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Effect of adoption of papaya ring spot virus management technology on economics of papaya cultivation

S.K. Sharma* and K.K. Zote
Indian Agricultural Research Institute, Regional Station, Agricultural College Estate, Shivajinagar, Pune 411 005

ABSTRACT

Based on the data collected *via* surveys conducted in Ahmadnagar and Solapur districts of Maharashtra, a financial viability study of papaya cultivation was conducted at various levels of papaya ringspot virus (PRSV) management technology adoption. Since commercial cultivation of papaya is limited to one year only, cost and revenues were calculated for one cycle of cultivation (*i.e.,* one year). Different cost components for manpower and material, and revenues were calculated on per hectare basis. Manpower cost for low adopters (Rs. 40,788/-) was lower than that of high adopters (Rs. 44,570/-), while average requirement of labour was Rs. 42,685/-. Weeding contributed about one-quarter of total labour cost. High adopters spent 16% more money on materials than low adopters. Average requirement of material was Rs. 93,070/-. Fertilizers (including manures) contributed about 34% of total material cost. Cost (C 2) of papaya cultivation was Rs.1,91,983/- for low adopters, Rs. 2,17,673/- for high adopters, and the average cost was Rs.2,04,848/-. Revenues generated were also higher in high adopters (Rs. 6,45,079/-) than low adopters (Rs. 5,08,850/-), while average revenues generated were Rs. 5,77,086/- per hectare. Since revenues generated were higher than total cost, papaya farmers registered net profit of Rs.3,16,867/- for low adopters, Rs. 4,27,406 for high adopters, and the average profit was Rs. 3,72,238/- per hectare. Overall B:C ratio was 2.82 - 2.65 for low adopters and 2.96 for high adopters. The additional returns for high adopters were Rs. 1,10,539/- against the additional expenditure of Rs.25,690/-. The economic analysis revealed that papaya cultivation was highly profitable in the surveyed area of Maharashtra even for low adopters. However, farmers pointed out certain problems in papaya cultivation these can be addressed by the following policy modifications: (i) encourage use of virus-free planting material, (ii) training of village level workers, and (iii) establish assured marketing channels for poor and marginal farmers.

Key words: *Carica papaya*, profitability, papaya ring spot virus management, technology adoption.

INTRODUCTION

Papaya is one of the major fruit crops of the world, having production of more than three million metric tonnes (mt) per annum (National Horticultural Board, 6). India contributed about 30% to total world production in 2008 from an area of about 83 thousand ha. Papaya is giving maximum productivity (35 t/ha) among fruit crops in India. It is mainly cultivated in Andhra Pradesh, Gujarat, West Bengal, Karnataka and Chhattisgarh (National Horticultural Board, 6). These states cover more than 75% of total area and contribute about 85% of country's total papaya production (Ray *et al*., 7; Syamal *et al*., 13) However, rate of growth (per cent change) of area and production of papaya in India is very slow (Figs. 1 to 6). One of the reasons for slow growth of these parameters is the limited availability of information on financial viability and social and economic costs of papaya cultivation. Some workers have analyzed economics of cultivation of fruits in India like date plantation (Bhati *et al*., 1), mango (Subramanyam, 10, 11; Rajput *et al*., 8; Verma *et al*., 14), Nagpur mandarin (Gupta and George, 3; Gangawar and Singh, 2; Mahale and Korde, 4, 5), Coorg mandarin (Subramanyam and Mohandas, 12), and jujube (Sharma and Saran, 9). However, very little work has been done on papaya. Financial viability and social impact of papaya cultivation technology are not precisely known. Farmers adopt the technology considering its assumed impacts on marketable production only. They are unable to take decision on selection of a cultivar or a particular cultivation practice in the absence of precise information about their financial implications. Many queries of papaya cultivators on the cost of production under different regimes of technology adoption and the potential returns could not be answered accurately. Therefore, the present study was undertaken to estimate the economics of papaya cultivation at farmers' fields at various levels of technology adoption.

MATERIALS AND METHODS

Data were collected from farmers' fields through a series of micro-level surveys in Ahmadnagar and Solapur districts of Maharashtra during 2005-06.

