Adoption of Tissue Culture in Horticulture: A Study of Banana-Growing Farmers in Andhra Pradesh

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Introduction

Horticulture is one of the allied areas of agriculture where technology improvement has been contributing to increased productivity over time. Horticulture deals with breeding, cultivation, pest management and post harvest technology of plants that produce ornamental flowers, fruits, vegetables and spices. India is second in fruit and vegetable production in the world. However, India's share in global export of horticultural commodities is negligible due to low productivity, lack of infrastructural facilities and inadequate post-harvest management.

Banana as a fruit has nutritional and cultural significance among many religious and social groups in India. Banana is the cheapest, abundant and most nourishing of all fruits. It contains nearly all the essential nutrients including minerals and vitamins and has several medicinal properties. Banana is a rich source of energy. It is one of the oldest cultivated tropical fruits in India and is available in large quantity throughout the year. It is a good source of vitamin A and a fair source of vitamins C, B and B2.

Traditionally, banana is cultivated through suckers or offshoot, which forms underground rhizome at the base of the main psudostem and the rhizome that are seedless. All the suckers may not be of the same age and therefore not uniform. Some suckers may be having diseases. Low yield is observed because of suckers from different mother plants having a low range of yield. Crop growth is also not uniform.

However, with the application of plant tissue culture technology the whole scenario of horticulture production has been undergoing change. Application of plant tissue culture technology in propagation of banana fruit seems to hold many advantages over conventional sucker cultivation. It is claimed that tissue culture banana plants are true to the type of the mother plant, pest and disease-free, attain uniform growth, give higher yield, attain early maturity of the crop, round the year planting, as seedlings are

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made available throughout the year and successive two rations in short duration which minimizes cost of cultivation, with 95% to 98% plants bearing bunches, there is no staggered harvesting and three harvests in 28-30 months are, some of the advantages of tissue culture technology in banana cultivation. Therefore, in-vitro clonal propagation i.e., tissue culture plants are recommended for planting. They are healthy, disease-free, uniform and authentic.

Plant tissue culture technology in banana crop production started in the early 1990s. Commercial tissue labs in the private sector were the first to encourage farmers to adopt tissue technology in banana crop. Later the Horticulture Department of the Government of Andhra Pradesh too started encouraging farmers to adopt this technology in banana crop by selling tissue banana seedlings to them. Farmers in the three regions adopted the tissue culture banana technology gradually over the years. In fact big farmers were the first adopters of this technology. Seeing the success of tissue culture banana crop cultivation and its uniformity in entire crop patterns, other categories of farmers like middle and small farmers started adopting tissue banana cultivation.

The present study was undertaken to understand the comparative advantage of tissue culture over traditional methods apart from problems involved in adoption of tissue culture technology.

Objectives

The objectives of the study are to:

1. Understand the cultivation practices followed in conventionally propagated banana,
2. Analyze the socio-economic background of farmers who have been adopting the PTC based banana plants, and motivational factors underlying their adoption of the PTC based banana cultivation,
3. Understand the organization of production of micro-propagated banana plants by farmers and to examine how tissue culture brings about the changes in the package of practices and also other essential input requirements such as fertilizer, seedlings, and irrigation etc.

Methodology

The study is based on a sample of banana growing farmers in four districts of Andhra Pradesh. The four districts selected were: Kadapa in Rayalaseema, West Godavari in Coastal region, Medak and Rangareddi in Telangana region. Tissue culture banana is being cultivated extensively in all the four districts. The farmers, who adopted tissue

culture, were once practicing conventional methods. Selection of farmers was carefully planned. Four tissue labs, in the corporate sector, located in Hyderabad which have been selling banana plants to farmers were contacted to obtain a list of the farmers who have been buying the plantlets from them. Only one of the labs provided the list of representatives of farmers in three regions of Andhra Pradesh who in turn provided information about fellow farmers who adopted tissue culture technology cultivation. The study was conducted during the year 2004.

Limitations of the study

There was a limitation to the study in terms of the sample framework. A complete list of farmers was not available; farmers were selected on the basis of information provided by the lab and fellow farmers. On the basis of that, snowball sampling was adopted.

