Short duration fruit crops for income enhancement of farm family

Technical Bulletin-23

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2013

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Citation - Babu, Naresh, Srivastava, S.K., Attri, B.L. Shukla, A.K and Prusty, M. 2013. .Short duration fruit crops for income enhancement of farm family. Tech. Bull. pp 28.

Published by
Director,
Directorate of Research on Women in Agriculture
P.O. Baramunda, Bhubaneswar 751003
Phone:+91-674-2386241
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E-mail:nrcwa@nic.in
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Printed at
Capital Business Service & Consultancy
B-51, Sahid Nagar, Bhubaneswar-751007
E-mail : capital.a1press@gmail.com

Preface

Fruit crops play a vital role in economy of the nations and provide basic needs like food, fodder, fuel and fibre. They are termed as protective foods as they are rich source of vitamins and minerals. Fruit production is remunerative and has high productivity per unit area. India is producing about 74.87 million tonnes fruits from 6.38 million hectare ranking 2nd after Brazil; however, there is ample scope of improvement in productivity. Among various crops, fruit crops contributed 31 percent of total production. Despite the 2nd largest producer, per day per capita availability of fruits (80gm) is far less than the dietary standard (140gm fruits) recommended by Indian Council of Medical Research and National Institute of Nutrition. Women, in general, play important role specifically in short duration fruit crops. A large variety of fruits is grown in India. Of these banana and papaya are the most important short duration fruit crops and available more or less throughout the year. People are consuming these fruits as fresh when ripe and as vegetable when unripe. Being of short duration, these fruit crops provide income to the farmers within a year or two. Presently they are gaining popularity in kitchen gardens because of high return and nutritional value. Fruit crops generate off- farm employment, especially for women in post harvest handling and value addition. Thus, nutrient rich fruit crops besides maximizing the production provide more income and employment to ensure sustainable development of farm families. However, with the traditional method, small and marginal farmers find it difficult to produce adequate food to feed their families. The intensive use of land through profit making crops is the only way to convert these holdings into profit- making ones. This publication encompassing suitable recommendations on varieties, nutrients management, intercropping, shelf life improvement, value addition and cost analysis. I believe that this publication will be helpful for researchers, state officials, extension workers and farmers in getting valuable information for ensuring nutritional security through such short duration fruit crops.

I appreciate the efforts made by Dr. Naresh Babu and his team in bring out this publication.

Bhubaneswar
Date: 03.07.2013

M.P.S. Ayra
Director

maize is grown in more than 130 countries, occupying 88.43 lakh ha with a total production of 97.15 million tonnes. India is largest producer in the world with a total production of 29.78 million tonnes from 8.30 lakh ha (N.H.B., 2011) which is 2 percent of world's banana production. It is an important fruit crop having great religious and economics value as its whole plant is utilized for worship, culinary and ripened fruits for table purpose. It is also important from the nutritional point of view due to high carbohydrate content, vitamins and minerals. Banana is gaining popularity in kitchen gardens because of high returns. Since women are involving in kitchen gardens and maintained local variety with traditional method resulting low production. Therefore, an experiment was conducted to find out the cultivar suitable for backyard cultivation. For that purpose five varieties of banana viz. Robusta, G-9, Patakapura, Banthal and Karpuravalli (propagated by both tissue cultures and suckers) were tested. Results showed that Robusta banana had minimum plant height 157. 40 cm in tissue culture and 179.13cm in sucker, plant circumference and early in crop duration, suitable for backyard cultivation. Performance of some genotypes of banana have been reported in earlier study (Babu, 2001). Being dwarfing and less spreading type it is easily accommodated in homestead garden without hindrance of sufficient light and creating a barrier for other harmful insects. Moreover, due to earliness in harvesting the women may get higher returns in the market. Maximum suckers/ plant, weight of fruit and yield were observed in G-9. Women may multiply planting materials and earn additional income by selling it (Table1).

PAPAYA

Papaya is an important fruit crop ranks fourth in production, occupying 41.96 lakh tonnes (N.H.B., 2011) which is 5.60 percent of total fruit production. Papaya (*Carica papaya* L.) belonging to the family Caricaceae was introduced in India in 16th century by the Portugese. It produces fruits through out the year and suitable for backyard cultivation. It

requires less area, comes to fruiting in a year is easy to cultivate and provides more income /ha next to banana. It has a high nutritive and medicinal value. It is used as vegetable if harvested prematurely, while ripe fruit is also widely used. In has been observed that farmers are not getting sufficient yield from their production system due to local varieties and improper management of the crop. Therefore an experiments were carried out to find out the varieties suitable for backyard cultivation. Under this experiment we have collected and screened twelve variety of papaya e.g. Farm Selection, Manjil, Madhu, Bankim, Co5, Ranchi, PY-06-011, Co2, Pusa Dwarf, Anjil, Honey Dew and Ranchi Dwarf in order to select out the suitable among them for homestead production. Results revealed that the lowest plant height was recorded in Pusa Dwarf (97.64 cm) followed by Ranchi Dwarf and Farm Selection. Maximum fruits/ plant (34.27) were recorded in Farm Selection (Babu and Sharma, 2002). Women may include these varieties in their backyard cultivation for income generation and nutritional security. Yield was more (38.59kg) in Pusa Dwarf followed by Farm Selection. Lowest seed content (3.21 g) was recorded in Pusa Dwarf followed by Ranchi and Co-2. Women preferred these varieties due to higher yield, less seed and peel contents. Based on feedback collected from women, all varieties were suitable for vegetable in immature condition and good in taste except PY-06-11 (Table5). In rainy season maximum storage life (4 days) was observed by all papaya variety.

SHELF LIFE

Banana: Fruits of Robusta turned black earlier (4 days) under polythene bag as compared to open condition (6 days). Fruits of G-9 banana turned black early (6 days) in open condition while fruits become black later (8 days) in polythene bags and stored maximum duration (12 days) with physiological loss in weight (13.70%). In case of Banthal, fruits become yellow and black early in open condition while fingers turned yellow later under polythene bags. Fruits of Patakapura become started yellow cum white spots in open condition but no infection was found in polythene bags. It has been noticed that unpacked banana fruits were started drying and blacking early but kept as a fresh and good condition in polythene bags (Table2).

