Research Article

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Technology impacts on area, production and productivity of cashew in Dakshina Kannada district, Karnataka

M.V. Sajeev*, P.L. Saroj and R. Lakshmisha

Directorate of Cashew Research, Puttur - 574 202, Karnataka, India

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Abstract

The study analyses the technology impacts on area, production and productivity of cashew in the Dakshina Kannada district of Karnataka state, for combating low productivity and profitability from cashew cultivation. Results revealed that highest area under cashew is occupied by the variety Ullal-3 followed by Bhaskara with similar trend in adoption levels. The 'Ullal-3 + Bhaskara' combination emerged to be the most popular one among farmers in the study area. Farmers realized highest yield from cashew varieties such as Bhaskara and Madakkathara-2 followed by Ullal-1 and Ullal-3. Productivity under normal density (8 x 8 m) as well as high density (5 x 5 m) planting was highest for Bhaskara and Madakkathara-2. Correlation analysis showed that four technologies; soil and water conservation, pruning and training, plant protection and harvesting and post-harvest technologies had highly significant relation with the cashew production achieved by farmers. Increased adoption of soil and water conservation techniques, development and popularization of user friendly plant protection measures and adoption of viable intercrops can contribute largely to increase cashew production while increased adoption of pruning and training in cashew orchards can significantly increase the per unit productivity of cashew orchards. The study concludes that socio-economic and bio-physical factors along with policy environment have a larger contribution in explaining cashew production and productivity and technology component alone cannot be expected to bring a positive impact. Understanding the above dynamics in technology impact can help researchers and extension agencies working in cashew sector to design better innovations and effective outreach strategies.

Keywords: Area, cashew, Dakshina Kannada, production, productivity, technology impact

Introduction

Cashew (*Anacardium occidentale* L.) is a high value tree crop that is being grown in several parts of India offering significant opportunities to generate income for farmers. It is one of the most valuable processed nuts traded on the global commodity markets and is also an important cash crop. Cashew can grow in fairly poor soils with relatively little rainfall, as long as there is a clear dry season of two-four months. Besides these attributes, the facts that low capital requirement for cashew establishment and low nut perishability which minimises the post-harvest activities, have given cashew the reputation of being a poor man's crop (Jaffee, 1995). Cashew industry provides source of livelihood for the growers, empowers rural women in the processing sector, creates employment opportunities and generates foreign exchange through exports (Yadav, 2010). Cashew gained status of a commercial crop through technological advancements with respect to propagation, production and management. This change was fuelled as a result of increasing demand for raw cashew nuts and enhanced interest for its commercialization (Venkattakumar, 2009).

The cashew cultivation in India is mainly confined to the states of Kerala, Karnataka, Maharashtra and Goa along the West coast and Tamil Nadu, Andhra Pradesh, Orissa and East coast of West Bengal. It is also grown in plains like Chhattisgarh, Gujarat, Bihar and north-east hill regions like Meghalaya, Manipur and Tripura and also in Andaman and Nicobar Islands. In India, it is cultivated in an area of 9.82 lakh ha with a

**Corresponding Author: sajeevmv@yahoo.co.in*

production of 7.28 lakh tonnes and productivity of 772 kg ha^{-1} (DCCD, 2012-13). India has the maximum area (21.6%) under cashew cultivation and is the third largest producer (17.3%) of raw nuts in the world. After Vietnam, India is the second largest exporter, accounting 34 per cent of the world's export of cashew kernels (DCR, 2011). India has a comparative advantage in the production and processing of cashew nuts on account of its cheap and skilled labour force. There are 3650 cashew processing industries in the country (both organized and unorganized sector together), with an installed capacity for processing of 15 lakh tonnes, for which the contribution from the indigenous production is only 38 per cent. India earned Rs. 4450 crores through export of processed cashew kernels and cashew nut shell liquid during 2011-12 (CEPCI, 2013).

