Global Research Review in Business and Economics [GRRBE]
ISSN (Online) 2454-3217, ISSN (Print) 2395-4671
| Open-Access | Volume 9, Issue 02,
Pages 12-19 ||2023||
CrossRef DOI: https://doi.org/10.56805/grrbe

Economic Benefits of HDP Technology in Guava Cultivation

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1. INTRODUCTION

Arable land and irrigation water resources are shrinking day by day both qualitatively and quantitatively. Under this scenario, task of ensuring food and nutritional security through cultivation of fruits and vegetables is a possible venture only by increasing the yield of such crops under reduced cultivation area and need based watering of plants. Any measure to increase the productivity of fruits and vegetables by utilizing less space, cultivated area, water, labour, sunlight and air will yield its fruits. A comprehensive policy to minimize the resource use right from the time of planting /sowing to the stage of consumption by the common people is needed.

It is reported that more than 30 million farmers in India will have no access to irrigation and arable land by the year 2030. Growing need to feed the bulging population through a healthy diet ensuring sustenance is the biggest challenge for India. It is a heartening fact that India is bestowed with wide range of climatic conditions that support cultivation of diversified fruit crops. Next to China, India stands second in total fruits production in the world. However, average productivity and per capita availability of fruits in India is very less when compared to other developed countries. Main reasons for low productivity of fruit crops can be attributed to cultivation of low yielding varieties coupled with poor orchard management including wider tree spacing with dense canopies, non-judicious irrigation and nutrients management, poor canopy management leading to reduced sunlight penetration.

Even though, India stands second in fruit production in the world, average productivity of fruit crops in India is very less when compared to the other developed countries. The main reasons for low productivity of fruit crops may be due to establishment of orchards with poor quality planting materials coupled with poor orchard management practices. High Density Planting (HDP) in fruit crops is relatively a new technique for enhancing productivity without compromising tree vigour and fruit quality. It makes maximum use of land to achieve high yield in the initial years of orchard establishment along with ease in its management.

This system warrants accommodation of more number of trees per unit area along with proper canopy management of the fruit trees and thereby increasing the yield per unit area and net returns from the orchards. High density fruit orchard is feasible only by controlling tree size and by planting in a system that accommodates more number of plants. Therefore, manipulation of tree vigour / tree size is a crucial prerequisite for the success of high density planting in any fruit crop and can be achieved by use of genetically dwarf scion cultivars, use of dwarfing rootstocks, adopting appropriate planting systems, adopting appropriate training and pruning methods and use of growth retardants to restrict vegetative growth. Adoption of formative pruning in the initial years of orchard establishment to have desirable plant architecture and annual pruning to encourage vegetative growth immediate after harvest are highly required for successful HDP orchard establishment. In addition, drip fertigation system is also highly essential to get higher yield with quality fruits.

2. NATIONAL SCENARIO

India is the top producer of guava that harvests 25M metric tons contributing to 45 per cent of the world's guava production. The second and third largest producers are Indonesia and China that contribute seven per cent and five per cent of the production. As per the reports till 2019, India tops the guava production with five per cent annual growth and Thailand becomes the top exporter with 15 per cent annual growth and China becomes the biggest importer with a 15 per cent increase annually. Guava production in India has increased by 64 per cent over the past four decades. Guava is the fifth most widely grown fruit crops of India and grown in an area of about 2.85 million ha. With a production of 3.72 MT annually. (National Horticultural Board, 2020-21).

Guava is grown in tropical and subtropical regions and tolerates high temperatures which makes India a favorable place to harvest guavas. Although guava can be grown throughout India due to favorable climatic conditions, Uttar Pradesh is the major contributor in the production followed by Madhya Pradesh and Bihar (Singh, 2007). In Tamilnadu, guavas are predominantly cultivated in Madurai, Salem, and Dindigul districts. (National Horticulture Board 2021-22).

Table 1. Production of Guava in India (1000 tonnes)

Sl.No.	State	Production	Per cent share (%)
1.	Uttar Pradesh	983.59	26.20
2.	Madhya Pradesh	776.75	20.70
3.	Bihar	434.41	11.57
4.	Andhra Pradesh	335.11	8.93
5.	Haryana	271.18	7.22
6.	Punjab	219.85	5.85
7.	West Bengal	203.56	5.42
8.	Chhatisgarh	187.04	4.98
9.	Gujarat	175.33	4.67
10.	Karnataka	167.48	4.46
	Total	3754.30	100,00

Source: National Horticulture Board 2021-22 First Advance Estimate

The high density orcharding is already successful in many fruits. Perhaps, the high density orcharding has been the area of most intense focus in the last decade. To meet the challenge of high productivity, one has to optimize the parameters of growth and minimise the unproductive components of plants without sacrificing the overall health of the tree and quality of the product.