*Corresponding author's E-mail: sunilksharma1959@yahoo.co.in

The main themes for which data were collected were various components of costs incurred by the techniques adopted by farmers for papaya cultivation, and the revenues generated. A questionnaire was developed for the purpose. Adoption of PRSV management technology comprised various farming activities, such as selection of aphid-free plantation season, raising border crop around papaya plantation, cultivar preference, adoption of healthy (virus-free) seedlings, use of insecticides, roguing of infected plants, and regular weeding in the orchard. These practices are also part of papaya cultivation. Most of the farmers follow them but at varying degree of adoption. Based on adoption of recommendations, farmers were categorized into low (<33% adoption) and high (>67% adoption) categories. Although papaya is a perennial crop, its commercial cultivation is limited to one year only due to heavy infestation of viral diseases. Therefore, cost and revenue data were calculated for one cycle of cultivation (*i.e.*, one year) only on per hectare basis. Different cost components for manpower and material, and revenues were calculated. Financial viability of papaya cultivation was calculated by taking into account all factors affecting fixed and variable costs of production, including the cost of capital and family labour. The output (fresh fruits) was given in monetary values based on average market price. Benefit:cost (B:C) ratio was calculated on cost C-2 basis.

RESULTS AND DISCUSSION

Based on data collected from farmers, a financial viability study was conducted for papaya cultivation both for 'Low adopters' and 'High adopters' categories of farmers (Tables 2, 3). Various components of cost and revenues are discussed here.

Manpower cost for low adopters was lower to high adopters in both districts. Difference of labour cost between low and high adopters was Rs. 4,303/- in Ahmadnagar and Rs. 3,262/- in Solapur. Overall difference was Rs. 3,782/-. Although both districts

Table 1. Area, production and productivity of papaya in India.

Year	Area (000 ha)	% of total fruit area	Production (m MT)	% of total fruit production	Productivity (t/ha)
1991-92	45.2	1.57	0.805	2.81	17.8
1992-93	47.4	1.48	0.804	2.44	17.0
1993-94	55.9	1.76	1.266	3.40	22.7
1994-95	61.0	1.88	1.373	3.56	22.5
1995-96	61.0	1.82	1.330	3.20	21.8
1996-97	63.0	1.76	1.299	3.21	20.6
1997-98	69.9	1.89	1.619	3.74	23.2
1998-99	67.7	1.82	1.582	3.59	23.4
1999-00	60.5	1.59	1.666	3.66	27.5
2000-01	70.2	1.81	1.796	4.16	25.2
2001-02	73.7	1.84	2.590	6.02	35.1
2002-03	68.0	1.80	2.147	4.75	31.6
2003-04	58.2	1.24	1.692	3.71	29.1
2004-05	72.8	1.44	2.535	4.98	35.2
2005-06	73.1	1.33	2.317	3.94	31.7
2006-07	72.0	1.30	2.482	4.17	34.4
2007-08	83.0	1.42	2.909	4.44	35.1
2008-09	98.0	1.61	3.629	5.30	37.0

Source: National Horticultural Board, Gurgaon, Haryana.

showed similar pattern of labour cost, it was more in Ahmadnagar than in Solapur. The difference was due to higher labour cost of 'irrigation' and 'transport and marketing' in Ahmadnagar. Main activities contributing towards labour cost were 'weeding', 'irrigation', and 'transport and marketing'. The trend is similar in both districts, except that in Solapur 'fertilizer application' contributed more towards labour cost than 'transport and marketing' cost. The trend of labour cost was similar both for low and high adopters. Maximum labour cost contribution came from 'weeding'. It was 23%, 26 and 24% in Ahmadnagar, Solapur and overall, respectively. However, both low and high adopters spent about quarter of their labour cost on 'weeding'. Overall labour cost was Rs.42,685/- per hectare. High adopters spent about 9% more on labour cost than low adopters.

