

PROJECT PROFILE ON BANANA CULTIVATION

1. Introduction

Banana (*Musa* sp.) is the second most important fruit crop in India next to mango. Its year round availability, affordability, varieties range, taste, nutritive and medicinal value makes it the favourite fruit among all classes of people. It has also good export potential.

Hi-tech cultivation of the crop is an economically viable enterprise leading to increase in productivity, improvement in produce quality and early crop maturity with the produce commanding premium price.

Banana is a very popular fruit due to its low price and high nutritive value. It is consumed in fresh or cooked form both as ripe and raw fruit.

2. Market demand

Although banana is the main fruit in international trade and the most popular one, ranking second after citrus in terms of value, main banana producing countries, such as India or Brazil, are hardly involved in it.

Bananas are imported mainly by the European Union, the United States of America and Japan, which together accounted for about 70% of world total imports in 2002, while the first ten banana importing countries represented more than 86% of total imports (considering the EU as a whole). Markets such as the Russian Federation, China or Eastern European countries are emerging now as destinations for banana exports.

India exports bananas mainly to Middle East countries viz. U.A.E., Saudi Arabia, Oman, Bahrain, Qatar. The varieties which are in demand internationally include Grand Naine and Cavendish.

3. Agro-climatic requirements

Banana, basically a tropical crop, grows well in a temperature range of 15°C – 35°C with relative humidity of 75-85%. It prefers tropical humid lowlands and is grown from the sea level to an elevation of 2000m. above m.s.l.. In India this crop is being cultivated in climate ranging from humid tropical to dry mild subtropics through selection of appropriate varieties. Chilling injury occurs at temperature below 12°C. High velocity of wind which exceeds 80 km /hr. damages the crop. Four months of monsoon (June to September) with an average 650-750 mm. rainfall are most important for vigorous vegetative growth of banana. At higher altitudes, banana cultivation is restricted to a few varieties like 'Hill banana'.

Deep, rich loamy soil with pH between 6.5 – 7.5 is most preferred for banana cultivation. Soil for banana should have good drainage, adequate fertility and moisture. Saline solid, calcareous soils are not suitable for banana cultivation. A soil which is neither too acidic nor too alkaline, rich in organic material with high nitrogen content, adequate phosphorus level and plenty of potash is good for banana.

4. Cultivation practice

Growing and Potential Belts

1. Khandwa, Badwani, Khargaon, Dhar are the district where Banana are cultivated in the state of Madhya Pradesh.
2. Variety : Basrai

3. Land Preparation

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Prior to planting banana, green manuring crop like daincha, cowpea etc. may be grown. The land can be ploughed 2-4 times and leveled. Ratovator or harrow is used to break the clod and bring the soil to a fine tilt. During soil preparation basal dose of FYM (about 50 tonnes/ha. before last harrowing) is added and thoroughly mixed into the soil.

4. Planting

5. Planting Material

About 70% of the farmers are using suckers as planting material while the rest 30% of the farmers are using tissue culture seedlings. Sword suckers with well developed rhizome, conical or spherical in shape having actively growing conical bud and weighing approximately 450-700 gm are commonly used as propagating material.

Suckers generally may be infected with some pathogens and nematodes. Similarly due to the variation in age and size of sucker, crop is not uniform, harvesting is prolonged and management becomes difficult. Therefore, in-vitro clonal propagation i.e. Tissue culture plants are recommended for planting. They are healthy, disease free, uniform in growth and early yielding.

6. Treatment of Planting material

The roots and base of the planting material may be removed. The suckers are dipped in a solution of 0.5 % monocrotophos and bavistin (0.1%) before planting.

7. Planting season

Planting of tissue culture banana can be done throughout the year as per the market demand except when the temperature is too low or too high. The planting time may be adjusted so as to avoid high temperature and drought at the time of emergence of bunches (i.e. approx. 7-8 months after planting). The planting time for long duration cultivars is different from short duration ones.