Papaya: The physiological loss in fruit weight was significantly reduced by polythene bags. On the 9th day of storage, the fruits of Bankim variety packed in polythene bag with 0.2 percent ventilation recorded the lowest PLW (7.07 %) as

compared to unpacked control fruits (16.66%). Fruits of Bankim, Ranchi and Pusa Dwarf packed in polythene bags recorded a shelf life of 12 days as compared to 9 days in case of unpacked fruits.

Effect of feeding nutrients : Robusta and G-9 varieties of banana were evaluated for low input homestead cultivation using indigenous organic and inorganic inputs. An application of 5g ammonium sulphate and 10g sulphate of potash blended with 500 g of fresh cow dung to the distal end of bunch showed significant enhancement in fruit weight , yield and maturity (Babu *et al,* 2008, Babu, 2002 and Rohilla *et al.,* 2004). The cost of treatment worked out to be Rs.4 per plant as compared to Rs. 8 per plant in soil application of recommended dose of NPK indicating cost effectiveness and ease of adoption by women.

Storage

Effect of etherel treatment during storage period

Banana: Fruits of banana var. G-9 were treated with 100 ppm etherel for 5 minutes and kept in different packaging materials viz. polythene, news paper, paper, gunny bag, brown paper, white cloth, plastic bag and control. Observations revealed that physiological loss in weight increased in all packaging treatments with increase in storage period. All packaging treatments significantly reduced the PLW in banana as compared to unpacked fruits. Minimum PLW was recorded in polythene (0.42%) followed by plastic bag (2.33%) after two days of storage. Fruits packed in gunny bags showed significantly higher PLW among different types of packaging materials.

Papaya: Fruits of papaya variety Co2 treated with the etherel in different concentrations of 100, 200, 300, 400 and 500 ppm for five minutes and the same were stored at ambient temperature. Observations revealed that a general trend in increase in percent physiological loss in weight with increasing in storage period in all treatments. All treatments had significantly reduced PLW in papaya fruits as compared to control. Treatment 400 ppm etherel was more effective in this regard and recorded minimum PLW (10.66%) after 6 days of storage.

Value addition

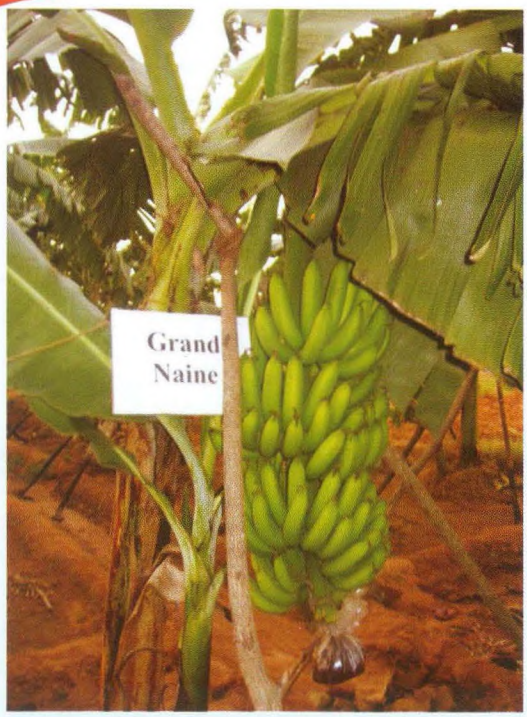
Banana

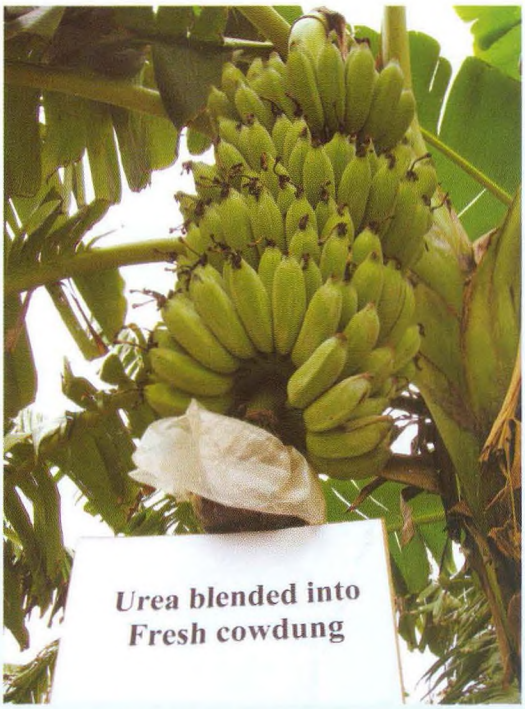
Banana has overtaken all other fruits occupying number one position and highest per capita consumption. Though the demand is tremendous for banana in our country, Due to poor infrastructure and inappropriate post harvest management practices the post harvest losses are high. It is estimated that 18-22 percent banana produced accounting to more than 3.0 million tonnes is lost

every year. On the other hand our rural masses especially women and children are suffering from malnutrition. Nutrition security is more important for every one particularly for women and children who are most at risk. The fruit and vegetable processing industry in India is still in its infancy and only around 1-2 percent of its total production is processed as compared to 70 percent in Brazil and USA, 78 percent in Philippines, 80 percent in South Africa, 83 percent in Malaysia and 30 percent in Thailand. Being highly perishable 20-30 percent of the total production of fruits goes to waste from the time of harvesting till they reach the consumers. It is therefore, necessary to make them available for consumption throughout the year in processed or preserved form and to save the sizeable amount of losses. With constant increase in production and productivity of fruits in general and banana in particular, there is going to be enormous surplus and rejection which can effectively be used in processing and value added products. The government and various developmental agencies have been giving sufficient funds in promoting rural agro-based industries to reduce the losses and create employment opportunities. Value addition and diversified products of banana can provide tremendous scope for generation of employment in rural areas. In the entire eastern region generally and in Odisha particularly, banana is grown by resource poor farmers in the homestead land. By making value addition and product diversification of banana farmwomen can earn income besides improving the nutritional security of the family. There are two groups of this crop viz. culinary type and table type grown in the Odisha.

