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Integrated Farming Systems and Income Security: The Case of Arecanut Farmers in Karnataka, India

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ABSTRACT

Surplus farm income and its stability are two important measures of income security of the farmers. These two parameters will have a profound influence on the economic welfare too. This study is an attempt to at evaluate the income security of farmers in areca based integrated farming systems in the state of Karnataka, India. The results revealed no significant difference in profitability among different arecanut based farming systems. The income generated from different areca based farming systems helped the majority of the farmers to cross the poverty line, indicating the role of such farming systems in ensuring income security in the region. Regression analysis of variability in farmers' income indicated negative association between diversification in income sources and income variability. Hence, it is beneficial for the farmers if they diversify their sources of income.

Keywords: Income security, areca based integrated farming systems, regression analysis, profitability

The magnitude of income from farm as a whole and its stability are two integral components of income security and consequently a measure of welfare of farm household. In recent years, focus on integrated farming, rather than sole crop or enterprise, has been intensified world over to impart much needed income security for farmers. Integrated farming system advocates consanguinity to the farm components like crops, livestock, workers, farm inputs and climate (Shekinah and Sankaran, 2007). For any integrated farming system to be successful, proper manipulation of some of these system variables is crucial. Synergistic interaction among the system variables will result in higher total income from the farm as a whole (Edwards *et al*., 1988).

Indian farming community is dominated by small and marginal farmers, and hence providing means to help them earn a stable income has always been a challenge for the researchers and policy makers. The efforts of late has been to develop an integrated approach which uses optimum levels of the suitable enterprises to yield maximum possible net income (Puste *et al*., 2013) which is stable as well. In this line, integrated farming systems have been developed with cereals, pulses, and horticulture and plantation crops as the base crop.

Arecanut is a traditional plantation crop that is being grown conventionally in many Indian states. Karnataka leads in arecanut production (2.24 lakh tonnes from 1.84 lakh ha area) with a share of 46 per cent in total arecanut production of India. At present, arecanut is being cultivated in 140 out of a total of 175 taluks[1] in the state.

The farmers growing arecanut especially in the traditional regions of south Indian states like Karnataka, Tamil Nadu and Kerala have been following many unique mixed cropping that normally include banana, coffee, pepper, beetle vine and coconut (Prakash, 2012). Particularly in Karnataka, farmers have been diversifying their crops and enterprise portfolio by including other commercial crops such as cocoa, vanilla and rubber along with dairy in recent years. Since

arecanut, as a sole crop, does not fully utilize natural resources such as soil fertility, water, space and sun light, mixed cropping is a strategy which the farmers use to optimize the utilization of the natural resources. This helps to increase income and reduce its variability. Arecanut along with the mixed crops and dairy is together called as "Areca Based Integrated Farming System (A-IFS), and this system has attracted the attention of the researchers as well as policy makers due to its significance from the income security point of view.

The present study is a modest attempt to quantify the farm income and its variability so as to assess the adequacy in addressing the issue of income security of farmers growing arecanut in different regions of Karnataka. The economics and income stability of the arecanut based farming systems is less studied and we target to address this gap. Attempt is made to identify and estimate costs and returns of different arecanut based farming systems, and to assess the stability of farmers' income and factors affecting the same. The adequacy in income or otherwise of the farmers growing arecanut in the region is also assessed.

MATERIALS AND METHODS

Primary survey was conducted to collect the data on areacanut farming systems, from both, rainfed as well as irrigated region. Three major types of areacanut cultivation exist in the state viz. (1) Traditional RBT (rainfed), (2) Traditional WCT (rainfed), and (3) Non-traditional RBT (irrigated). RBT stands for Red Boiled Type[2] and WCT stands for White Chali Type[3], the two types in processing of arecanut. Arecanut growing belts in the state are also classified into traditional and non-traditional regions. Traditional regions are those where arecanut crop is grown historically and non-traditional regions are those where arecanut crop is introduced recently. Three major arecanut growing districts of Karnataka, practicing these different cultivation types, and contributing mostly to the total arecanut production of the state, were selected at the first stage. The districts thus identified were Shimoga, Dakshina Kannada and Tumkur representing traditional RBT, traditional WCT and non traditional RBT respectively. Further, from each district a representative taluk based on the same criterion was selected. Thirthahalli, Puttur and Gubbi taluks were chosen from Shimoga, Dakshina Kannada and Tumkur districts respectively. From each taluk, cluster villages were chosen and 30 random farmers growing arecanut were included in sample from each cluster resulting in total sample of 90 farmers.