8. Spacing

Traditionally banana growers plant the crop at 1.5m x 1.5m with high density; however plant growth and yields are poor because of competition for sunlight. The region like north India, coastal belt and where humidity is very high and temperature falls down upto 5-7°C, the planting distance should not be less than 2.1m x 1.5m.

Season	Spacing
Kharif	1.5 x 1.5 m., 2 x 2 m. or 2.5 x 2.5 m.
Rabi	1.5 x 1.2 m., 1.5 x 1.37 m.

Banana planting is carried out on the basis of patta double line method. In this method, the distance between the two lines is 0.90 to 1.20 m. while plant to plant distance is 1.2 to 2 m. Due to this spacing, intercultural operations can be carried out easily and cost of drip irrigation is decreased. Experiments carried out recently show that good quality banana and heavy bunch can be achieved by keeping the planting distance at 1.8 X 1.8 m. However, to get maximum yield plantation is done at 1.2 X 1.5 m.

9. High Density Planting

High density planting is in practice to accommodate 4444 to 5555 plants per ha. and yield of plants is recorded to be in the order of 55-60 tonnes/ha. or even more. In general square or rectangular system of planting is a common practice followed by the cultivators. Planting 3 suckers / pit at a spacing of 1.8 x 3.6 m. (4,600 plants per ha.) for Cavendish varieties and 2 x 3 m. for Nendran (5000 plants per ha.) varieties are also followed.

10. Planting Method

Pit planting is commonly followed in garden system of cultivation. A pit size of 0.5 x 0.5 x 0.5 m. is normally required. Small pits are dug in case of ridges and furrows. The pits are to be refilled with topsoil mixed with 10 kg of FYM (well decomposed), 250 gm of neem cake and 20 gm of carbofuran. Prepared pits are left open for 15-20 days for solar radiation to kill all the insects, soil borne diseases and for aeration before refilling. In saline alkali soil where pH is above 8, pit mixture is to be modified incorporating organic matter and gypsum.

The suckers are planted in the centre of the pit and soil around is compacted. Plants are planted in the pits keeping pseudostem 2cm below the ground level. Soil around the plant is gently pressed. Deep planting should be avoided. The field is irrigated immediately after planting.

Furrow planting is practiced in annual planting system in the states of Gujarat and Maharashtra. Trench planting is practiced in wet land cultivation of Cauvery delta region of Tamil Nadu.

11. Nutrition

Banana requires high amount of nutrients, which are often supplied only in part by the soil. Nutrient requirement (worked out on all India basis) is 10 kg FYM, 200 - 250gm N; 60-70gm P; 300gm K/plant. Banana crop requires 7-8 Kg N, 0.7- 1.5 Kg P and 17-20 Kg K per metric ton yield. Traditionally farmers use more of urea and less of phosphorous and potash. Urea is applied in three to four split doses.

About 100 g. of N/plant as top dressing in three equal split doses 60, 90 and 120 days after planting. Further application of 100 g. potash and also 40 g. of phosphorus are essential and applied at planting. Application of full dose of P and K at planting and N in three equal doses in shallow rings about 8-10 cm. deep are recommended.

Application of 150 g. N in vegetative phase and 50 g. N in reproductive phase enhances the yield. Application of 25% N as farmyard manure and 1 kg. neem cake is beneficial. The application of 25 % N in organic form, 75 % N in inorganic form along with growing green manure crops is found to be beneficial. The requirement of phosphorus is comparatively low. Superphosphate forms the major source of P followed by the application of rock phosphate 50-95 g./ plant at planting. In acidic soils, triple superphosphate or diammonium phosphate is recommended. Phosphorus is applied in single dose at the time of planting and quantity of P_2O_5 depends upon the soil type and varies from 20 to 40 g. /plant.

Potassium is indispensable in banana cultivation due to its role in vital functions. It is not stored and its availability is influenced by temperature. Thus continuous supply is required at finger filling stage. Application of K (100 g.) in two splits during vegetative phase and 100 g. in two splits during reproductive phase is recommended. Application of 200-300 g. K_2O is recommended depending upon the cultivar. Plantains need higher K than other group of cultivars. Muriate of potash is generally used as a source of K. But in soils with pH above 7.5, potassium sulphate is advantageous.