1. Culinary Type : Banthal, Gaja, Bental, Batisa *etc.* are come under this group. The green fruits are used for vegetable curry. Fruit is also used for all religious ceremonies and in temples in preparation of 'Prasad' for offering deities. As such , there is great demand of this type of banana in Odisha.

2.Table Type: Patakapura, Champa, Dwarf Cavindish, Robusta are grown in





this group. In Odisha, the Patakapura variety is highly prized for its size and pleasant flavor, taste and quality. However, the champa variety is preferred for its wide range of adaptability and is suitable for handling and transport.

Women can utilize banana by making some easily and common products at home level individually or in Shelf Help Grops (SHGs) and reduce losses.

Culinary of banana flower: Banana flower, a waste product, has least commercial value and is generally being cut and thrown in the field. Now it is being converting into a value added product 'Banana flower pickle'. As pickle is

common item of daily Indian meal, this product has been successfully prepared. Due to its demand, farmers are selling banana flower at a premium price to pickle manufacturers. Women used flowers of Banthal variety of culinary purpose. Cooked flower of this variety as vegetable is good in taste and preferred by household family. However, flowers of other varieties were not acceptable for vegetable purpose due to its bitterness in taste.

Culinary of banana fruit: Fruits of Banthal variety are also used as a vegetable. Women preferred this variety due to high pulp and thin peel content, almost fibreless, easy in peeling, cooking and no browning after cutting and even after cooking of fruits and also good in taste. Women may include this variety in their production system for nutritional security and income generation.

Culinary of banana stem: Women use centre core (inner portion of stem) as a vegetable which is having good taste. It has been observed that women were using centre core of other varieties of banana as vegetable when culinary type were not available. However, the taste of vegetable prepared from centre core of other varieties was not good. Demand of tender inner portion of core of the stem as a vegetable in Odisha is more and people are selling it in the market at very cheaper rate.

Banana jam: Banana jam is prepared by cooking fruit pulp with equal quantity of sugar along with pectin and acid in right proportions till it gives a good set. Dwarf Cavendish, Robusta, Champa varieties of banana is suitable for jam preparation. This product has good demand and commercial value and ready market with very high returns per rupee investment. Women can easily prepare banana jam at home level after attending training and serve to their family.

Banana jelly: Jelly is semi solid product prepared by boiling, clear stained fruit extract free from pulp after addition of equal amount of sugar, citric acid and pectin. A perfect jelly should be transparent, attractive and sparkling in colour with strong flavor of fruit.

Banana chips: Banana chips are made by deep frying of raw banana slices in suitable cooking medium and salting them. In Kerala, it is prepared from Nendran plantain. Coconut oil is the medium of frying preferred in our country. Sugar coated banana chips is another product which has good demand after salted chips in Kerala. It has high carbohydrate and fat content with high calorific value. Women can easily made banana chips at home after attending a training conducted by ICAR institutes and State Agricultural Universities. Presently banana chips have a high demand in the market and fetching high prices.

Women visiting banana crop

Custard: Custard is prepared by boiling of milk and add some quantity of sugar according to taste. Custard powder is dissolved in cold milk separately and make solution and this solution mix in concentrated boiled milk. After that some pieces of ripe banana pulp, apple, grapes and other dried fruits such as cashew nut almond, cardamom are added in to boiled milk. Custard is a sweet dish and very much popular in northern parts of our country.

Baby food: In NEH region one such variety locally known as 'Bhimkol' (*Musa bulbisiana*) is available. Though seedy but it has very soft pulp and fruit which is abundantly used by women in Assam and some part of Nagaland as infant food.

Mashed banana pulp along with curd and rice flakes : This dish can be prepared by mixing of rice flakes soaked in water for a half hour and mashed ripe banana pulp in curd and add sugar or jaggery according to taste. Women can prepare this dish easily and serve to their children and family members as a breakfast. This is very nutritious and provides more energy. It has been observed that in Odisha women serve the dish to the school going children in the morning as this dish take less time for its preparation. Curd, sugar and rice flakes are easily available in the market.

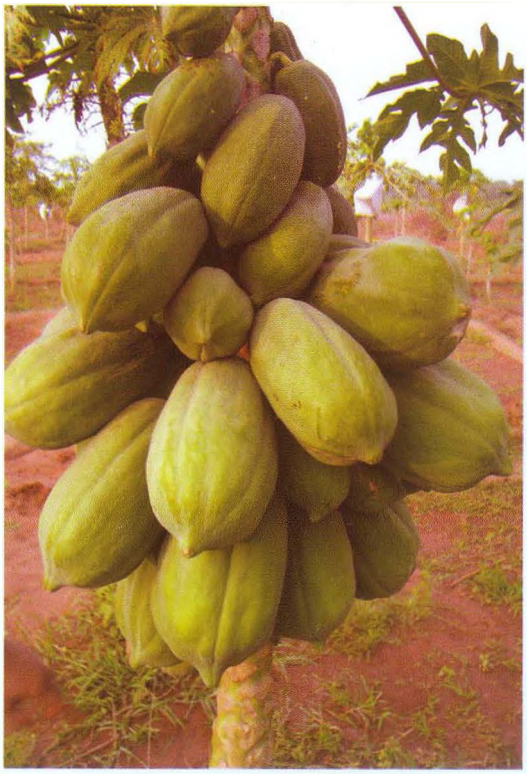
Papaya

Papaya fruit has a high perishability rate and cannot be stored for longer periods. Therefore, it needs quick disposal and utilization. Jam is common dessert consumed in rural as well as in urban areas in different ways. Therefore, an attempt has been made to prepare a value added product like jam from papaya fruits. For that purpose good quality jam was prepared from papaya (Co-2) and stored at ambient temperature for 3 months without spoilage.