Problem focus

Guava cultivation in India particularly under High Density Planting system gets support from Government of India through several schemes. Many States have implemented those schemes and Tamil Nadu is one among them. In spite of the efforts taken by the Government and several benefits reported and documented in favour of High Density Planting, the technology has not been received well by the farmers. Guava being a perennial crop intervening the production techniques and other related aspects is a challenging task.

Farmers decision on area under guava cultivation practices, and adoption of modern techniques like HDP is determined by several factors. Altering the production technology in the case of crops like guava will have a slow but steady effect in the long run. Researcher has to observe the changes very closely and patiently in the case of perennial crops. One has to document and analyse the field level problems experienced by the farmers in adopting the HDP technology. There is a need to study the adoption pattern and behaviour of the farmers in accepting a new technology. An assessment of the benefit or otherwise of adoption of the components of HDP technology is needed in order to make appropriate changes in technology, method of dissemination, field application and implementation.

Hence present study is taken with the following objectives:

1. To compare the resource productivity under normal and high density planting of guava.
2. To evaluate the impact of HDP at farm level
3. To evaluate the impact of HDP at household level
4. To analyse the constraints in adoption of high density planting and to suggest remedies

3. RESEARCH METHODOLOGY

Two blocks in Dindigul district with largest area under guava were selected. One village from each of the selected block in the district where HDP was introduced was selected. Another village in the same block where HDP is not introduced was selected as control. From each selected village, 25 farmers were selected. Thus 50 farmers to represent high density planting in guava and 50 farmers as control were selected from Dindigul district. Thus a three stage sampling technique was followed to select 100 respondents.

Secondary data pertaining to area and production of guava in the selected blocks of Dindigul district were collected from the Department of Horticulture. All India level and State level data on area production and productivity of guava were collected from indiastat website.

Preliminary discussions were held with the Assistant Directors of Horticulture and Horticulture Officers in Dindigul district regarding the role of State Department of Horticulture in promoting High Density Planting technology among the farmers.

Primary data were collected from the sample farmers by administering the pre tested interview schedules. In between COVID 19 pandemic also crept in and so needed information from the farmers were gathered through telephonic interview/conversation. After the pandemic was over again personal interview was continued.

4. RESULTS AND DISCUSSION

Data collected from the sample respondents were analysed with reference to the objectives of the study and the results are presented in the following section.

Land particulars in sample farms

Details of land types and their distribution are presented in Table 2. It could be seen from the table that average farm size in the sample was 2.96 ha. It was the lowest in Palani block (2.66 ha) and the highest in Natham block (3.35 ha). Major type of land in both the blocks was garden land and the average size of garden land was 1.86 ha. In Palani block and in Natham block it was 2.35 ha. Average size of garden land in the sample was 2.13 ha. Next predominant land type in the sample was the dry land with sample mean of 0.55 ha. Average size of dry land was the highest in Natham block (0.85 ha.) followed by Palani block where the average size of dry land was 0.45 ha. Wetland occupied the meagre size of 0.28 ha for the sample as a whole and the average size of the same was 0.35 ha. In Palani block and it was still lower (0.15 ha.) in Natham block. This revealed the predominance of garden land in the sample farms.

Table 2. Land Area Cultivated in Sample Farms (in ha.)

Name of the block	Wet land	Garden Land	Dry Land	Total
Natham	0.15	2.35	0.85	3.35
Palani	0.35	1.86	0.45	2.66
Average	0.28	2.13	0.55	2.96

Assets owned by the sample farmers

Financial status of the sample farmers could be judged by the value of assets owned by them and hence the same was computed and presented in Table 3. It could be understood from the table that an average sample farmer owned assets valued at Rs.12,1,8830 in which the share of machinery and equipments was the highest (38.59 per cent) followed by the buildings and fence (30.43 per cent), livestock and birds (17.28 per cent) and wells and related structures (13.71 per cent) in that order.