Material cost too was less in case of low adopters than high adopters in both the districts. Difference of material cost between low and high adopters was Rs. 8,360/- in Ahmadnagar and Rs. 19,826/- in Solapur. Overall difference of material cost between low and high adopters was Rs. 14,093/-. Although both districts showed similar pattern of material cost, it was more Solapur than Ahmadnagar. The difference was due to higher cost of 'planting material' and 'fertilizers, manures, etc.' in Solapur. Overall total material cost was Rs. 93,070/-. Major contributing items to materials costs were 'fertilizers (including manures, etc.)', 'planting material' and 'irrigation'. Fertilizers added about one

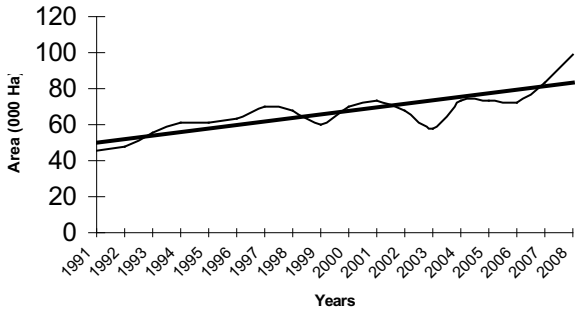

Fig. 1. Trend line of area under papaya cultivation in India.

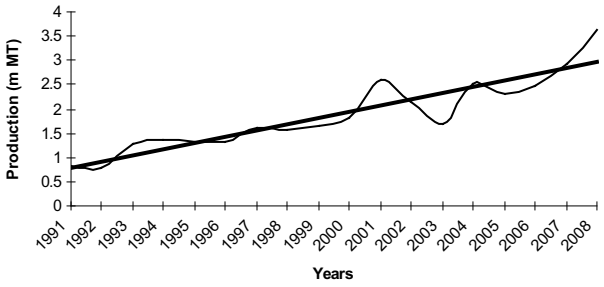

Fig. 2. Trend line of papaya production in India.

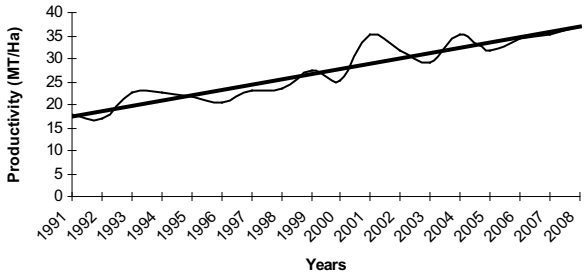

Fig. 3. Trend line of productivity of papaya in India.

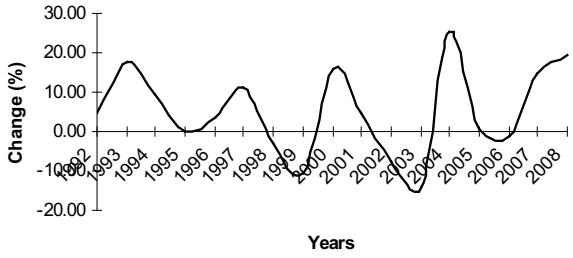

Fig. 4. Per cent change in area under papaya cultivation in India since 1992.

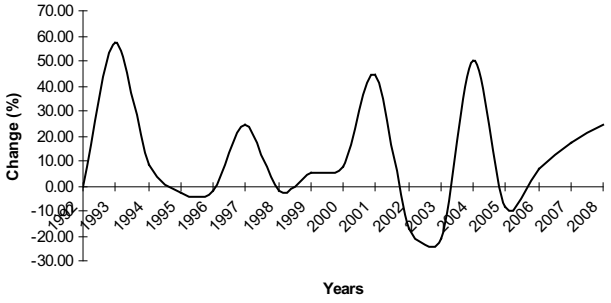

Fig. 5. Per cent change in production of papaya in India since 1992.

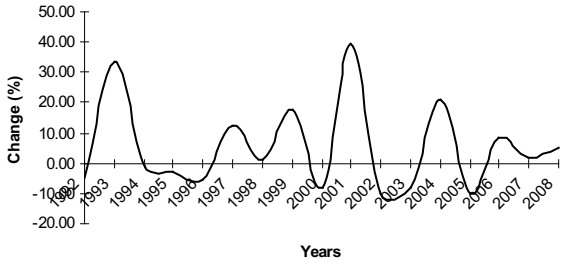

Fig. 6. Per cent change in productivity of papaya in India.