Calcium influences yield through its interaction with N, P and K. In acidic soils, use of dolomite (Mg_2CO_3) and limestone ($CaCO_3$) as soil amendments is common.

In case of acute Mg deficiencies, foliar application of $Mg SO_4$ is found to be effective. Although sulphur deficiency in soils has been reported in some cases but is not a serious problem in case of banana. Sulphur uptake is active during sucker to shooting stage but after shooting sulphur supply comes from leaves and pseudostem.

12. Irrigation

Banana being a succulent, evergreen and shallow rooted crop requires large quantity of water for increasing productivity. Water requirement of banana has been worked out to be 1,800 – 2,000 mm per annum. In winter, irrigation is provided at an interval of 7-8 days while in summer it should be given at an interval of 4-5 days. However, during rainy season irrigation is provided if required as excess irrigation will lead to root zone congestion due to removal of air from soil pores, thereby affecting plant establishment and growth. In all, about 70-75 irrigations are provided to the crop.

Banana production should be supported by an efficient irrigation system like drip irrigation. Normal furrows, basin and trench systems are followed. Application of drip irrigation and mulching technology has reported to improve water use efficiency. There is saving of 58% of water and increasing yield by 23-32% under drip. Besides, the system also enables efficient fertilizer application through the fertigation technique.

13. Intercultural Operations

The following inter-cultural operations are recommended for optimum productivity of the crop :

- i) Spraying of Glyphosate before planting @ 2 lit/ha is carried out to keep the plantation weed free.
- ii) Four to five weedings are to be done whenever necessary.
- iii) Harrowing the field three to four times to keep the soil loose. Earthing up should be done at 3-4 months after planting raising the soil level around the base of the plant by 10-12". It is better to prepare a raised bed and keep the drip line on bed 2-3" away from the plant. It also helps to protect plants from wind damage and production losses to some extent.

14. Dehusking

Removal of unwanted suckers is a critical operation in banana for reducing internal competition with the main plant. Small suckers are removed on regular basis upto 7-8 months.

15. Propping

Due to heavy weight of bunch the plant goes out of balance and the bearing plant may lodge and production and quality are adversely affected. Therefore they should be propped with the help of two bamboos forming a triangle by placing them against the stems on leaning side. This also helps in uniform development of bunch.

16 Bunch cover & spray

Covering bunch using dried leaves of the plant is economical and prevents bunch from direct exposure to sunlight and also enhances the quality of fruit. But in rainy season this practice should be avoided. Sleeving of bunch is done to protect fruits against dust, spray residue, insect and birds. Transparent and perforated polythene sheets with 2% (during cool season) – 4% (during summer season) ventilation may be used to cover bunches. This may be combined with neem cake application (1 kg./ha.) . It increases the temperature around developing bunch and also helps in early maturity.

Spray of monocrotophos (0.2%) after emergence of all hands is effective in controlling the thrips. Thrips attack discolors the fruit skin and makes it unattractive.

17 Dehandling of false hands of bunch

Some incomplete hands in a bunch which are not fit for quality produce should be removed soon after bloom. This helps in improving the weight of other hands, finger size and improved skin : pulp ratio to meet the export standards.

18 Mulching

Use of wheat straw and banana straw as a mulch material (12.5 kg./plant) in banana orchards is useful in increasing the bunch weight and conservation of soil moisture. The mulch is applied at the beginning of summer (February).

19 Other farm operations

Other farm operations include the following :

- i) Removal of dry leaves (green leaves should not be removed).
- ii) During the winter months if temperature goes below 10⁰ C, growth of the plant is affected. Under such circumstances, irrigation is to be provided at night or smoking is to be done by inducing fire.
- iii) If neem cake of 1 kg. per plant is applied during winter months, the formation of bunch becomes easier.
- iv) Plantation should be protected from strong winds by growing tall plants along the farm border.
- v) Bamboo poles or eucalyptus poles are used for giving support to the banana plant.