Table 1. Distribution of Farmers in the sample

Name of the District	Households	
	Frequency	Percentage
Kadapa	102	63.75
Medak	8	5.00
Rangareddi	13	8.12
West Godavari	37	23.13
Total	160	100

According to a private banana tissue laboratory, that sells saplings, farmers in Kadapa district first adopted tissue culture banana technology in the state. Now Kadapa district accounts for extensive tissue banana cultivating area in Andhra Pradesh. Earlier farmers of Kadapa district cultivated banana through traditional method of cultivation or sucker cultivation.

The size of the sample was 160. The data were collected through personal interview and semi-structured questionnaire. Observation method was also extensively used during data collection. According to the government, farmers who hold land above 11 acres are considered as large or big farmers, farmers who hold 6 to 10 acres of land are called medium range farmers, farmers who hold between 2 and 5 acres of land are called small farmers; and those who hold below 2 acres are marginal farmers. As the list of farmers in terms of size of landholdings was not available, the study team approached the farmers on the basis of the list provided by the Tissue culture lab and fellow farmers. The team had to resort to snowball sampling to include farmers from small and medium category of farmers. The questionnaire contained questions related to the farmers socio-economic

background, their banana plantation area, motivational factors behind their adoption, reasons for cultivation with Plant Tissue Culture in banana crop, source of information, differences between conventional cultivation and tissue culture cultivation and the problems they experienced in cultivation, labour requirement, other technologies like drip irrigation etc. The study examined the sources of supply of tissue culture plantlets. It is found that 76.87 per cent of the farmers purchased tissue culture banana saplings from private commercial tissue culture labs, 22.50 per cent of the farmers purchased from the horticulture department, and 1.63 per cent of the farmers purchased from both the sources. Farmers indicated that they purchased banana tissue plantlet at the rate of Rs.9.00 per plantlet. The government gives subsidy through Department of Horticulture up to 50 per cent i.e. 4.50 per plant up to 1 hectare of land or 2.5 acres. In other words, the government is providing direct subsidy to marginal farmers who cannot afford to buy plantlets at market price.

Results and Discussion

Tissue Culture Banana Adoption: Before and After

Farmers, prior to adoption of tissue culture banana, used to cultivate a variety of crops. They practiced intercropping along with traditional banana crop cultivation. At the time of the study there were three categories of farmers in terms of those who cultivated: a) banana by employing conventional method and shifted to tissue culture banana, b) banana plus other crops like Sunflower, Sugarcane, Chilli, Ginger, Onion, Turmeric, Paddy, Maize, Oil palm, Papaya, Potato, Groundnut, Coconut and Pomegranate and shifted to tissue culture banana; and c) farmers who used to cultivate other crops and shifted to tissue culture banana cultivation.

Table 2. Crops grown by Farmers before the adoption of PTC Banana Crops Grown

Category of Farmers	Banana	Banana plus other crops	Other crops	Total
Small	5	50	30	85
Medium	5	40	10	55
Big	--	10	10	20
Total	10	100	50	160

Table 2 shows that prior to adoption of PTC, 10 farmers used to cultivate traditional banana. Among them 5 were from small farmer category and 5 were medium farmers. Among 100 farmers who cultivated traditional banana with other crops, 50 were small

farmers, 40 were medium farmers and 10 were big farmers. Among 50 farmers who used to cultivate crops other than traditional banana, 30 of them were small farmers, 10 were medium farmers and 10 were big farmers. The significant aspect of traditional banana is intercropping along with other crops like turmeric, onion, chilli and spinach etc. In the case of tissue culture banana cultivation there is no intercropping with other crops.

Table 3 shows the farmers who cultivate PTC banana and other crops also. Among 110 farmers who cultivate PTC banana, 85 are small farmers, 10 are medium farmers and 15 are big farmers. Among 50 farmers who cultivate PTC banana plus other crops, 45 are medium farmers and 5 are big farmers.

Table 3. Farmers growing PTC Banana and other Crops

Landholding Size	PTC Banana Crop only	PTC Banana+ Other Crops	Total
Small farmer	85	---	85
Medium range farmer	10	45	55
Big farmers	15	05	20
Total	110	50	160

In Medak and Rangareddi districts, small farmers used to cultivate sugarcane and chilli before they shifted to tissue culture banana cultivation whereas in Kadapa and West Godavari districts they used to cultivate Sunflower and Groundnut along with traditional banana.