Table 2. Activity-wise labour and material inputs required for papaya cultivation (Rs./ha).

Activity	District						Average		Overall
	Ahmadnagar			Solapur					
	Low adopters	High adopters	Average	Low adopters	High adopters	Average	Low adopters	High adopters	
Labour cost									
Tillage	5,581	6,069	5,977	5,435	5,511	5,481	5,508	5,790	5,704
Transplantation	762	770	766	893	1,111	998	828	941	882
Irrigation	6,637	7,035	6,840	5,054	4,938	4,998	5,846	5,987	5,919
Weeding	9,695	10,591	10,152	9,966	11,058	10,491	9,828	10,823	10,316
Fertilizer application	3,470	3,764	3,620	4,373	5,150	4,747	3,922	4,457	4,183
Insecticide application	2,855	3,021	2,940	2,634	2,949	2,785	2,745	2,985	2,863
Pesticide application	2,014	2,070	2,033	1,599	1,950	1,768	1,807	2,010	1,905
Harvesting	4,609	5,465	5,036	4,889	5,256	5,085	4,749	5,361	5,060
Transport and Marketing	6,692	7,833	7,264	4,417	4,599	4,543	5,555	6,216	5,853
Total	42,315	46,618	44,628	39,260	42,522	40,896	40,788	44,570	42,685
Material cost									
Irrigation	16,127	15,833	15,982	16,417	18,846	17,585	16,272	17,340	16,783
Planting material	15,706	21,147	18,421	21,771	25,373	23,503	18,739	23,260	21,062
Fertilizers/ manures, etc.	28,719	30,381	29,566	28,725	39,061	33,694	28,722	34,721	31,630
Growth promoters	11,198	11,503	11,343	9,360	11,773	10,713	10,229	11,638	11,033
Pesticides	6,319	6,714	6,520	6,583	6,889	6,740	6,451	6,802	6,625
Small implements	5,900	6,751	6,334	5,107	5,847	5,540	5,553	6,298	5,937
Total	83,969	92,329	88,166	87,963	1,07,789	97,775	85,966	1,00,059	93,070

Table 3. Economic analysis of virus management technology in papaya (Rs./ha).

Activity	District						Average		Overall
	Ahmadnagar			Solapur					
	Low adopters	High adopters	Average	Low adopters	High adopters	Average	Low adopters	High adopters	
1. Total labour	42,315	46,618	44,628	39,260	42,522	40,896	40,788	44,570	42,685
2. Total materials	83,969	92,329	88,166	87,963	1,07,789	97,775	85,966	1,00,059	93,070
3. Land revenue	500	500	500	500	500	500	500	500	500
4. Inst on working capital (@12% p.a.)	7,577	8,337	7,968	7,633	9,019	8,320	7,605	8,678	8,145
5. Inst on fixed capital	34,560	36,050	35,040	12,010	12,550	12,240	23,285	24,300	23,640
6. Rental value of owned land	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
7. Imputed value of family labour	26,064	32,513	28,090	22,613	27,618	24,644	24,339	30,066	27,308
Cost A1 (1+2+3+4)	1,34,361	1,47,784	1,41,262	1,35,356	1,59,830	1,47,491	1,34,859	1,53,807	1,44,400
Cost B1 (Cost A1+5)	1,68,921	1,83,834	1,76,302	1,47,366	1,72,380	1,59,731	1,58,144	1,78,107	1,68,040
Cost B2 (Cost B1-3+6)	1,78,421	1,93,334	1,85,802	1,56,866	1,81,880	1,69,231	1,67,644	1,87,607	1,77,540
Cost C2 (Cost B2+7)	2,04,485	2,25,847	2,13,892	1,79,479	2,09,498	1,93,875	1,91,983	2,17,673	2,04,848
Total revenues (G)	4,22,058	5,52,244	4,88,427	5,95,641	7,37,913	6,64,041	5,08,850	6,45,079	5,77,086
Net profit	2,17,573	3,26,397	2,74,535	4,16,162	5,28,415	4,70,166	3,16,867	4,27,406	3,72,238
B:C	2.06	2.45	2.28	3.32	3.52	3.43	2.65	2.96	2.82

third of total material cost to the papaya cultivation. High adopters spent more money on almost all the materials required for papaya cultivation. The trend is similar in both the districts, except that in Ahmadnagar, low adopters spent higher amounts on 'irrigation' than high adopters. The highest cost difference between low and high adopters was observed in cost of 'planting material' in Ahmadnagar and 'fertilizers' in Solapur. High adopters used costlier virus-free planting material of preferred cultivars. Overall, they spent 16% more money on materials required for papaya cultivation than low adopters.