Papaya can be used in many ways in our life. It is consumed primarily in two ways. (1) Table use (2) making preserves. Unripe

fruits are consumed as vegetables and filler material in various preserves like soups, jams and sauces of other fruits. It is also used for the tapping of papain which is highly priced for its enzymatic and medicinal properties. The leaves have medicinal uses. Stem and bark can be used for making ropes. Roots are used to cure piles and act as generative toxin. The other uses include extraction of oil as a source of protein and in medicine to quench thirst and as a vermifuse. Because of all these reasons papaya is popularly known as common man's fruit.

Scope of value addition was explained to household women through trainings and demonstrations. The products were displayed in exhibition and stalls.



Farm Selection – High yielder

Women collecting fruits for consumption purpose

Cost of cultivation of banana

It is evident from the following table that cost of cultivation of banana was Rs. 96,500/- per hectare with average yield 32 tonnes of main crop and 20 tonnes of ratoon crop. The sale of banana is @ Rs 8,000/t so total earning was Rs 2,56,000/- with net income of Rs 1,59,500/- from main crop and Rs 1,60,000/- with net income of Rs 1,25,000/- from ratoon crop. The benefit cost ratio was 2.65 in main crop and 4.57 in ratoon crop.

The details of economics of banana cultivation is depicted in Table 1.

Cost of cultivation of papaya

Papaya is a profitable crop and provides an income next to bananas. It can be grown for plant material (seedlings), fruits and for papain extraction. A farmer can easily generate an income of about Rs 1,20,000 from one hectare of papaya plantation for a fruit by marketing ripe fruits. The yield from the plantation is 40 tonnes / ha in the first year and 30 tonnes in the second year. The benefit – cost ratio in the present study was found to be 2.21 in the first year and 3.90 in the second year which indicated that for each

Table 1. Cost of cultivation and net income from banana cultivation

Name of the items	Rate per unit (Rs/ha)	Total cost (Rs)	
		Main crop	Ratoon crop
Inputs cost (Rs/ha)			
Field preparation			
Ploughing of field (twice)	3000.00	6000.00	-
Pit digging - 50 man days	150.00	7500.00	-
Planting material (2000 No)	16000.00	16000.00	-
Planting - 20 man days	150.00	3000.00	-
Manure (20 t)	1000.00	20000.00	10000.00
Fertilizers	10000.00	10000.00	6000.00
Plant protection measures	5000.00	5000.00	3000.00
Weeding (four times) 30 man days	150.00	9000.00	4500.00
Irrigation	5000.00	5000.00	3500.00
Staking of plants	4000.00	4000.00	2000.00
Harvesting of crop	6000.00	6000.00	3000.00
Miscellaneous	5000.00	5000.00	3000.00
Total cost of input		96500.00	35000.00
Output			
Average yield (32t)	8000.00	256000.00	160000.00 (20 t yield)
Net income		159500.00	125000.00
B:C		2.65	4.57

rupee invested in papaya enterprise yields Rs. 2.21 and 3.90 returns. Thus, it could be concluded that investment in papaya orchard was economically feasible and financially viable. It has been observed that farmers of Odisha mainly harvested premature fruits and sold their crop as vegetable at a price of Rs. 8/kg. The details of economics of papaya cultivation is depicted in Table 2.

Marketing functions

From the study it was revealed that packing, transportation and selling were the main marketing functions involved in the process of marketing of papaya. Fruits are packed with help of paper. Better packing always helped in maintaining the quality and in reducing the losses during transit on account of spoilage. The producer sold their maximum quantity through commission agent cum wholesaler at the farm level. About 80 per cent of the sample farmers sold their produce to commission agent cum wholesaler and remaining 20per cent of the sample farmers sold them to the distant markets. The commission agent in the distant market arranged for sale in the market and charged a commission of 10 per cent of sale of proceeds to the producer seller.

Table 2. Cost of cultivation and net income from papaya cultivation

Name of the items	Rate per unit (Rs/ha)	Total cost (Rs)	
		Main crop	Ratoon crop
Inputs cost (Rs/ha)			
Field preparation			
Ploughing of field (twice)	3000.00	6000.00	-
Pit digging - 50 man days	150.00	7500.00	-
Planting material (2000 No)	16000.00	16000.00	-
Planting - 20 man days	150.00	3000.00	-
Manure (15 t)	1000.00	15000.00	8000.00
Fertilizers	10000.00	10000.00	4000.00
Plant protection measures	8000.00	8000.00	3000.00
Weeding (four times) 30 man days	150.00	9000.00	4500.00
Irrigation	5000.00	5000.00	3500.00
Harvesting of crop	6000.00	6000.00	5000.00
Miscellaneous	5000.00	5000.00	4000.00
Total cost of input		90500.00	32000.00
Output			
Average yield (40t)	5000.00	200000.00	125000.00 (25 t yield)
Net income		109500.00	93000.00
B: C		2.21	3.90

Pay Back Period (PBP)

The period required to recover initial investment incurred in establishing banana and papaya garden was found to be one year. This clearly indicates that a shorter period of about one year would require to get back the initial investment. This could be attributed with the fact that the initial investment itself was lower, besides higher rate of returns. The pay back period in banana and papaya were found to be lower than that of other perennial horticultural crops such as arecanut (with gestation period of 7 years). Subrahmanyam and Mohandas (1982) has observed that pay back period in the case of Coorg Mandrin in Karnataka was 9 years. From this it can be concluded that banana and papaya gardens pay back period were shorter than that of other perennial crops and these crops are profitable to the farming communities.

The composition and food value of ripe banana fruits

It contains nearly all essential nutrients including minerals and vitamins and has several medicinal properties. Banana is a rich source of energy. The composition and food value of ripe banana fruits are given in table 3.