Table 3. Assets Owned by the Sample Farmers

Sl.No.	Particulars	Natham		Palani		All Farmers	
		Present Value (Rs)	Percent share	Present Value (Rs)	Per cent share	Present Value (Rs)	Per cent share
1	Buildings and fence	333170	37.51	395170	31.00	370840	30.43
2	Livestock and Birds	156660	17.64	217110	17.03	210580	17.28
3	Machinery and Equipments	224300	25.25	497710	39.04	470360	38.59
4	Wells and related structures	174110	19.60	164890	12.93	167050	13.71
	Total	888240	100.00	1274880	100.00	1218830	100.00

Block wise analysis revealed that average farmer in Palani owned assets worth Rs. 1274880 in which the share of machinery and equipments was the highest (39.04 per cent) followed by the buildings and fence (31 per cent), livestock and birds (17.03 per cent) and wells and related structures (12.93 per cent) in that order. Scenario in Natham block was different with share of buildings and fence was the highest (37.51 per cent) followed by the machinery and equipments (25.25 per cent), wells and related structures (19.60 per cent) and livestock and birds (17.64 per cent). Hence it could be concluded that sample farmers in Palani block invested more on machinery and equipments which include drip irrigation layouts. Whereas in Natham block major investments (37.51 per cent) was on buildings and fencing with a view to protect guava gardens supported by sufficient investment (25.25 per cent) on irrigation structures also. Hence it could be concluded that in both the blocks, investments on buildings and fencing and machinery and equipments formed the major share of farm investment.

Table 4. Area and Yield of Guava in the Sample Farms

Name of the block and crop	Area (ha)	Yield (tonnes)	Irrigated/Dry
Natham			
Guava	33.30 (49.92)	32.48	Irrigated
Sapota	18.20 (27.28)	24.16	Dry
Onion	5.70 (8.55)	12.48	Irrigated
Chillies	3.50 (5.25)	8.36	Dry
Total	66.70 (100.00)		
Palani			
Guava	28.80 (49.09)	5.00	Irrigated
Paddy	14.26 (24.27)	34.16	Irrigated
Groundnut	8.38 (14.27)	12.57	Irrigated
Tomato	7.30 (12.43)	8.45	Irrigated
Total	58.74 (100.00)		

Major crops cultivated and their yield in sample farms

In order to understand the position of guava in total crop area and the yield levels of major crops details of crops cultivated in the sample farms and their yield were collected from the sample farms and the same were presented in Table 4. It could be observed from the table that total cultivated area in the sample farms of Natham block were 66.70 ha. and in which 33.30 ha. Was occupied by guava accounting for 49.92 per cent and 18.20 ha. Occupied by sapota accounting for 27.28 per cent. Average yield of guava was comparatively higher (58 tonnes)

Area under guava, varieties cultivated, age of the tree and root stock

Knowledge about the area under guava, varieties, age of the trees and source of root stock provide a fair idea on the status of bearing and growth stage of guava in the sample farms. Hence the same were analysed and presented in Table 5. The table reveals that average area under HDP system guava in the sample farms of Natham block was 1.10 ha. and area under traditional cultivation of guava in Natham was 2.64 ha. Major variety under HDP system was Lucknow 49 and the same under traditional system of cultivation was local variety. In Palani, major variety under HDP system was Allahabad and the same under traditional system was local variety. Average age of trees under HDP in Natham was 2.86 years and the same under traditional system in the same block was 3.84 years. In Palani block average age of trees under HDP system was 4.75 years and the same under traditional system was 6.28 years.In both the blocks source of root stock for traditional system farms was own farm whereas the farmers adopting HDP system sourced the root stock from the State Department of Horticulture.

Table 5. Area, Varieties Cultivated, Age of trees and Root stock used

Block and variety	Area under Guava (ha)		Age (years)		Source of Root stock	
	Traditional	HDP	Traditional	HDP	Traditional	HDP
Natham						
Lucknow 49		1.10		2.86		Hort. Dept
Local	2.64		3.84		Own	
Palani						
Allahabad		0.96		4.75		Hort.Dep
Local	1.96		6.28		Own	
Average	2.30	1.03	5.02	3.81		

Source of income in sample farms

Understanding the sources of income in the sample farms would reveal the contribution of guava crop in the total household income and hence it was computed and presented in Table 6. It could be noticed from the table that average income of the household in the sample was Rs. 16,69,882 and the guava crop contributed 41.94 per cent share. However, comparative share of guava in HDP farms was higher (52.65 per cent) than in traditional system farms (17.22 per cent) in Natham block. Comparative share of guava in HDP farms was marginally higher (53.25 per cent) than in traditional farms (15.23 per cent) in Palani block. In line with the above, contribution of other crops except guava had come down in HDP farmers in both the blocks.