Total per hectare revenue generated by high adopters, Rs. 5,52,244/- (Ahmadnagar) and Rs. 7,37,913/- (Solapur) were higher than low adopters, Rs. 4,22,058/- (Ahmadnagar) and Rs. 5,95,641/- (Solapur). Higher revenues in Solapur (Rs. 6,64,041/- per ha) than in Ahmadnagar (Rs. 4,88,427/- per ha) could be attributed to better opportunities for Solapur farmers to sell their fruits at higher prices in Pune, Hyderabad and Bangalore markets. Overall revenues were Rs. 5,77,086/- per hectare.

Overall cost (C-2) of papaya cultivation was Rs. 2,04,848/-, while total revenues received were Rs. 5,77,086/-. Revenues received in Solapur, Rs. 6,64,041/-, were considerably higher than those received in Ahmadnagar, *i.e.*, Rs. 4,88,427/-. The cost and revenues generated were higher in case of high adopters than low adopters (Table 3). In Ahmadnagar, high adopters had 10% higher cost of cultivation and 31% more revenue generation than those of low adopters. While in Solapur, differences between low and high adopters in cost and revenue generated were 17 and 24%, respectively. Since differences in revenues generated were more than differences in cost, higher adopters had better benefit:cost (B:C) ratios. The B:C ratio was 2.06 for low adopters and 2.45 for high adopters in Ahmadnagar, whereas in Solapur, it was 3.32 and 3.52 for low and high adopters, respectively. Overall the B:C ratio for high adopters was 2.96 as compared to 2.65 for low adopters. The additional returns for high adopters were Rs.1,30,186/- per ha for Ahmadnagar and Rs.1,42,272/- for Solapur which was far more than the incremental cost of technology adoption, *i.e.*, Rs. 21,362/- per ha for Ahmadnagar and Rs. 30,019/- per ha for Solapur. This showed that papaya cultivation is financially viable even for low adopters in the western Maharashtra region. This is quite in contrast with date plantation that was not found financially viable in western Rajasthan (Bhati *et al*., 1). Papaya is more remunerative than other fruit crops, like, Nagpur mandarin in Vidarbha region of Maharashtra, which had average total cost of cultivation Rs. 22,642/- and the average net returns Rs. 18,483/- per ha (Gangawar and Singh, 2).

The economic analysis revealed that papaya cultivation was highly profitable in the surveyed areas of Maharashtra even for low adopters. However, farmers pointed out certain problems in papaya cultivation which can be addressed by the following policy modifications: There is a perpetual shortage of seeds of the preferred cultivars, therefore, seller of seeds charge a premium over MRP. This also leads to a parallel market of spurious seeds. Both conditions are harmful to papaya cultivators. Government agencies should ensure timely availability of genuine seeds in adequate quantity. Majority of papaya seedlings available in market are raised in open nurseries, leading to viral infection in seedlings. Farmers are forced to plant inferior quality seedlings, which leads to avoidable yield losses. Authorities should encourage private nursery owners, especially women farmers, in rural areas to raise papaya seedlings using modern techniques. Competent organizations should also provide training to nursery persons on raising virus-free papaya seedlings. Farmers pointed out limited knowledge about papaya cultivation as one of the major causes for its low adoption. To overcome this constraint, training of village level extension workers on papaya cultivation is urgently required. These trained extension workers, in turn, will train farmers at village level for better adoption of technology of papaya cultivation. Many farmers are unable to take full advantage of good harvest because of inaccessibility to profitable markets. They are badly exploited by middlemen. Establishment of assured marketing channels for poor and marginal farmers are urgently required so that they can reap full benefits of papaya cultivation.

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