The study showed that big and medium farmers used to gain returns over other crops in addition to the returns on tissue culture banana whereas small farmers had to depend on sole crop i.e., tissue culture banana. In other words, the small farmers have to bear the risk associated with exclusive dependence on a single crop.

One of the significant observations of the study is that a majority of the big and medium farmers adopted tissue culture banana in a relatively large area of land and they gradually increased the area of plantation as it was more profitable. Earlier, they used to allot some area of land to paddy, some area to oil palm and some area to tissue culture banana and medium range farmers too followed this pattern of land allocation to various crops including tissue culture banana crop.

Differences between Conventional Cultivation and Plant Tissue Culture Cultivation

Traditionally banana has been cultivated by using suckers. Farmers said that with traditional suckers, they were not sure whether all the suckers were of the same age and

therefore could not ensure uniformity. Some suckers happened to be diseased. Low yield was observed because suckers were from different mother plants having a low level of yield potential. Crop growth was also not uniform. Moreover, cost of irrigation and labour were a significant proportion of the total cost because crop duration was longer.

However, commercial tissue culture laboratories in the private sector, have begun to sell suckers developed though micro propagation technique, to the farmers. These laboratories claim that the micro propagated plants are superior to conventional banana in terms of higher yields and better quality of fruit. The laboratories also assist farmers through their extension personnel in adopting the new package of practices associated with micro propagated plantlets.

Farmers, in the study who adopted tissue culture technology in banana cultivation reported that they bought tissue banana plants from either commercial tissue culture labs in the private sector or Horticulture Department of the government. The crop growth was uniform. The tissue culture bananas carry the same characters of mother plants. Selected from a high quality mother plant with high yields, the tissue culture plants give high yield. Tissue banana crop is ready for harvest in 11 to 12 months from plantation.

According to the farmers cost of irrigation and labour are less in the case of PTC because crop period was short. The farmers reported that the cost of labour (person-days) was reduced by 20 to 30 per cent. According to tissue culture banana growing farmers, they could get one main harvest and two ratoon harvests in 28 to 30 months leading to more yield and more profit (farmers reported that they obtained 3 crops in 30 months against 2 crops in traditional sucker cultivation). According to the Horticulture Department sources, yield in tissue culture banana is 30 per cent more than the yield obtained by employing the conventional method.

It was observed that farmers employed more women laborers in Rayalaseema and Coastal Andhra Regions. It was observed that 65 to 70 per cent were women workers in tissue culture banana crop. The farmers said that they reduced the cost of labour by 15 to 20 per cent (i.e., person-days) by employing more women. This is because wages paid to women workers tend to be lower than the wages paid to male workers. Table 4 gives differences reported by the farmers between traditional banana cultivation and tissue culture banana cultivation.

Table 4. Banana Cultivation in Conventional and Tissue Culture Methods (average acre)

Particulars	Traditional method with flood irrigation	Tissue Culture method with flood irrigation	Tissue Culture +Drip irrigation
Reaped or Harvested plants (out of 1200 plants planted per Acre)	850	1080	1140
Ratoon Weight (in Kgs)	18	21	24
Yield (tonnes/acre)	15.30	22.68	27.36
Returns/acres (Rs.4000/tonnes) (then Market price per tonne)	61200	90720	109440
Cultivation Expenditure/per acre	24000	35000	39000
Net income (Rs/acre)	37200	55720	70440
Approximate Water requirement per hectare	850 mm	850 mm	500 mm
Number in harvests	2	3	3
28-30 months			
Crop duration (in months)	12 to13 plus	11 to 12	11 to 12

The farmers, who earlier cultivated banana crop by employing traditional method and later adopted tissue culture technology in banana cultivation, reported that in the traditional method of cultivation, out of 1200 plants planted, they harvested from 850 plants; in the case of tissue culture method with flood irrigation they harvested from 1080 plants and in the case of tissue culture with drip irrigation, 1140 plants were harvested. The weight of banana of 1200 Ratoon or bunch was 18 kgs in traditional method, 21 kgs in tissue culture with flood irrigation methods and 24 kgs in the case of tissue culture with drip irrigation. Regarding yield, with traditional method it was 15.30 tonnes/acre, in tissue culture with flood irrigation it was 22.68 tonnes/acre, in the case of tissue with drip method it was 27.36 tonnes/acre.