Table 6. Sources of Household Income among the Sample Farmers

(Rs. Per year)

	Guava	Other Crops	Livestock	Off Farm	Non Farm	Self employment	Total
Natham							
Traditional	148680 **(17.22)**	305000 (35.33)	74500 (8.63)	32650 (3.78)	286000 (33.13)	16400 (1.91)	863230 (100.00)
HDP	1100000 **(52.65)**	532000 (25.46)	68400 (3.27)	42680 (2.04)	327000 (15.65)	19380 (0.93)	2089460 (100.00)
Palani							
Traditional	172900 **(15.23)**	468000 (41,22)	82500 (7.27)	43700 (3.85)	346000 (30.46)	22370 (1.97)	1135470 (100.00)
HDP	1380000 **(53.25)**	634000 (24.47)	78600 (3.03)	52650 (2.03)	420630 (16.24)	25490 (0.98)	2591370 (100.00)
Average	700395 (41.94)	484750 (29.03)	76000 (4.55)	42920 (2.57)	344907 (20.65)	20910 (1.26)	1669882 (100.00)

Resource productivity under traditional and HDP system

Difference in the productivity of resources under traditional and HDP system of planting was assessed and the results are presented in Table 7. It could be observed that productivity of labour has increased from 220 kgs/manday under traditional system to 289 kg/manday under HDP system, recording an increase of 31.36 per cent. In the case of plant nutrients nitrogen productivity has increased by 63 per cent from 35 kg/kg of N to 64 kg/kg on N. Similarly, phosphorus and potash productivity has increased by 80.73 per cent from 83 kg/kg to 150 kg/kg.

Table 7. Resource productivity under traditional and HDP system

Labour (Kgs/Manday)		N, P and K (Kg/Kg of fruit)	
HDP	**Traditional**	**HDP**	**Traditional**
289	**220**	**N - 64** **P - 150** **K - 150**	**N - 35** **P - 83** **K - 83**

Impact assessment at farm level

Introduction and continuous adoption of a technology from the view point of farmers depends on the impact realised at the farm level. Hence impact of HDP technology at the farm/level was assessed and the results are presented in Table 8.

It could be inferred from the table that both net sown area and gross cropped area in the sample farms have reduced resulting in reduction in the cropping intensity. In percentage terms cropping intensity in the normal system of planting was 81.72 and the same under HDP technology was 50.83. This shows that HDP system of planting has the potential to save the cultivable land. Since cultivation is carried out in less area compared to normal system of planting, the intensity of irrigation was expected to decline. It could also be noticed that both net irrigated and gross irrigated area have come down in the HDP system. This resulted in reduction in the irrigation intensity from 67.59 per cent to 51.78 per cent. Because of reduced usage of irrigation water, water table in the HDP system of planting has raised to 12.58 feet from 14.28 feet. Cultivation of guava in lesser area was expected to reduce the days of employment of farm labour. It could be observed that employment days got reduced from 285 in the normal system of planting to 182 in HDP system. This shows that there is saving in labour use due to adoption of HDP system and the residual/surplus labour could be engaged in other farm/off farm/non-farm activities.

Table 8. Impact Assessment of HDP at Farm Level

Particulars	HDP System	Normal System
Net sown area (acres)	2.46	4.38
Gross cropped area (acres)	4.84	5.36
Cropping Intensity	50.83	81.72
Net irrigated area (acres)	2.32	3.17
Gross Irrigated area (acres)	4.48	4.69
Irrigation Intensity	51.78	67.59
Employment (days/Year)Income (Rs/Year)	182	285
Water table (feet)	12.58	14.28

Impact assessment at household level

Farm household members are actively taking part in the crop cultivation activities and hence the impact of adopting HDP technology would have the possibility of sustaining in future provided the members of the farm household realise and enjoy the benefits to their fullest satisfaction. Hence the impact of adopting HDP technology at the household level also was analysed. Consumption level is defined as “the aggregate of the food, fuel, and the other nondurable goods used up, the services of house, automobiles, clothing and other durable and semidurable goods utilised, and the services of human beings used, by an individual or group in a given period of time (Davis, 1945). Since the impact at household level has a bearing on the consumption level the change in the consumption level due to adoption of HDP technology was assessed and the results are presented in Table 9. Data presented in the table reveals that an average household in the sample earned Rs. 332000 per year under normal planting system of guava plantation.

It has increased to Rs.356000 under HDP system recording an increase of 7.23 per cent. In line with increase in income, household expenditure also increased from Rs.230700 to Rs.250900 recording a percentage change of 0.76. Percentage share of expenditure on food, education, recreation, social and religious expenditures did not record any significant change. However, expenditure share on clothing recorded a marginal increase and that on health had declined. This result confirmed the fact that the farm households were able to earn the same level of income by cultivating mango at a smaller area under HDP system than under normal system. Similarly the HDP system of mango cultivation has maintained the standard of living of the farm households adopting the same on par with those adopting normal system of planting. Reduction in area under mango orchard under HDP system did not negatively impacted on the standard of living in the study area.

