANCE	TON	1016	80432363
U K	TON	1005	63736374

(Source: Directorate General of Commercial Intelligence and Statistics (DGCI&S), Kolkata)