Primary data on socio-economic status, size of land holdings, costs and returns of different enterprises in the farming system, and historical data on returns from different enterprises were collected from the sample farmers using pre-tested well-structured schedule through survey method in the agricultural year 2012-13. Tabular method was employed to compile the socio economic status, resource use pattern, cost and returns from different enterprises and income of the respondents. The stability in income was gauged through coefficient of variation (CV). Income diversification within farming system as well cropping system was computed using Simpson diversification index. Linear functional analysis was performed using coefficient variation in farmers' income (computed for three years income) with a set of explanatory variables.

RESULTS AND DISCUSSION

Arecanut Based Farming Systems Identified in Karnataka

We identified five major arecanut based farming systems in the study area (Table 1). These farming systems identified were spread across the three major types of arecanut cultivations in the region, i.e. Traditional RBT and Traditional WCT as rainfed crop, and Non-traditional RBT as irrigated crop. Dairy enterprise was a common component in all the identified farming systems, and the Areca + Dairy (A+D) farming system was the most prominent in all the types of cultivations. More than half of the sample farmers followed the A+D farming system in all the regions studied. A+D farming system was, however, more prominent in the rainfed region in comparison to the irrigated region. This indicates the income support that the farmers in the rainfed regions get due to the inclusion of Dairy enterprise in the farming system.

Areca + Paddy + Dairy (A+P+D) farming system was also common in the rainfed regions, with 30 and 17 per cent of sample farmers following it respectively in the Traditional RBT and Traditional

Table 1: Areca Based Farming Systems Identified in Karnataka

Type of arecanut cultivation	Farming systems	Number of sample farms	Total
Traditional RBT (Rainfed)	Areca+Paddy+Dairy (A+P+D)	9(30)	30
	Areca+Rubber+Dairy (A+Ru+D)	4(13)	
	Areca+Dairy (A+D)	17(57)	
Traditional WCT (Rainfed)	Areca+Rubber+Dairy (A+Ru+D)	8(27)	30
	Areca+Paddy+Dairy (A+P+D)	5(17)	
	Areca+Dairy (A+D)	17(57)	
Non-traditional RBT (Irrigated)	Areca+Ragi+Dairy(A+Ra+D)	9(30)	30
	Areca+Redgram+Dairy (A+Re+D)	6(20)	
	Areca+Dairy (A +D)	15(50)	

Note: Figures in the parenthesis indicate per cent values

Table 2: Cropping Pattern in Different Areca Based Farming Systems

Farming system	Main Crops	Intercrops	Acre
		Traditional RBT	
A+P+D (9)	Arecanut	Cocoa, Banana, Pepper and Coconut	4.22
	Paddy		2.11
A+Ru+D (4)	Arecanut	Cocoa, Banana, Pepper and Coconut	8.20
	Rubber		5.60
A+D(17)	Arecanut	Cocoa, Banana, Pepper and Coconut	5.30
		Traditional WCT	
A+Ru+D(8)	Arecanut	Banana, Pepper, Coconut	5.22
	Rubber		8.64
A+P+D (5)	Arecanut	Banana, Pepper, Coconut	3.20
	Paddy		1.60
A+D (17)	Arecanut	Banana, Pepper, Coconut	4.30
		Non-traditional RBT	
A+D (15)	Arecanut	Banana, Coconut	4.20
A+Ra+D (9)	Arecanut	Banana, Coconut	4.88
	Ragi		2.11
A+Re+D (6)	Arecanut	Banana, Coconut	3.53
	Redgram		2.11