Tabel 9. Impact Assessment of HDP Technology at Household Level

Particulars	HDP System	Normal System
Food expenditure (Rs/Year)	2400 (0.95)	2260 (0.98)
Clothing (Rs/Year)	2600 (5.02)	10570 (4.58)
Education (Rs/Year)	82400 (32.84)	74280 (32.20)
Health (Rs/Year)	36400 (14.52)	34750 (15.06)
Recreation (Rs/Year)	15400 (6.14)	14500 (6.28)
Social & Religious (Rs/Year)	27400 (10.92)	23690 (10.27)
Vehicle Purchased (Rs/Year)	74300 (29.61)	70650 (30.63)
Total Expenditure	250900 (100.00)	230700 (100.00)
Farm Income (Rs/Year)	356000	332000

Problems faced by the sample farmers in adopting HDP system of guava cultivation

Above discussion about HDP system of guava cultivation has highlighted the rosy picture of the technology. However, the sample farmers had expressed certain problems in adopting and practicing HDP system. The problems are presented in Table 10. It could be observed that major problem reported was complications in nutrient scheduling (95 per cent) followed by canopy management (91.67 per cent), high labour requirement (86.67 per cent) and marketing issues (83.33 per cent). Detailed discussion with the respondents came out with the observation that since guava is a perennial crop usual practice of supplying nutrients is on per plant/tree basis. Depending on the age and growth stage of the crop and the capacity of the plant to uptake the nutrients the dose of major and minor nutrients differ from time to time. Moreover, depending on the rainfall received and intensity of the shower, nutrient requirement of the growing plant differs and hence the nutrients have to be applied to the plants with at most care. Application of minor nutrients and growth hormones to guava crop needs highly professional skill with scientific outlook.

Yet another issue is with crop canopy management. Since the spacing between rows as well as between plants so narrow the normal growth of the guava plants has to be controlled and properly pruned or trained to allow the sunlight flow into the space between the plants. Removal of leaves and branches make the growing plants weaker because of the loss of leaf area that is needed for normal photosynthesis. To ensure normal growth, needed nutrients have to be supplied to the plants in exact doses decided based on scientific experiments conducted in the research field.

Another specific requirement of the HDP system is drip system of irrigation. The chemical fertilizers have to be mixed with the irrigation water and applied through the network of irrigation system. This needs professional knowledge about the physiology of crops, nutrient movement, nutrient uptake and absorption rate. So nutrient scheduling must be in line with the canopy structure and coverage over the soil surface and the shoot coverage above the ground level.

Since the number of plants maintained is more under HDP system than the normal system requirement of labour will be eventually more. Sample farmers have reported that in the present context of shortage of labour available for farm operations in time, adopting HDP system of cultivation poses challenges to farmers.

Next follows the issues related to marketing of the harvested produce. Since the contractors and other type of buyers were used to the procurement of guava fruits under the normal system of planting they find it difficult to adjust their trading practices in line with the fruiting behaviour of the guava trees grown under HDP system.

Table 10. Problems faced in adoption of HDP technology

Problems	Number and Per cent
High labour required	86.67
Unsuitability of variety	75.00
Unsuitability of soil	61.67
Canopy management	91.67
Nutrient scheduling	95.00
Marketing	83.33
Poor water quality	70.00

Suggestions offered by the sample respondents to improve the performance of HDP

Sample farmers were requested to offer their suggestions to improve the performance of HDP system of planting in guava. The details are presented in Table11. Among different suggestions given soil amendment was suggested by the majority of sample farmers (96.67 percent) followed by training in nutrient scheduling (95 percent), partial mechanisation (93.33 per cent), recommending suitable variety (91.67 per cent) and training in canopy management (88.33 per cent).

Table 11. Suggestive Opinions Given by the Sample Farmers

Suggestions	Number and Percent
Partial mechanization	93.33
Recommend suitable variety	91.67
Soil amendment	96.67
Canopy management Training	88.33
Nutrient scheduling training	95.00

Policy Recommendations

Above discussion about HDP system of planting led to some policy suggestions mentioned below

- ✓ Technology Mission on HDP technology as already introduced for pulses and oilseeds
- ✓ Development of nutrient mixture exclusively for use under HDP as on the case of Coconut, Rose etc., (An exclusive nutrient mixture for fertigation in guava)
- ✓ Technology team with skilled labour and unemployed horticulture graduates at block level to guide and assist the farmers willing to adopt HDP.

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