Regarding returns from the three methods (the then market price was Rs. 4000 per tonne/acre,), in conventional method with flood irrigation it was Rs. 61,200, on an average, in tissue culture with flood irrigation it was Rs. 90,720 and in tissue culture with drip irrigation method it was Rs. 1,09,440. Cost of cultivation by employing traditional method was Rs. 24,000; Rs. 35,000 with tissue culture method using flood irrigation,

ands Rs. 39,000 with tissue culture with drip irrigation method. Net average income received by farmers with traditional method was Rs. 37,200, Rs. 55,720 with tissue culture method and Rs. 70,440 with tissue culture plus drip method. In traditional method, farmers got two crops in 28 to 30 months, whereas in tissue culture method farmers got three crops in the same period. Regarding water requirement, in tissue culture plus drip method it was 500 mm (mille cubic meters) approximately per hectare and farmers said that with drip system they saved 35 to 40 percent of water whereas in the case of flood irrigation in both traditional and tissue culture it was 850 mm approximately per hectare. Farmers informed that watering depended on weather conditions and soil conditions. In the traditional method crop period was 12 to 13 plus months and likely to increase whereas in tissue culture it was 11 to 12 months.

Problems with Banana Tissue Culture Plants among Adopters

No technology is risk free. This is also true of tissue culture technology. In this study respondents had problems with plant tissue culture in their field. The problems reported are different in the three different regions in the study and among three different categories of farmers.

Though banana plant tissue culture plants, as mentioned above, are certified by Private tissue culture labs and Horticulture Department as disease-free, with no variations among plants, farmers found that the claim made by tissue culture labs and Horticulture are not entirely borne out by guidance. The following section gives district wise detailed account of the problems faced by the banana tissue culture farmers.

In Kadapa, overall farmers expressed their happiness over tissue culture banana cultivation and its associated results like fresh fruits, uniformity in crop from flowering to harvest, good quality fruit, high yield which they were getting through the cultivation of tissue culture banana. On the basis of results in yield they have been extending their plantation of tissue culture banana, on their own land. Some big farmers have begun to take land from marginal farmers on lease basis to cultivate tissue culture banana crop.

One of the significant findings observed in the field is that reverse tenancy is occurring where big farmers acquire land from small and marginal farmers for deploying new technology. Small and marginal farmers, who cannot afford the costs, have chosen this practice.

Despite the success of banana tissue culture the farmers faced some problems while cultivating the crop. Table 5 gives a brief description about the problems faced by the Kadapa district adopters.

Table No. 5 Problems faced by the Adopters of Tissue Culture Banana Crop

Problem	Districts			
	Kadapa	West Godavari	Rangareddy	Medak
High cost of cultivation and high cost of plants	54 (53.2%)	8 (21.6%)	10 (77.2%)	2 (25%)
Disease occurrence	12 (11.7%)	5 (13.5%)	2 (15.2%)	5 (62.5%)
Variations in the Plants	4 (3.9%)	-	-	-
Poor extension services from Government	20 (19.6%)	4 (10.8%)	1 (7.6%)	1 (12.5%)
Lack of quality control in PTC lab	5(4.8%)	-		
No problem	7 (6.8%)			
Marketing problems	-	20 (54.1%)		
Total	102 (100)	37 (100)	13 (100)	8 (100)

Table 5 shows that in Kadapa district, 4 farmers (3.9 per cent) expressed that there was some variation in the growth of tissue culture banana plants 3 months after planting. About 5 percent plants dried up.

Fifty four farmers (53.2 per cent) complained about the relatively high cost of cultivation and also high cost of plants. Many of those who expressed this were small farmers. Twelve farmers (11.7 per cent) said that plants were getting affected by diseases like Root club, Ringworm, Bunchy top, Banana Streak virus. Some plants are affected due to sunrays. Seven (6.8%) respondents said that there was no problem with tissue culture banana. This indicates that the claims made by the private tissue culture labs and the horticulture department that tissue culture banana is disease-free are not supported by the experiences of farmers in actual field situation.

Medium farmers too expressed that there was a need for improving extension services by the Government. They found some variations in the growth of plants and also some diseases like Ringworm affecting the plants, when the plants were 3 to 4 months old.