Dakshina Kannada District is the major cashew producing region in Karnataka state. Increasing production in this district will contribute largely for the cashew production in Karnataka (Dixit *et al.,* 1998). Cashew cultivation receives dwindling importance in Dakshina Kannada district in relation to the prices of other crops like arecanut, cocoa, rubber and coconut. (Ganapathi and Akash, 2013) Fall of prices of the above crops brings attention and interest among farmers towards cashew (Venkattakumar and Bhat, 2003).

Impact assessment of agricultural technologies in the past primarily focused on release of modern varieties and their associated economic returns from increased production (Pingali, 2001). Most studies on impact of agricultural technologies appears to document overall positive impacts, with far less evidence at the individual household level that specifically show the technology impact. To improve the cashew cultivation scenario of major cashew-growing regions, assessment of the impact of recommended cashew production technologies are very important. Hence, to explore the applicability of technology impact premise in the context of cashew cultivation in Karnataka, the present study was undertaken with the objective to measure the impact of different varieties of cashew on area, production and productivity and also to measure the impact of recommended technologies on cashew production and productivity in Dakshina Kannada district.

Materials and methods

The study was conducted at Directorate of Cashew Research (DCR), Puttur. Purposive sampling technique was used to select Dakshina Kannada district, a major cashew producing area of Karnataka, under two research stations and development departments working on cashew to get better chances of technology utilization at farm level. Farmers from five taluks of the district namely Mangalore, Bantwal, Puttur, Belthangady and Sullia were represented in the sampling.

Detailed pre-tested questionnaire were administered to 75 respondents. In the present study, inferences on the relationships between independent and dependent variables had to be drawn on the basis of effects already manifested. Hence an '*ex-post-facto* cause to effect' design was applied. Since cashew is a perennial crop with multiple phases of growth, only those orchards and trees which were in economic yielding period between 6th and 15th year of growth were considered for the study.

An interview schedule measuring the adoption status of the farmers, along with their profiles, was developed. The instrument was pre-tested on a group equivalent in size to 10 per cent of the sample used in the subsequent research. Based on the results, the schedule was structured, sharpened and standardized. The content validity was ensured by examining the responses for appropriateness and through subsequent discussion with the researchers working on impact analysis at various Institutes under the Indian Council of Agricultural Research. The data were collected during the 2012-13 through questionnaire and personal interviews. Appropriate statistical measures such as Phi, Spearman's rank correlation and regression analysis were employed to arrive at conclusions. Data was analyzed using Microsoft Excel 2007 and IBM SPSS statistics Ver. 20.

Results and discussion

Adoption and impact of different varieties on cashew area

Study on impact of recommended varieties on total cashew area showed that highest area under cashew is covered by the variety Ullal-3 (41%) followed by variety Bhaskara (26.6%). It may also be noted that adoption pattern also shows similar trend with variety Ullal-3 adopted by 59 per cent of

farmers followed by variety Bhaskara (55%). Most farmers have adopted a minimum of two cashew varieties in their field and 'Ullal-3 + Bhaskara' combination emerged to be the most popular one in the study area. Varieties Ullal-1 and Vengurla-4 (V-4) were found to cover around 8 per cent each of rest of the area. But, these varieties are not popular among farmers with only 13 and 4 per cent farmers respectively adopting the above mentioned cashew varieties in the district. Venkattakumar *et al.* (2004) also reported the high demand for specific varieties by farmers resulted in the production and supply of such varieties in large numbers to meet the advance intents from farmers before the planting season. This also explain the high demand for cashew grafts of above varieties in government run as well as private nurseries in the locality. Variety wise adoption and impact on area is given in Table 1.

Table 1. Variety wise adoption and impact on cashew area (n=75)

Variety	Adopted by (% farmers)*	Rank	Area covered (%)	Rank
Bhaskara	55	2	26.62	2
NRCC Seln-2	19	3	5.21	5
Madakkathara-2	4	8	4.62	6
Ullal-3	59	1	41.00	1
Ullal-1	13	4	7.66	4
Ullal-4	11	5	2.93	7
VRI-3	7	6	2.66	8
V-4	5	7	8.43	3
V-7	4	8	0.75	9
Other varieties	3	-	0.09	-
Total	92 **	-	99.96	-
Seedling origin	8	-	0.04	-

* the percentages won't add upto 100 due to adoption of multiple varieties by single farmer;

** represents total percentage of farmers who have adopted released varieties

Other varieties like NRCC Selection-2 (5%), Madakkathara-2 (4%), Vridhachalam-3 (VRI-3) (3%), Ullal-4 (3%) and Vengurla-7 (V-7) (1%), had low impact on total cashew area. In total, improved varieties were found to be adopted by 92 per cent of the farmers while 8 per cent were still continuing with seedling plantations. However, seedling origin plantations have only negligible coverage in farmer fields (0.04%).