Note: Figures in the parenthesis indicates the number of farmers cultivating

WCT cultivation types. Areca + Rubber + Dairy (A+Ru+D) farming system was practiced more by the Traditional WCT farmers than their counter parts in the rainfed region. The farming systems in the irrigated regions differed completely from that of the rainfed, except for the fact that Dairy is a common enterprise in both. Rubber is gaining popularity as one of the alternate crop to arecanut in rainfed regions and has become a part of the traditional areca based farming system due to its distinct advantages. Except for tapping, the labour requirement for rubber is very less. Rubber also have additional advantage since it is grown purely as rainfed crop, because of which it doesn't require irrigation and intensive plant protection measures. Besides, it also generates better returns to farmers. The percentage of farmers adopting it is however low, because of high gestation period (eight years in average) and huge initial capital investment.

Table 3: Economics of Areca Based Farming Systems Practicing Traditional RBT type of Cultivation (₹/farm)

Farming system	Enterprises	Total cost	Gross returns	Net returns	% share in total net returns	Net returns per rupee cost
A+P+D	Arecanut	489971	542644	52672	38	0.11
	Intercrops	110071	173952	63881	47	0.58
	Paddy	52571	58109	5539	4	0.11
	Dairy	132988	147936	14948	11	0.11
	Total	785601	922641	137040	100	0.17
A+Ru+D	Arecanut	982628	1000776	18147	7	0.02
	Intercrops	70311	150060	79749	31	1.13
	Rubber	540293	688190	147897	58	0.27
	Dairy	118310	128088	9778	4	0.08
	Total	1711542	1967113	255572	100	0.15
A+D	Arecanut	632193	666597	34404	30	0.05
	Intercrops	135312	197632	62320	55	0.46
	Dairy	132710	149436	16726	15	0.13
	Total	900216	1013665	113450	100	0.13

Cropping Pattern Followed By Sample Farmers in Different Areca Based Farming Systems

Cropping pattern followed by the sample farmers in different farming systems is presented in Table 2. Main crops along with their area and, intercrops, is given subsequently along with the number of farmers growing that particular intercrop, separately for each of the farming systems. In the traditional RBT type of cultivation, Banana and Pepper were the most important intercrops grown with arecanut. Cocoa and Coconut were also grown as border crops, even though, by a few farmers. In the traditional WCT type, pepper, banana and coconut were the three most important crops grown with arecanut. Pepper and banana were grown as intercrop and coconut as border crop. In the non-traditional RBT, coconut and banana were the two important crops in all the farming systems.

Economics of Different Areca Based Farming Systems

The annual cost and returns of different arecanut based farming systems practicing traditional RBT type of cultivation are presented in Table 3. With respect to net returns per rupee of cost, there was no much difference between the three farming systems. A+P+D farming system fared marginally better with a net returns per rupee of cost value of 0.17 closely followed by A+Ru+D with 0.15. Low income from areca coupled with high cost incurred on rubber in A+Ru+D farming system had resulted in lower net returns per rupee of cost despite higher magnitude of total income. The larger size of land holdings in case of A+Ru+D made it difficult to take up timely plant protection measures against mahali (kole roga) disease causing considerable yield loss in areca gardens. Rajashekarappa (2004) reported considerable yield loss (to the tune of 15 %) in areca gardens in the region, due to mahali disease.

The cost and returns of different areca based farming systems practicing traditional WCT type of cultivation presented in Table 4 suggest that among the three farming systems, A+Ru+D had the highest net returns per rupee of cost (0.34) followed by A+D (0.27). In A+Ru+D farming system, as high as 67 per cent of the income was contributed by rubber alone. This highlights importance of rubber in the system. Rubber crop was more remunerative in traditional WCT type compared to the traditional RBT due to congenial agro-climatic conditions. Regularity in income, quantum of returns, reduced drudgery, less labour requirement and stability in yield and prices made rubber the most preferred crop of the region. But the adoption of the farming system is constrained by the availability of crucial resources like land and capital. Singh (1992), also reported similar problem of fragmentation of land, preventing the farmers from adopting most profitable farming system.