Twenty farmers (19.6 per cent) mentioned that the extension services, from government were poor. Extension officials do not seem to maintain active contact with the farmers. However, they expressed satisfaction over the services rendered by

extension personnel of private commercial tissue culture labs. Five farmers (4.8 per cent) expressed that private lab should maintain quality control and should check before they delivered plantlets to farmers. The farmers expressed that Private labs should listen to their experience by frequently meeting the farmers, so that effective solutions could be evolved through research.

For any technical help the small farmers went to big farmers and village leaders or knowledgeable farmers in the village. They expressed that 50 per cent subsidy given by the Government enabled them to purchase the plants at the rate of Rs; 4.50 per plant which costs Rs 9.00 per plant in the open market.

In Medak district, farmers belonging to Koheer, Pecheregadi, Zaheerabad, Ranjol, Uggelly, villages adopted tissue culture banana cultivation. Farmers cultivating tissue culture banana were generally satisfied. Many of them said that tissue banana plants were qualitatively superior to suckers, which they used before the introduction of tissue culture banana.

In Medak district the banana farmers indicated the nature of problems they faced during the cultivation. In Medak district, 5 (62.5 per cent) farmers interviewed said that diseases like Root Club and Ringworm were affecting the tissue culture banana plants. They also observed variations in plants after the three months of plantation of banana saplings; and wind also damaged some plants. Two adopters complained of high cost of plants as well as cost of cultivation of banana tissue culture technology. One adopter mentioned that they needed better extension services from the government on a regular basis. In Medak district also it is observed that there is discrepancy between the claims of the PTC labs and horticulture department on the one hand and experiences of the farmers in the actual field conditions.

In Rangareddi district the major tissue banana cultivation areas are Marpally amd Pattlur. The tissue banana farmers were generally satisfied about their decision to employ tissue culture in cultivating banana crop. The majority said that tissue culture banana was good in quality as compared to banana traditionally cultivated with suckers. In the district, out of 13 farmers who adopted tissue culture the majority i.e. 10 (77.2 per cent) complained of the problem of high cost of plants and cost of cultivation as the major problem, 2 (15.2 per cent) farmers said that their banana crop was affected by diseases like Ringworm, fading of the plants. One farmer felt that they needed better extension services from the government, as they did not even know about extension services. In this district a private tissue culture lab initiated extension services for farmers. The farmers strictly felt that officials of the government extension department should look after their needs.

In West Godavari district, villages like Krishnapalem, Mudicharla, Pedavegi, Ayodhyalanka, Laxmipuram, Sitanagaram, Challchintalapudi are major tissue banana cultivation areas. Here farmers started cultivating tissue culture banana since 2002. Farmers despite better yield and uniformity in the tissue culture banana also reported some problems relating to tissue culture banana cultivation.

Out of a total thirty-seven tissue culture banana farmers, 20 (54.1 per cent) farmers encountered the problem of marketing in West Godavari district. Almost all categories of farmers faced the problem of marketing the fruit. In order to get a good price for tissue culture banana fruit, they had to go to Khammam town to sell their products. Eight farmers (21.6 per cent) said the cost of cultivation and cost of plants were relatively high. Five (13.5 per cent) farmers said that tissue banana plants are affected by disease, and four (10.8 per cent) farmers felt that they needed better quality extension services from the Government. They compared the services provided by the government extension department with Godrej Biovet Company, a private tissue culture company.

They were more satisfied with the services rendered by Godrej Biovet lab from Hyderabad than the services provided by the Government. Farmers pleaded that the Government should do something to facilitate marketing of their tissue culture fruit so that they could get a better price. They suggested that the government should create facilities to sell the fruit at the place of production.

For small farmers the high cost of cultivation is the main problem in addition to the marketing problem. They said that they sell their product to some middle men for less than the market price sometimes, due to lack of good marketing facilities in West Godavari district. In addition to this, soil problem (predominantly Red soil) and nematode infestation is common in coastal areas. Further, the surrounding area of Eluru is a cyclone- prone area and high-speed wind is a problem affecting banana plantations. High-speed winds uproot the plants.