Table 3: Composition and fruit value of banana fruit

Sl. No	Components	Amount (per 100 g edible portion)
1.	Moisture	74.4
2.	Food energy (cal)	94.0
3.	Protein (g)	1.3
4.	Fat(%)	0.9
5.	Total carbohydrates (%)	22.7
6.	Fibre (%)	0.3
7.	Ash (%)	0.7
8.	Calcium (mg)	139.0
9.	Phosphorus (mg)	20.0
10.	Iron (mg)	0.8
11.	Thiamine (mg)	0.04
12.	Riboflavin (mg)	0.04
13.	Niacin (mg)	0.8
14.	Ascorbic acid (mg)	10.0

The composition and food value of ripe papaya fruits

The composition and food value of ripe papaya fruits are given in table 4.

Table 4 : Composition and fruit value of papaya fruit

Sl.No	Components	Amount
1	Moisture	89.6 %
2	Protein	0.5 %
3	Fat	0.1 %
4	Carbohydrate	9.5 %
5	Calcium	0.01 %
6	Phosphorus	0.01 %
7	Vitamin A	2020 I.U./100g
8	Vitamin B2	0.04 mg/100g
9	Vitamin C	40 mg/100g
10	Micotinic acid	0.2 mg/100g
11	Riboflavin	250 mg/100g

Intercropping

Intercropping in banana

Longer gestation period of orchard crops is a major constraint towards crop diversification by small and marginal farmers. This constraint can be overcome by having an intercrop. It is revealed from the several studies that intercropping is more resilient and more profitable than monocropping. The crop should be such which can be economically grown under the shade else the opportunity time of the crop should be short. Thus need was felt to select a crop which can grow under the shade as well as can be irrigated through existing system. To fill this research gap, a study was conducted on different intercropping in banana i.e. cowpea, amaranthus (leafy vegetable) and elephant foot yam along with a control (Banana sole crop). Among the intercrops, Banana + Cowpea was proved to be ideal with maximum number of functional leaves at flowering (13.21), the least days for flowering (241.55) and harvesting (329.47), maximum number of hands per bunch (9.45), fingers per bunch (135.8), maximum finger length (20.41cm), bunch weight (21.32 kg) and yield per ha (52.84 MT). Maximum additional income from cowpea was

about Rs 16,600/- per ha/year followed by elephant foot yam (Rs 14 650/-) Banana+ cowpea intercropping was found to improve the soil fertility status.

Intercropping in papaya

A field experiment was carried out to evaluate different papaya based intercrops as well as their benefit cost ratio at DRWA farm during 2006-2008. Papaya plants were planted at a spacing of 2mx 2m plant to plant and 2.50 mt row to row accommodating 2000 plants in a hectare. Vegetables such as cowpea , colocasia, elephant foot yam and amaranthus were planted in the interspaced of papaya plants. Observation revealed that among all intercropping combination highest benefit cost ratio of 2.24 per hectare was recorded under papaya + elephant foot yam intercropping system. Sole crop of papaya was found least profitable with B: C ratio of 1.50. Papaya based intercropping was accepted by the farmers due to secondary source of income from papaya.

Socio-Economic Benefits

The following socio-economic benefits from intercropping of banana and papaya with different vegetables e.g. cow pea, amaranth and elephant foot yam are:

1. Banana is a fast-growing fruit crop that starts fruiting in 8 – 12 months from field-planting. There is a year-round stable demand (and still growing) locally and globally for different varieties (table and cooking banana) for various uses as fresh fruit, chips and flour.
2. The banana fruit is high in carbohydrates, minerals potassium, calcium, vitamin C, vitamin B6 (pyridoxine). B6 is essential for maintaining healthy skin and nerves, in the formation of red blood cells, in providing general resistance, and stops the human premature aging.
3. Papaya is an excellent source of vitamins A, B and C, together with small amounts of calcium (Ca), iron (Fe), thiamine, riboflavin and niacin. Papaya contains the multi-function enzyme papain, for digestion, tenderizing meet and human skin care.
4. Intercropping papaya and banana with different vegetables e.g. cow pea, amaranth and elephant foot yam intensifies land use which increases economic returns on cash inputs and provides better labor-use pattern of the farm family and income distribution. Intercrops serve diverse food uses. Their nutritive value and health benefits are well known.
5. Its nutritive value and health benefits are: a) elephant foot yam – rich in carbohydrates (starch), Ca, vitamin A, C, and energy calories; b) amaranth – cheap and excellent source of Ca and K and moderate source of thiamine and iron; and c) cow pea – good source of protein.

Incidence of insect pests in banana and papaya and their eco- friendly control measures suitable for farmwomen

Banana: Banana is mainly produced in low input systems in homestead land by the farmwomen and provides nutrition as well as income. During the visit of farmwomen they were discussed about the various components of IPM in banana. The high cost of inputs is the main reason for not using IPM practices. Farmwomen are practicing mostly sanitation, which requires only labour. Most of the farmwomen do not apply pesticides to control insect pest in banana. Incidence of pseudostem weevil, fruit scarring beetle, leaf eating caterpillar and thrips was noticed during the investigation period.

Eco- friendly management technique of Pseudostem weevil (*Cosmopolites sordidus* Germar) : The pest infestation was characterized by small holes on pseudostem with exudation of transparent gummy substance; existence tunneling in leaf sheath and inner core of the stem. Pseudostem trap was found to attract the weevils. Cutting the pseudostem of harvested plants and exposing it in small pieces to the sun prevent weevils from approaching banana plants. Destruction of crop residues was effective to reduce damage. However, no incidence of banana weevil was found in tissue cultured plants. Sanitation method has been found gender friendly because it mostly involved labor, which can be provided by the family.

Management

- Maintaining banana crop weed - free to avoid the spread of weevils.
- Removing roots and outer skin of banana corm and dip the suckers in Monocrotophos or Triazophos solution (10 ml in 1 litre water) for about 30 minutes to kill the eggs and grubs of corm weevil and plant parasitic nematodes.
- Removing pseudostems after harvesting and treating it with Carbaryl (2g/litre) or Chlorpyriphos (2.5 ml /litre).
- Monitoring weevil activity in a garden by keeping longitudinal split banana pseudostem traps @ 10- 15/ acre. Once weevil is attracted to the laid traps, keep the longitudinal split banana traps @ 100 /ha with 20 g biocontrol agents like *Beauveria bassiana*. This biocontrol agent can be swabbed on the stem traps and keep the cut surface facing the ground.
- Keeping pheromone traps @ 4 traps/ ha. Collect the trapped weevils and destroy them.