Impact of cashew varieties on production and productivity

Analysis of variety wise impact on cashew production showed that farmers realized highest yield from variety Bhaskara (4.73 kg tree^{-1}) followed by Madakkathara-2 (4.45 kg tree^{-1}). This was followed by Ullal-1 (3.90 kg tree^{-1}) and Ullal-3 (3.87 kg tree^{-1}). Ullal-4, another recommended variety was at fifth position, yielding of 3.67 kg tree^{-1} while NRCC selection-2 fared low at sixth place with 3.47 kg tree^{-1}. Productivity under normal density (8 x 8 m) as well as high density (5 x 5 m) planting was highest for Bhaskara (737.88 and 1882.54 kg ha^{-1}) and Madakkathara-2 (694.20 and 1771.10 kg ha^{-1}). This was followed by Ullal-1 (608.40 kg ha^{-1}), Ullal-3 (603.72 kg ha^{-1}) and Ullal-4 (572.52 kg ha^{-1}) under normal density. Under high density planting system, Ullal-1 (1556.10 kg ha^{-1}), Ullal-3 (1540.26 kg ha^{-1}) and NRCC Selection-2 (1374.12 kg ha^{-1}) stood respectively at third, fourth and fifth positions. High density plantations of Ullal-4, VRI-3, V-4, V-7 and other varieties were not observed during data collection for this study. Variety wise impact on production and productivity is presented in Table 2.

Bhaskara variety was released during March 2006 for coastal region of Karnataka. This variety is having midseason flowering habit (Dec-Mar) with a flowering duration of 60 days and has potential to escape from the attack of the tea mosquito bug (TMB) under low to moderate outbreak situation. The average yield was reported to be 10.7 kg tree^{-1}. The nut and kernel weight were 7.4 g and 2.2 g respectively. The shelling percentage is 30.6 and kernel grade conforms to export grade W 240. The potential to escape from the attack of the tea mosquito bug (TMB) along with very good yield potential have definitely favoured this variety in its high adoption among farmers of Dakshina Kannada district. Madakkathara-2 (NDR 2-1) is a selection released in 1987. The mean yield is 17 kg tree^{-1}. The nuts are bold (7.3 g nut weight) with shelling percentage of 26.2. Kernel weight is 2 g having a count of W 240 export grade. However, this highly yielding variety was found to be adopted by only 4 per cent of the farmers mainly due to low awareness of this variety.

Table 2. Varietal impact on production and productivity of cashew (n=75)

Sl. No.	Variety	Production (kg tree^{-1})*	Rank	Productivity (kg ha^{-1}) under normal (8 x 8 m) density	Rank	Productivity (kg ha^{-1}) under high (5 x 5 m) density	Rank
1.	Bhaskara	4.73	1	737.88	1	1882.54	1
2.	NRCC Seln-2	3.47	6	541.32	6	1374.12	5
3.	Madakkathara-2	4.45	2	694.20	2	1771.10	2
4.	Ullal-3	3.87	4	603.72	4	1540.26	4
5.	Ullal-1	3.90	3	608.40	3	1556.10	3
6.	Ullal-4	3.67	5	572.52	5	-	-
7.	VRI-3	3.06	7	477.36	7	-	-
8.	V-4	1.51	9	235.56	9	-	-
9.	V-7	3.00	8	468.00	8	-	-
10.	Other varieties	2.23	-	347.88	-	-	-
11.	Seedling origin	1.23	-	147.60	-	-	