Caste and Landholding Profile of Respondents

The study indicates that tissue culture technology adoption is influenced by social, economic and cultural factors. The socio-economic profile of tissue culture banana farmers reveals that nearly 93.8 per cent of the farmers who have relatively large landholding belong to the upper caste, followed by Scheduled Castes (4.4 per cent) and Backward Castes (1.9 per cent) as may be seen in Table 6. Social inequalities as well as economic inequalities are interrelated in rural society.

Table 6. Caste and Landholding Profiles of Farmers

Area of Land	OC	BC	SC	Total
Below 5	75(47.3%)	3(1.9%)	7(4.4%)	85
5.1 to 10	55(34%)	-	-	55
10.1 +	20(12.5%)	-	-	20
Total	150(93.8%)	3(1.9%)	7(4.4%)	160

The majority of the adopters of tissue culture technology in the study belonged to joint family (77.5 per cent) followed by nuclear family (17.5 per cent); Lateral Joint Family with (3.8 per cent) and Lineal Joint Family (1.3 per cent) as may be seen in Table 7. This indicates that joint family in agrarian society is preferred because of the need to protect property from getting divided into small unviable holdings and also the possibility of more family labour that can be employed in agriculture.

Table 7. Composition of the Households of the Farmers

Type of Family	Frequency	Percentage
Nuclear Family	28	17.5
Joint Family	124	77.5
Lineal Joint Family	2	1.3
Lateral Joint Family	6	3.8
Total	160	100

Gender profile

It is found that 95.63 per cent are male and 4.37 per cent are female farmers (Table 8). In rural society male farmers' domination prevails in adopting new technology.

Table 8. Gender Composition of the Farmers

Gender	Frequency	Percentage
Male	153	95.63
Female	7	4.37
Total	160	100

Religion of the Respondents

The primary concern of religion is to provide a code of conduct to social individuals or social groups through its basic tenets and preaching. As part of the code of conduct, religion assigns roles to men and women. Religious codes sometimes hamper adoption

of new technology in addition to economic and social factors.

Table 9. Religious Profile of the Farmers

Religion	Frequency	Percentage
Hindu	152	95.0
Muslim	2	1.3
Christian	6	3.8
Total	160	100

In terms of religious background the majority of the farmers were Hindus (95 per cent) followed by Christians (3.8 per cent) and Muslims (1.3 per cent).

Level of Education of the Respondents

Education plays a vital role in technology adoption in crop cultivation and associated practices. It increases awareness about technology, credit, marketing etc., In this study the majority of the farmers (76.25 per cent), had education upto school level, followed by college level education (12.50 per cent), and 4.37 per cent were retired government employees. As the majority of the farmers were literate they could comprehend technological practices in a better way than others. Thus, the technical element in terms of technical knowledge and the cultural element, i.e., the education of the adopters seem to have a positive relationship.

Table 10. Level of Education of the Respondents

Level of education	Frequency	Percentage
Nil Education (illiterates)	3	1.87
School level education (up to SSC)	122	76.25
College level education	20	12.50
Degree level education	11	6.90
Technical Education	4	2.50
Total	160	100

Awareness about Plant Tissue Culture Technology among Adopters

Plant tissue culture technology in Banana crop is a new technology. Since it is a new technology, farmers generally don't adopt in their crop. They came to know about the technology through Newspapers, Mass media, officials from the Private Labs and knowledgeable farmers.

Table 11. Awareness among the Adopters

Source of Information	Frequency	Percentage
Knowledgeable Person in the village (co-farmer and village leader)	117	73.25
Horticulture Department	17	10.6
Private Tissue Lab People	11	6.87
Mass media ((Newspaper)	15	9.28
Total	160	100

Table 11 indicates that out of 160 respondents in the study 117 (73.25%) respondents came to know about tissue culture banana technology through knowledgeable persons in the village. This shows that communication plays a vital role in rural society. In rural society, there is a network among the villagers of different classes. While formal communication came into existence as part of network relations between adopters and promoters, especially the private biotech laboratories, informal communication was found to be more effective among the adopters. Though rural society is stratified in terms of caste and class, when it came to sharing of technical information and adoption of technology, farmers of these villages depended more on their fellow men than mass media i.e. news paper, television etc. Seventeen (10.6%) respondents got awareness through Horticulture Department officials and 15(9.28%) respondents got it through the Newspaper. In rural areas, educated and enterprising farmers play the role of change agents by playing the role of pioneers in adopting tissue culture technology; others in the village tend to follow the pioneers.