Table 4: Economics of Areca Based Farming Systems Practicing Traditional WCT type of Cultivation (₹/farm)

Farming system	Crops	Total cost	Gross returns	Net returns	Percentage of net returns	Net returns per rupee
A+Ru+D	Arecanut	550367	635622	85255	16	0.15
	Intercrops	93199	167636	74437	14	0.8
	Rubber	778313	1127520	349207	67	0.45
	Dairy	101691	111667	9976	2	0.1
	Total	1523571	2042445	518874	100	0.34
A+P+D	Arecanut	326912	389888	62976	69	0.19
	Intercrops	53846	71727	17881	19	0.33
	Paddy	55618	50416	-5202	-6	-0.09
	Dairy	155704	171969	16265	18	0.1
	Total	592080	684000	91920	100	0.16
A+D	Arecanut	433634	534490	100856	63	0.23
	Intercrops	93057	139211	46154	29	0.5
	Dairy	122990	134809	11819	7	0.1
	Total	216047	274020	57973	100	0.27

Table 5: Economics of Areca Based Farming Systems Practicing Non-traditional RBT type of Cultivation (₹/farm)

Farming systems	Crops	Total cost	Gross returns	Net returns	Percentage of net returns	Net returns per rupee
A+Ra+D	Arecanut	585122	620682	35560	19	0.06
	Intercrops	89556	196967	107411	59	1.20
	Ragi	31451	33359	1908	1	0.06
	Dairy	192722	230996	38274	21	0.20
	Total	898851	1082003	183152	100	0.20
A+Re+D	Arecanut	412542	429196	16653	11	0.04
	Intercrops	64601	149418	84816	56	1.31
	Red gram	42686	51779	9093	6	0.21
	Dairy	200911	241010	40099	27	0.20
	Total	720741	871403	150662	100	0.21
A+D	Arecanut	492977	530829	37852	28	0.08
	Intercrops	79803	152774	72971	55	0.91
	Dairy	113305	135927	22622	17	0.20
	Total	686085	819530	133445	100	0.19

Table 5 shows the comparative cost and return structure of areca based farming systems under Non-traditional RBT. It is evident that there is no much difference between the three farming systems with respect to net returns per rupee of cost. The share of income from arecanut was highest in A+D farming system (28%) followed by A+Ra+D (19%). The share of income from arecanut was on lower side inspite of low incidence of biotic stresses. The return from arecanut was very low because of high establishment and maintenance cost. Creation of irrigation infrastructure prior to planting of arecanut has inflated the cost of establishment and consequently maintenance cost too. Share of intercrops in the total farm income was highest in case of A+Ra+D (59%) closely followed by A+Re+D (56%). The reason for this stems from the fact that, in the region, all the farmers cultivated Coconut as an intercrop which proved to be highly profitable, contributing significantly to total farm income. The contribution of returns from dairy was also to the tune of 27 per cent in case of A+Re+D followed by

A+Ra+D farming system (21%). Dairy enterprise was having commercial outlook in the region compared to other study areas.

Stability of Farmers' Income in Different Areca Based Farming Systems and Factors affecting it

The income of farmers was computed on per acre basis for different farming systems separately and coefficient of variation was worked out and presented in Table 6. The analysis revealed that the cross sectional coefficient of variation (CV) was highest in case of traditional RBT (19.26 %). The reason for such high CV could be attributed to sporadic occurrence of biotic stresses like Mahali disease (Koleroga). The other likely reason would be the non uniformity in the returns generated by intercrops due to diseases like pepper wilt. Lowest CV was observed in case of non-traditional RBT where it was 15.67%. The CV in income was lowest indicating stable returns from arecanut, intercrops and dairy. Further, CV was lowest in A+Ru+D farming system in case of both traditional RBT and traditional WCT (16.34% and 14.41 % respectively) due to presence of rubber in the system.