* In trees above 5 years of age

Ullal-3 is a selection released in 1993 from Agricultural Research Station (ARS), Ullal. It is early in flowering (November - January) and fruiting period is very short (50-60 days). The fruiting is from January to March and sometimes starts from last week of December. It is a high yielding variety with average yield of 14.7 kg tree^{-1}. The nut size is medium with nut weight of 7 g. The shelling percentage is 30 and the kernel grade conforming to W 210 grade. Its mid season nature coupled with higher yields seems to have made it a favourite among farmers. Ullal-1 is a selection released by ARS, Ullal in 1984. The average yield is 16 kg tree^{-1}. The duration of harvest is long (about 110 days). The nut weight is 6.7 g with shelling percentage of 30.7. Even though the variety recorded slightly higher yields (3.90 kg tree^{-1}) in field compared to Ullal-3 (3.87 kg tree^{-1}), the adoption by farmers (13%) was found to be far below than its counterpart Ullal-3 (59%) which tops in adoption among farmers in all varieties.

Production and productivity profile of cashew farmers

The production and productivity profile of cashew farmers showed that farmers achieved a mean production of 425 kg and productivity of 2.92 kg tree^{-1}. In case of production, majority fell in to medium (40%) and low (43%) producer categories while they were almost equally divided into high (33%), medium (36%) and low (31%) categories with respect to productivity achieved. As far as their operational holdings are concerned, majority (41%) belonged to small farmer group while the rest were almost equally divided between medium (31%) and large holder (28%) groups with an average holding size of 1.9 ha.

Technology impact on production and productivity of cashew

The recommended cashew production technologies starting with recommended varieties

Table 3. Classification of farmers based on production and productivity of cashew (n=75)

Categories	Production			Productivity		
	f	%	Range	f	%	Range
High	13	17	>674	25	33	>3.96
Medium	30	40	674-177	27	36	3.96-1.87
Low	32	43	<177	23	31	<1.87
Mean		425			2.92	
SD		497			2.09	

were categorized to eight groups such as varieties, planting and initial care, soil and water conservation, manures and fertilizers, pruning and training, plant protection, intercropping and harvesting and post-harvest technologies. Their impact on production and productivity were studied separately and are presented here.

Adoption and relationship of cashew production technologies towards cashew production and productivity

The overall adoption of cashew production technologies had received an index score of 44. Majority (51%) of the farmers belonged to medium adopter category while rest was almost equally divided between high (25%) and low (24%) categories (Table 4). Most cashew production technologies scored moderate to poor adoption index with exception of recommended varieties (72) and planting and initial care (73). Soil and water conservation (48) and pruning and training (43) showed medium adoption index while manures and fertilizers (30), plant protection (20), intercropping (22) and harvesting and post harvest technologies (43) scored low adoption index. Similar findings were made by Zagade *et al*. (2000, 2003), Lakshmisha (2000), Bhairamkar *et al.* (2004), Shivaramu *et al.* (2004), Venkattakumar *et al*. (2005) and Venkattakumar (2006; 2008; 2009). Correlation analysis showed that four technologies; soil and water conservation, pruning and training, plant protection and harvesting and post harvest technologies had highly significant relation with the cashew production achieved by farmers (Table 5), while pruning and training had a significant relation with the productivity of cashew.

Cashew farmers were found to adopt maximum practices under planting and initial care (Rank 1) followed by recommended varieties. The findings can be read along with that of Lakshmisha (2000), Venkattakumar *et al.* (2004) and Yadav (2010). Also, these practices were easy to adopt and initial interest plays a major role in the high adoption rate of this technology. Soil and water conservation techniques were also moderately followed by most of the farmers (Rank 3). This is in contrast to findings by Shivaramu *et al.* (2004) and Venkattakumar (2009) in which adoption of soil and water conservation techniques were found to be low. However earlier studies had shown a positive perception of cashew demonstration farmers towards soil and water conservation techniques (Venkattakumar *et al.,* 2005). The increased availability of heavy machineries at affordable rates for land leveling, pit digging, terrace making *etc*. is a major reason behind this. Also, the practices under this technology are mostly adopted along with or in continuance with planting and after care, thereby increasing its chance of adoption due to initial interest. Accordingly, the technology also showed a positive significant relationship (r=0.344) with cashew production achieved by farmers.