20 Harvesting and Yield

Banana is harvested when the fruit is slightly or fully mature depending on the market preferences. For long distance transportation, harvesting is done at 75-80 % maturity. The fruit is climacteric and can reach consumption stage after ripening operation.

The planted crop gets ready for harvest within 12-15 months of planting and the main harvesting season of banana is from September to April. Bunches attain maturity from 90-150 days after flowering depending upon variety, soil, weather condition and elevation. Bunch should be harvested when fingers of second hand from top are 3/4 rounded with the help of sharp sickle 30cm above the first hand. Harvest may be delayed upto 100-110 days after opening of the first hand. Harvested bunch should generally be collected in well padded tray or basket and brought to collection site. Bunches should be kept out of light after harvest, since this hastens ripening and softening. For local consumption, hands are often left on stalks and sold to retailers.

The dwarf varieties are ready for harvesting within 11 to 14 months after planting while the tall varieties take about 14 to 16 months. After harvest of bunch, only leaves are to be cut and plant system is retained for ratoon crop development. This improves the food supply and about 15 % can be saved on irrigation. For getting good quality banana, only 7 to 8 berries are to be retained in a bunch.

First ratoon crop would be ready by 8-10 month from the harvesting of the main crop and second ratoon by 8-9 months after the second crop. Thus over a period of 28-30 months, it is possible to harvest three crops i.e. one main crop and two ratoon crop. The yield of banana depends on a number of factors such as variety, plant density, management practices etc.

Table - 4 : Variety-wise average yield of banana (tonnes/ha.)

Varieties	Average yield (tones/ha.)
Basrai, Rasthali	40-50
Shrimanti	70
Grand Naine	65
Ardhपुरी , Meanyham	55
Hirsal, Safed Velchi, Red banana, Lal Velchi	45
Poovan	40-50
Monthan	30-40
Dwarf Cavendish , Robusta Champa & Chini desi	50-60
Nendran	30-35

21 POST HARVEST MANAGEMENT

Grading

Grading is mainly based on size, colour and maturity of the fruits. While grading, smaller fruits are separated from the larger ones in order to achieve uniform ripening. Immature, overripe, damaged and diseased fruits are discarded in the process of grading.

The fruits are generally harvested early in the season at a pre-mature stage to capture early market. Ethylene application is the best method to hasten ripening without loss in fruit quality and flavour. Mature fruits are ripened with lower doses of ethrel for uniform colour development (slow ripening under controlled condition at 15⁰-18⁰ C).

Storage

Mature green bananas can be stored for upto 3 weeks in ethylene free air or upto 6 weeks in a controlled atmosphere at 14⁰ C.

Packing

Wooden or cardboard boxes, rectangular in shape and bamboo baskets are used for packaging and transportation of fruits. In some cases banana bunches are packed in old gunny bags wrapped with banana leaves. Due to poor packing quality the bananas deteriorate and fetch low price.

Packing of hands or dehandled fruits in polythene (about 100 gauge polythene bags with 0.2% holes) enhance the shelf life under room temperature as well as in cold storage, while polythene bags without perforations develop fungal infections due to high humidity.

High quality bananas are generally exported. Firstly, fingers are removed from the bunch and washed in water. Then they are washed in dilute sodium hypochloride solution to remove the latex, dipped in 0.1 % of carbendazime solution and finally air dried. These fingers are graded on the basis of their length & girth and packed in plastic corrugated fibre board (CFB) cartons having capacity of about 13 to 14.5 Kg. A suitable packing material like foam etc. may be used. These boxes are kept at 13-15⁰ C temperature and 80-90% humidity having cold storage. Bananas can be stored in such controlled atmosphere in a cooling chamber for a period of 20-25 days. The bananas are to be exported via cold chain of shipment at 13⁰ C and refrigerated vans in the country.

Transportation

Road transport by trucks/lorries is the most popular mode of transport due to easy approach from orchards to the market. For distant markets rail wagons are used.

Marketing

Several intermediaries like wholesalers and commission agents, are involved in marketing of the fruit. Private traders carry out nearly 95% of the trade and even provide credit to farmers for cultivation, but at high rate of interest. Cooperatives account for the balance 5% of the volume of trade.