Eco- friendly management technique of fruit scarring beetle (*Besilepta subcostatum*): Adults caused damage by feeding on tender leaves and fruits by scarring of skin. Plant losses its vigour and quality of fruits. In order to develop eco- friendly control measures suitable for farmwomen, three inflorescences of same date of shooting from each treatment were covered with white, black polythene and gunny bags. The bags were 1.5 x 0.6 m in size to allow free growth and development of the fruits inside the bag. Few holes were made for proper aeration and easy exit of moisture condensed inside. The bags were removed after 75 percent maturity of fruits. Observations on the number of healthy and infested fruits/ bunch were recorded. Banana bunches covered with white polythene bags recorded lowest fruit infestation (8.35%) of scarring beetle. Bunches covered with white polythene bags attained physiological maturity earlier (12 days) then control (Srivastava *et al.*, 2008). Covering of banana bunches with polythene or a gunny bag is considered as a gender friendly techniques for the management of fruit scarring beetle of banana.

Management

- Spray Azadirachtin (2.5 ml/ litre) or Chlorpyriphos (2.5 ml/ litre) on leaf whorls.
- Spray *Beauveria bassiana*.(2g /litre) on leaf whorls, leaves and bunch.
- To prevent infestation, cover the bunch at the time of shooting by low- density polythene bunch sleeve having 6 percent ventilation. The sleeve should be tied on peduncle and other end to be open.

Eco- friendly management technique of cotton aphid (*Aphis gossypii* Glover):

Incidence of brown shiny banana aphid (*Pentalonia nigronervosa*) was recorded in plants grown with suckers; however no incidence of aphid was noticed where camphor bolls were hanged in cotton cloth as a lobe. Nymphs and adults suck the sap from tender leaves. Hanging of Naphthalene boll and camphor boll were found effective to repel the aphid.

Management

- Virus affected plant should be rogued out.
- Ratoon and intercrops should not be taken up.
- Collect planting material only from healthy field.
- Spray Azadirachtin (2.5 ml/litre) or Dimethoate 0.05 percent (1.8 ml/ litre).
- Spray Conidiospores of *Verticillum lecanii* (2g/litre).

Eco- friendly management technique of leaf eating caterpillar (*Spodoptera litura Fab.*): Banana leaf eating caterpillar was noticed on tender leaves of all varieties grown from suckers during young age of 4 month. Spraying of Bt @ 3 g /lit of water in evening was effective for the management of insect.

Eco- friendly management technique of thrips (*Heliaothrips kodaliphilus*): Flower tips and fruits before bud emerges were infested by flower thrips. Maximum incidence was noticed in Karpuravalli variety. They scraped the fruits and render them brown and discoloured. *Eulophid* wasp was visited the flower tips and fruits before bud emergence for their prey.

Important diseases in banana and their control measures suitable for farmwomen

India's bananas production requirement by 2020 is around 25million tonnes. Since increase in area of cultivation is impossible; the alternative approach is to increase the productivity. But the main hurdle in increasing the productivity is threat posed by pests and diseases. Among these, diseases of banana such as Fusarium wilt, Sigatoka leaf spot, crown rot and rhizome rot were found major limitations to banana production during study period. Their control measure scientifically is the essential for achieving higher productivity.

Fusarium wilt / Panama disease: Fusarium wilt (*Fusarium oxysporum*) of banana is most widespread and destructive disease. In India, Fusarium wilt was recorded in 1911. It attacks almost all commercial cultivars of banana except Poovan and Nendrun. Its incidence was observed 30percent in main crop and 85percent in ratoon crop. Yellowing of oldest leaves or a longitudinal splitting of lower portion of outer leaf sheaths on pseudostem are symptoms. As the disease progresses, younger leaves collapse until the entire canopy consists of dead or dying leaves. Generally, bunches are not produced and if produced, the fruits are small with few developed fingers. Fruits ripen irregularly and flesh is pithy and acidic.

Management

- Crop rotation with cereals once or twice followed by banana for 2-3 cycle.
- Planting material should be selected only from healthy field and tissue-cultured plants should be used.
- Eradicate infected plants as soon as symptoms are observed and apply lime @ 2-3 kg in infected pits.
- Providing good drainage especially in rainy season.
- Drenching soil with Carbendazim 0.2percent solution around the

pseudostem at bimonthly intervals starting from five months after planting.

- Apply bio-control agents to soil such as *Trichoderma viride* @ 25 g for 4 times once at the time of planting and remaining doses 3,5 and 7 months after planting mixed with well- decomposed compost around plants.

Rhizome Rot : Generally, disease attack young plant, causing germination failure mostly in Cavendish group of bananas. Failure of germination of planting materials is due to rotting of corm. Yellowing of leaves and stunting of the plants, trunk base may become swollen or split and results in breakage of rhizomes at ground level causing toppling of plants at the time of fruit maturing stage. The diseased plants produce more number of suckers.

Management

- Planting of vigorous, good diseases-free suckers taken form healthy fields.
- Providing drainage facilities for improving aeration of soil, application of more organic matters and other cultural practices to improve texture, aeration and steady supply of moisture to root development.
- Drenching soil around plants with bleaching powder @ 8g / plant followed by drenching with streptomycin sulphate @ 500 ppm/ 1 litre/ plant) at 10- 15 days intervals for two times is effective in controlling the disease.

Crown Rot: This is the most serious post-harvest and complex disease occurring in all banana – growing belts of the country whenever the dehanding is not done properly. The pathogens involved in causing crown rot are: *Botryodiplodia theobromae, Cera- tocystics paradoxa, Verticillium theo- bromae, Colletotr- ichum musae, Fusarium spp.* and *Nigrospora sphaeria.* The spores of these pathogens are present on surface of crown, fingers and finger stalk, infect crown tissues after bananas are dehanded and causing blackening of infected portion. Thereafter, blackening spreads to pulp through the pedicel, resulting in rotting of fingers. While separation of fingers from bunch heavy post- harvest losses occurred during transit and storage.