Adoption of pruning and training along with harvesting and post harvest technologies stood together at fourth place with adoption index of 43. This finding is in line with earlier reports of Shivaramu *et al.* (2004). Pruning and training was also found to have significant relationship with production (r = 0.338) as well as productivity (r = 0.271) of cashew. Harvesting and post harvest

Table 4. Adoption index of farmers for cashew production technologies (n=75)

Sl. No	Category	Range	Respondents f	Respondents %
1	Low (<Mean-1/2S.D)	<36.27	18	24
2	Medium (Mean (+/-)1/2S.D)	36.27-51.39	36	51
3	High (>Mean+1/2S.D)	>51.39	19	25

Mean= 43.83, S.D=15.12

Table 5. Relationship of production technologies towards cashew production and productivity

Technology	Adoption Index	Production 'r' value	Productivity 'r' value
Varieties	72	0.174 NS	0.020 NS
Planting and initial care	73	0.201 NS	-0.011 NS
Soil and water conservation	48	0.344**	0.165 NS
Manures and fertilizers	30	0.094 NS	-0.042 NS
Pruning and training	43	0.338**	0.271 *
Plant protection	20	0.345**	0.146 NS
Intercropping	22	0.062 NS	0.014 NS
Harvesting and post-harvest	43	0.321**	0.123 NS
Overall adoption	44	-	-

NS – Non-significant, ** - Significant at 1% level, * - Significant at 5% level

technologies was also found to have highly significant relationship with production (r = 0.321).

Adoption of manures and fertilizers was found to be poor among farmers with adoption index of 30. Similar observations were made by Nirban and Sawant (2000) with respect to adoption of manures and fertilizers in cashew plantations. Intercropping was another technology which was poorly adopted (Rank 6). Similar observation was made by Shivaramu *et al.* (2004). Low to medium adoption with respect to most cashew production technologies could be attributed to the fact that farmers are yet to realize the importance of recommended technologies on yield and potential economic benefits that accrues from their adoption.

Plant protection, which is one of the most important components affecting production, scored the lowest adoption index (20) among cashew farmers in the present study. This finding is in line with earlier reports of Nirban and Sawant (2000) and Zagade *et al.* (2000, 2003) but in contrast with findings by Venkattakumar (2009) who reported fairly good adoption of plant protection measures in cashew. However, 90 per cent of demonstration farmers who availed subsidies were found to have adopted plant protection measures (Venkattakumar *et al.,* 2005). Non-adoption was particularly high for plant protection technologies against cashew stem and root borer (CSRB) due to the complexity of the technology, while majority had adopted measures against tea mosquito bug (TMB) due to less complexity, higher trialability and observability of results in comparison to measures recommended against CSRB. Dixit and Bhaskara Rao (1999) and Venkattakumar *et al.* (2005) also reported farmer responses indicating that recommended control measures could not check attack of CSRB explaining poor adoption rates of plant protection technology as a whole. The technology showed highly significant positive relation (r=0.345) with cashew production. It is obvious from these findings that there is tremendous scope in the region for increasing adoption of recommended cashew production technologies.

Contribution of cashew production technologies towards variability in cashew production and productivity

Regression analysis revealed the extent of contribution of each production technology towards variability found in levels of cashew production and productivity in the district (Table 6). Plant protection component which scored the lowest adoption index and also showed highly significant relation (r = 0.345) with cashew production achieved by farmers emerged as the most significant contributor towards cashew production (b = 0.339**) in the district. This clearly indicates that adoption of plant protection techniques cannot be ignored at any cost if cashew production in the district has to be improved. The finding also calls for development of plant protection measures which are user friendly (less complex), having relative advantage over existing technology and also compatible with farmer situations. Soil and water conservation technology which showed a significant relationship (r = 0.344) with cashew production, also had significant contribution towards explaining the variability in cashew production (b = 0.326). Interestingly, intercropping; another poorly adopted technology was also found to have a significant contribution towards explaining the variability in cashew production (b=0.243). The positive influence of intercropping by way of reasons such as better receipt of cultural operations and reduced weed growth on the growth and yield of main crop of cashew documented by Nayak *et al.* (2011) and Lakshmana *et al.* (2013) holds good in this case also. Jose Mathew *et al.* (2013) reported increase in yield of main crop of cashew to the tune of 12 per cent in