Source of Tissue Culture Saplings

Tissue culture farmers purchased plants from various sources like Private tissue laboratories, Horticulture Department or sometimes both. According to respondents it depends on the availability of plants either in the private lab or horticulture department. Table No 12 gives details about the farmer's purchase of banana plant tissue culture plants.

Table No .12 Source of Supply of Saplings

Method of Purchase	Frequency	Percentage
Private Tissue Lab	119	76.87
Horticulture Department	36	22.50
Both (Private Tissue lab & Horticulture Department)	5	1.63
Total	160	100

The current study examined the sources of supply of tissue culture plantlets. Table 12 shows that among 160 respondents, 36 (22.50%) purchased from Horticulture Department, 119 (76.87%) purchased from Private Tissue Culture Laboratories and 5 (1.63%) purchased from both sources. According to some big farmers in the study, when there are no stocks of plants available in the Private Lab, they purchase it from the Horticulture Department. If the stock is not available in the Horticulture Department they go to Private Tissue Labs. Farmers indicated that they purchased banana tissue plantlets at the rate of Rs.9.00 per plantlet. The government gives subsidy through Department of Horticulture up to 50% i.e. 4.50 per plant up to 1 hectare of land or 2.5 acres. In other words, the government is providing direct subsidy to marginal farmers who cannot afford to buy plantlets at the market price.

Regarding the motivation underlying the adoption of tissue banana crop cultivation among adopters, it was found to be higher yield and consequent higher profitability of tissue culture banana technology and less risk relating to pest attacks compared to traditional banana crop cultivation; subsidy from the government, and uniformity in crop cutting, uniformity in harvest, and flowering etc.

The study shows that with the adoption of tissue culture banana cultivation, labour requirement has reduced with the introduction of drip irrigation and use of liquid fertilizer. Person-days were reduced by 20%-25% compared to conventional banana cultivation that employed flood irrigation.

The output was considered in terms of the yield in kilograms per acre or tonnes per acre. The relationship between performance and social and economic attributes of the farmers was examined in terms of their education, occupation, caste and economic class background. Output/yield was calculated adding up the entire yield of the adopters and dividing the output by total number of the acres of the adopters. The average yield was 20 tonnes/per acre.

It is found that the majority of the large and medium farmers obtained above average yield and small farmers got average yield. The yield depended on several factors, and it could not be correlated with any single factor. Judicious use of inputs, risk-bearing capacity, and farm management practices, which in turn are related to social and economic status of the farmers and education and availability of adequate labour in time, both family labour and hired labour seem to influence yield. Large farmers were able to afford latest methods like drip irrigation and liquid fertigation methods that gave above average yield. However, small farmers who used tube well irrigation and water flooding methods got below average or average yield.

Another significant finding is that reverse tenancy is occurring among tissue culture banana farmers in all the three regions. Big farmers take land on lease for Rs. 15,000

to 20,000 per acre from small and marginal farmers in all three regions. Earlier, it was small farmers who used to take land on lease from large farmers, but in tissue culture banana cultivation the opposite is happening. Large farmers took land from small and marginal farmers on lease basis, and extended the area under tissue culture banana crop cultivation.

Overall, farmers with relatively large size land holdings in all regions were very quick in adopting any new technology in agriculture or horticulture as it demonstrated higher returns on their investments.

The study reveals that there is an extension gap between farmers and Government extension officers or local horticulture department officials. Farmers felt that their problems need to be understood thoroughly, by taking farmers account regarding what happening in the field on the field itself.

Farmers in the three regions were happy over extension services by private tissue labs but unhappy over Government services for not providing comparative services to those provided by private tissue labs.

One important lacuna is that there exists a gap between farmers and Government extension officers or local horticultural officers. Farmers felt that his lacuna needs to be removed by strengthening extension services taking farmers opinion on the field itself.

Conclusion

The findings suggest that the multiple factors like uniformity in crop, uniformity in flowering, fruiting, harvesting, pest free/disease free, remunerative price, and consumer demand for tissue banana and subsidy from the Government influenced adopters. In addition to the crop related factors, socio-economic background, education, occupation seem to have influenced the adoption process.

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