22 ECONOMICS OF A ONE ACRE MODEL

High quality commercial cultivation of crop by using tissue culture planting material and drip irrigation leads to multiple benefits viz.

- Synchronized growth, flowering and harvesting;
- Reduction in variation of off-type and non-fruit plants;
- Improved fruit quality;
- Makes possible harvesting of three crops within 36 months and harvesting of 99% plants;
- Increases average productivity by more than 60%.

23 Costs & Returns

A one acre plantation of the crop is a highly viable proposition. The cost components summary is given in the figure below. The project cost works out to Rs.1.25 lakhs.

Figure-I : COST OF PROJECT

Project Cost:

(Amount in Rs.)		
Sl. No.	Component	Proposed Expenditure
1.	Plantation Expenses	
	(i) Cost of planting material	11,000
	(ii) Manures & fertilizers	5,000
	(iii) Insecticides & pesticides	2,000
	(iv) Cost of Labour	5,000
	(v) Others, if any, (Power)	2,000
		25,000
2.	Irrigation	
	(i) Tube-well/submersible pump	40,000
	(ii) Cost of Pipeline	-
	(iii) Others, if any, please specify	-
		40,000
3.	Cost of Drip/Sprinkler	25,000
4.	Infrastructure	
	(i) Store	-
	(ii) Labour shed & Pump house	10,000
	(iii) Farm Equipment	1,000
		11,000

5.	Land Development	
	(i) Soil Leveling	4,000
	(ii) Digging	-
	(iii) Fencing	20,000
	(iv) Others, if any, please specify	-
		24,000
6.	Land, if newly purchased (Please indicate the year)	@
	Grand Total	1,25,000

@Cost of newly purchased land will be limited to 10% of the total project cost.

24 The major components of the model are:

- Land Development: (Rs.4.00 thousand): This is the labour cost of shaping and dressing the land site.
- Fencing (Rs.20.00 thousand): It is necessary to guard the orchard by barbed wire fencing to safeguard the valuable produce from animals and prevent poaching. This is part cost of fencing.
- Irrigation Infra-structure (Rs.40.00 thousand): For effective working with drip irrigation system, it is necessary to install a bore well with diesel/electric pumpset and motor. This is part cost of tube-well.
- Drip Irrigation & Fertigation System (Rs.25 thousand): This is average cost of one acre drip system for banana inclusive of the cost of fertigation equipment. The actual cost will vary depending on location, plant population and plot geometry.
- Equipment/Implements (Rs.1.0 thousand): For investment on improved manually operated essential implements a provision of another Rs.1.00 thousand is included.
- Building and Storage (Rs.10.0 thousand): A one acre orchard would require minimally a labour shed and a pump house which could be used as store also.
- Cost of cultivation (Rs.24.90 thousand): Land preparation and planting operations will involve tractor hiring and manual labour, the cost of which will come to Rs.4.90 thousand. The cost of planting material works out to Rs. 11.0 thousand i.e. 2200 plants @ Rs. 5 per plant.

25 Labour cost has been put at an average of Rs. 70 per man-day. The actual cost will vary from location to location depending upon minimum wage levels or prevailing wage levels for skilled and unskilled labour.

26 Recurring Production Cost: The main components are planting material, land preparation, inputs .application (FYM, fertilizers, liming material, plant growth regulators, plant protection chemicals etc.) and labour cost on application of inputs, inter-cultural and other farm operations.

27 Besides, provision is also included for power charges, protection of the plantation (cost of material for wind protection and polythene bunch covers), labour for harvesting and packing/transportation charges for the produce to the nearest secondary market. The total recurring production cost for a one acre orchard works out as below:

(Rs.Thousand)

Year 1	25.40
Year 2	14.70
Year 3	14.30

28 Returns from the Project: The yield from the plantation is estimated at 22 tonnes (per acre) comprising 12 tonnes from the main crop and 10 tonnes from the following two ratoon crops. Valued at Rs.6500 per tonne the total realization of the three crops works out to Rs.1.43 lakhs.