Table 6. Contribution of cashew production technologies towards variability in cashew production and productivity

Technology	Production 'b' value	Productivity 'b' value
Varieties	-0.131 NS	-0.077 NS
Planting and initial care	0.037 NS	-0.159 NS
Soil and water conservation	0.326 *	0.208 NS
Manures and fertilizers	-0.195 NS	-0.184 NS
Pruning and training	0.178 NS	0.313 *
Plant protection	0.339**	0.139 NS
Intercropping	0.243 *	-0.097 NS
Harvesting and post-harvest	-0.012 NS	0.024 NS
	R^2 = 0.406	R^2 = 0.149

NS – Non-significant; ** - Significant at 1% level;

* - Significant at 5% level

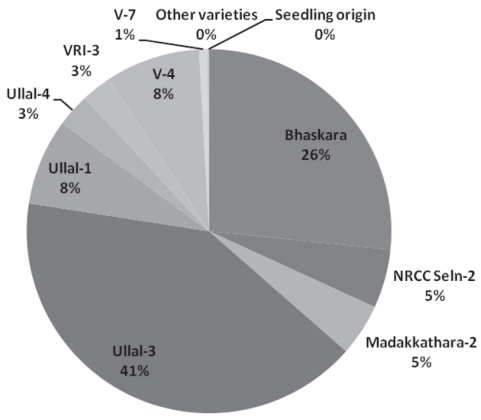

Fig. 1. Area coverage (%) by different recommended varieties of cashew

intercropped plots. Recommended varieties, manures and fertilizers and harvesting and post harvest technologies were found to have a non-significant but negative contribution towards cashew production. In case of recommended varieties, even though the study found that highest production was given by Bhaskara, Madakkathara – 2, Ullal - 1 and Ullal - 3 varieties, the same varieties covered only 26.62, 5.21, 7.66 and 41.00 per cent respectively of total area under cashew cultivation. Thus, the findings make it clear that by increasing the adoption and area coverage of above varieties we can bring a quantum increase in cashew production in the district.

Farmers in the study area were found to have poor adoption in case of manures and fertilizers for cashew. The study also found that harvesting cashew from the trees itself is a common practice to avoid theft and this coupled with improper drying practices including less number of drying days has contributed more volume to the cashew production. If proper harvesting and drying practices are followed, it will decrease the total volume of cashew thus explaining the negative relation. Similarly by increasing the adoption levels of manures and fertilizers in cashew and by adopting proper harvesting and post-harvest drying techniques, the cashew production can be further improved. All the recommended production technologies together could explain only up to 40 per cent of variability in cashew production (R^2 = 0.406). Adoption of pruning and training in cashew orchards was found to have a significant contribution towards increasing the per unit productivity of cashew orchards. However, the adoption level of this technology is very low at present.

Conclusion

The present study analyses the technology impact on area, production and productivity of cashew as a pre-requisite for developing and initiating innovative technology interventions for combating low productivity and profitability from cashew cultivation. Even though highest production was recorded by Bhaskara, Madakkathara – 2, Ullal - 1 and Ullal - 3 varieties, these covered only minimal share of total area under cashew cultivation. By increasing the adoption and area coverage of above varieties, we can bring a quantum increase in cashew production in the district. Increasing adoption of soil and water conservation techniques and development and popularization of user friendly plant protection measures can contribute largely to increased cashew production while increasing adoption of pruning and training in cashew orchards can significantly increase the per unit productivity of cashew orchards. The results clearly indicate that socio-economic and bio-physical factors along with policy environment have a larger contribution in explaining cashew production and productivity and technology component alone cannot be expected to bring a positive impact. Understanding the above dynamics in technology impact can help researchers and extension agencies working in cashew sector to design better innovations and effective outreach strategies.

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