Management

- Treating harvested hands with *Solanum nigrum* extract (50%) or Thiabendazole @ 200-400 ppm is effective in reducing the disease.

Sigatoka Leaf Spot: Sigatoka leaf spot diseases caused by *Mycosphaerella spp.* is serious in reducing the yield and quality

of fruit in all banana growing regions. The leaf spot disease becomes severe in rainy season i.e. September to February which coincides with advanced vegetative and shooting stages of crop. The maximum disease severity of 90- 100 percent infection is observed in Robusta banana. The crop loss was up to 30- 60 percent.

Management

- Remove leaf spot infected leaves regularly.
- Timely removal of weeds, improving drainage condition and maintaining proper spacing of crop reduce disease incidence significantly.
- Spray Propiconazole @ 0.1 percent (1ml/litre of water), Carbendazim (0.1%) and Mancozeb @ 0.25 percent (2.5 g/litre of water) is effective.

Papaya: Papaya has emerged from the status of home garden crop to commercial orchards in India. The fruit is prescribed for ailments like piles, dyspepsia of liver, spleen and digestive disorder. Insects like white flies, aphids and fruit flies were found damaging the crop during investigation period.

Eco- friendly management technique of whiteflies and aphids: Incidence of whiteflies and aphids were noticed during the investigation period which is responsible to transmit leaf curl and ring spot diseases in papaya, respectively. Nymphs and adults of whitefly *Bemisia tabaci* both suck the sap from the lower surface of the leaves, which leads to yellowing of leaves and later on the leaves wither away. Adult is a small white insect, which can be detected by shaking the young leaves of the plant. During the project period Naphthalene boll and Camphor boll were tied in the cotton cloth as a lobe and hanged on the plants. Naphthalene boll were changed at monthly interval while Camphor boll were changed at weekly interval. This technique was effective to repel white flies and aphids; therefore, transmission of virus was minimized and decreased the incidence of papaya ring spot virus (PRSV) and leaf curl virus and increased the fruit yield. This technique is found gender friendly, because it is cost effective, material is easily available with farmwomen and easy in handling. During the field visit farmwomen were agreed to adopt the technique.

Eco- friendly management technique of papaya fruit fly (*Toxotrypana curvicauda* Gerstaecker): Fruit infected with papaya fruit fly was turned yellow and dropped from the tree prematurely. Gender friendly control measures like use of gunny bags were implemented to prevent egg laying by fruit flies. Each fruit was covered by gunny bag tied around the fruit stem, beginning when the fruit was small. Fruit flies were not noticed to sit over the gunny bags, therefore egg laying was avoided and no premature fruit drop was noticed. This technique of control of fruit fly is more suitable for farmwomen because they have few plants and old gunny bags are easily available with them.

Table5. Performance of banana variety propagated by tissue culture and suckers method.

Variety	Plant height (cm)	Plant circumference (cm)		No. of suckers/ plant	Crop duration(days)	No. of fruit/ bunch	Weight of fruit (g)	Yield (kg/ bunch)	Size of fruit	Taste	pulp
		EW	NS								
Robusta											
Tissue culture	157.40	256.33	249.80	7.08	296.54	152.68	164.32	22.67	Medium	Sweet	Very soft
Suckers	179.13	256.25	259.23	8.46	323.05	116.60	148.86	19.13	Medium	Sweet	Very soft
G-9											
Tissue culture	223.40	331.55	339.71	10.42	301.53	147.22	286.47	33.12	Large	Sweet	White , soft
Suckers	252.56	312.24	311.09	10.71	340.86	104.56	273.86	27.29	Large	Sweet	White, soft
Patakapura											
Tissue culture	253.11	307.63	266.31	4.78	363.04	141.72	149.59	25.84	Medium	Sour- sweet	White, soft
Suckers	247.75	311.61	252.08	5.67	382.27	61.53	115.90	16.72	Medium	Sour- sweet	White, soft
Karpuravalli											
Tissue culture	271.49	321.02	298.67	9.62	358.06	124.02	142.29	24.06	Small	Very sweet	Soft
Suckers	296.97	355.68	329.02	11.24	383.22	105.72	134.75	18.70	Small	Very sweet	Soft
Banthal											
Tissue culture	288.62	365.25	366.63	9.30	324.36	89.64	168.44	24.50	Medium	*	Slight hard
Suckers	294.74	274.25	310.12	10.75	348.41	92.77	152.31	21.32	Medium	*	Slight hard

Table 6. Shelf life of banana fruit propagated by tissue culture and suckers method at ambient temp.

Days (%PLW)

Variety	2		4		6		8		10		12	
	Open	Packed	Open	Packed	Open	Packed	Open	Packed	Open	Packed	Open	Packed
Robusta												
Tissue culture	6.33	2.02	10.33	3.47-**b**	16.03-**b**	5.71	32.26	spoiled	-	-	-	-
Suckers	7.58	2.16	11.40	3.86-**b**	19.74-**b**	5.21	30.37	spoiled	-	-	-	-
G-9												
Tissue culture	8.68	2.16	10.37	3.52	17.90 -**b**	5.48	23.32	8.05-**b**	27.25	10.62	32.84	13.70
Suckers	9.18	2.98	11.67-**b**	4.17	23.30	6.23	26.52	8.47-**b**	32.48	12.14	-	-
Patakapura												
Tissue culture	5.87	2.17	8.10-**y**	4.36	13.75	6.73	**19.73**	10.44-**y**	spoiled	13.21	-	-
Suckers	6.81	3.42	9.70 -**y**	4.82	15.62	7.31-**y**	20.46	12.02	spoiled	14.69	-	-
Karpuravalli												
Tissue culture	6.29	2.43	9.28	4.31	12.46-**b**	5.34	18.46	11.34-**b**	spoiled	12.82	-	14.50
Suckers	6.87	2.84	10.75	4.78	13.21-**b**	6.46	20.24	11.38-**b**	spoiled	13.06	-	14.05
Banthal												
Tissue culture	7.40	2.14	11.49	3.78	16.40-**y**	5.89	21.08	-**b** 8.21	25.40	10.24	-	16.78-**y**
Suckers	8.67	3.21	12.65	5.47	18.23-y	6.45	23.46	9.10	27.90	12.40	-	16.82-y

Table 7. Effect of post- harvest treatment of banana ripening treated by 100 ppm etherel (var G- 9) during storage.

Treatment	Days (PLW %)	
	1	2
Polythene	0.21	0.42
News paper	1.30	2.49
Paper	1.51	2.91
Plastic bucket	0.32	0.64
Gunny bag	1.37	3.54
Brown paper	1.46	3.04
White cloth	1.45	2.91
Plastic bag	1.35	2.33
Control	2.16	4.33
C.D. (p=0.05%)	0.037	0.035

In the packaging and storage study of banana var. G-9 treated with 100ppm ethrel and packed in different materials. The minimum PLW (0.42%) was recorded in polythene followed by plastic bucket (0.64%) after 2 days of storage (Table 7).

Table 8. Effect of post- harvest treatment of papaya var Co-2 treated with etherel for 5 minutes during storage

Treatment	Days (PLW%)				
	2	4	6	8	10
100ppm	4.85	8.22	12.68	18.00	18.87
200ppm	3.51	7.16	11.56	15.06	16.29
300ppm	4.31	7.75	11.87	Spoiled	-
400ppm	3.41	6.82	10.66	14.40	14.95
500ppm	3.50	6.81	10.70	15.08	15.71
Control	3.83	8.81	12.10	18.40	19.19
CD (P=0.05)	0.022	0.020	0.024	0.036	0.037

In papaya variety Co - 2 treated with the etherel in different concentration for5 minutes and minimum PLW (14. 95%) was recorded in 400 ppm followed by 500 ppm after 10 days of storage (Table 8).

Table 9 : Performance of different cultivars of papaya

Cultivars	Plant height (cm)	No. of fruits /plant	Weight of fruit (g)	Seed (%)	Pulp (%)	Peel (%)	Maturity (days)	Yield/ Plant (kg)	Suitable for vegetable
Farm Selection	103.10	34.27	1156.57	4.14 M	91.30	6.16 L	202.45	37.45	Good
Ranchi	133..58	19.56	0.834	3.26 L	90.04	8.70 M	196.32	25.23	Good
Bankim	122.41	16.43	0.589	9.65 H	89.58	6.77 L	192.66	26.78	Good
Manjil	112.25	22.56	0.645	8.69 H	89.75	8.56 M	179.65	34.23	Good
Anjil	138.25	21.40	0.726	9.79 H	85.16	10.05 H	201.46	32.46	Good
Co-5	119.41	23.08	0.858	9.69 H	85.76	11.05 H	194.65	35.67	Good
Co-2	116.58	19.43	0.768	3.28 L	90.02	8.67 M	199.37	29.47	Good
Madhu	144.58	26.18	0.693	7.16 M	89.70	8.14 M	212.21	32.24	Good
Ranchi Dwarf	102.83	15.46	0.945	4.76 L	87.30	10.94 H	188.40	28.87	Good
Honey Dew	171.56	31.42	0.856	3.65 L	90.05	7.29 M	176.64	36.46	Good
Pusa Dwarf	97.64	31.62	1234.35	3.21 L	91.17	7.62 M	188.24	38.59	Good
PY-06-11	151.45	18.35	0.945	1.55 L	90.07	8.38 M	220.68	25.57	Not good
C.D. at 5%	6.81	4.39	37.56	0.24	4.02	2.44	13.43	4.81	-

Table 10. Shelf life of different variety of papaya at room temperature

Variety	Days (PLW%)							
	3		6		9		12	
	O	P	O	P	O	P	O	P
Anjil	9.33	4.11	17.33	7.45	25.52	10.79	-	12.59
Co5	8.49	3.55	14.28	6.47	20.46	10.03	-	-
Ranchi	8.89	3.53	15.60	6.18	21.96	8.65	-	10.95
Honey Dew	14.90	5.82	25.10	11.00	-	15.53	-	-
Farm Selection	7.69	3.96	12.55	7.38	18.01	9.90	-	-
Co2	6.87	4.33	11.79	7.05	16.70	11.39	-	13.92
Bankim	6.98	2.74	12.00	5.06	16.66	7.07	20.07	9.26
Py-06-11	10.00	3.94	17.40	9.19	-	11.97	-	-
Pusa Dwarf	6.00	3.03	10.44	6.07	14.88	9.51	-	11.74
CD (P=0.05)	2.68	2.92	4.23	5.56	6.24	5.87	-	-

The physiological loss in fruit weight was significantly reduced by polythene bags. On the 9th day of the storage, the fruits of Bankim variety of papaya packed in polythene bags with 0.2 percent ventilation recorded the lowest PLW (7.07%) as compared to unpacked control fruits (16.66%). Fruits of Bankim, Ranchi and Pusa Dwarf packed in polythene bags reported a 12 days shelf life as compared to 9 days in unpacked fruits (Table 10). Polythene proved highly effective in lowering the PLW of fruits over the control. polythene reduced the evapo-transpiration of fruits, resulting in low PLW of fruits. The fruits remained more fresh and firm condition.

Summary

India has been a predominantly agrarian economy and agriculture continues to be main stay of our economy even today. With the globalisation the agricultural sector is opened up with the new avenues especially for horticultural enterprises. The fruits are of vital importance not only in providing nutritional support but also earning additional income to the farm families. Among the fruits, banana and papaya are considered as "common man's fruit" in the country. Considering the scope and utility of these short duration fruit crops in our daily life we must have to plant these crops at least in our garden to take full benefits. Banana varieties

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