Linear regression model was employed to identify the factors affecting stability of farmer's income. Regression results (Table 7) implied that the extent of crop diversification reduces the variability in Farm income. The extent of diversification in income within the cropping system will indicate reduced dependence on any one crop enterprise. Hence variation in returns from any single enterprise will not have profound effect on stability of income. The size of land holding had shown a negative association with coefficient of variation in case of traditional WCT and traditional RBT, because of relationship between adoption of rubber crop and holding size. Whereas, the variable 'enterprise diversification index' has shown the negative and significant effect on farm income in non-traditional RBT, implying its potential in stabilising farm income. The negative association between coefficient of variation and extent of diversification is also reported by earlier studies (Ashok *et al.*, 2005 and Jerry *et al.*, 2000).

Surplus Income of Farmers in Different Areca Based Farming Systems

Surplus income (net income) per household and per capita income was worked out by dividing farm income by average family size for study areas. Surplus income is a measure of efficiency of any production system. The analysis (Table 8) revealed that per farm income was highest in traditional WCT (2,56,541 ₹/farm) followed by traditional RBT (1,68,687 ₹/farm). The reason for this was the profitability associated with rubber crop. Per acre annual income generated by rubber crop was to the tune of ₹ 26,411 and 40,418 in traditional RBT and traditional WCT respectively. A micro analysis of income of farmers in different farming systems revealed that the per capita income of farmers was highest in A+Ru+D farming system in both

Table 6: Stability in Household Income of Different Areca Based Farming Systems

Type of cultivation	Farming systems	Mean income (₹/Farm)	Standard deviation (Rs/farm)	CV (%)
Traditional RBT	A+P+D	137040	28972	21.14
	A+Ru+D	255572	41763	16.34
	A+D	113450	23030	20.30
	Average	168687	32490	19.26
Traditional WCT	A+Ru+D	518874	74787	14.41
	A+P+D	91920	16496	17.95
	A+D	57973	10806	18.64
	Average	222922	37897	17.00
Non-traditional RBT	A+Ra+D	183152	28196	15.39
	A+Re+D	150662	22834	15.16
	A+D	133445	21966	16.46
	Average	155753	24407	15.67

Table 7: Factors Affecting Variability in Farm Income- Results of Linear Regression

Particulars	Traditional RBT		Traditional WCT		Non-traditional RBT	
	Coefficient	t value	Coefficient	t value	Coefficient	t value
Intercept	1.24	1.69	0.49	3.50*	1.18	3.40
Land holdings (acre)	-0.36	-2.96*	-0.84	-2.03*	0.36	2.96*
Crop diversification index	-3.48	-2.10*	-3.13	-2.92*	-0.78	-2.10*
Enterprise diversification index	-2.04	-0.28	0.95	0.10	-1.04	-2.28*
Proportion of income contributed by arecanut	3.74	2.49*	4.23	0.59	1.74	0.04
Magnitude of total income (₹)	0.00	2.64*	3.22	1.97	3.00	2.64*
R^2	0.71		0.62		0.70	
Adjusted R^2	0.62		0.50		0.60	
F ratio	4.12		3.92		2.58	

Note: (Dependent variable – Coefficient of variation of income in real terms)

**Significant at 5% level*

Table 8: Average Annual Net Farm Income of Households in Areca Based Farming Systems (₹)

Type of cultivation	Farming systems	Farm income	Per capita farm income
Traditional RBT	A+P+D	137040	27408
	A+Ru+D	255572	65531
	A+D	113450	29855
	Average	168687	40931
Traditional WCT	A+Ru+D	518874	133045
	A+P+D	91920	18384
	A+D	158829	36937
	Average	256541	62788
Non-traditional RBT	A+Ra+D	183152	36630
	A+Re+D	150662	35872
	A+D	133445	28393
	Average	155753	33631

Table 9: Average Annual Net Income of Households Categorised According to Land Holding Size (₹)

Categories of farmer	Traditional RBT		Traditional WCT		Non-traditional RBT	
	Farm income	Per capita farm income	Farm income	Per capita farm income	Farm income	Per capita farm income
Marginal	59565	14891	93746	25201	91499	19635
Small	140224	35056	179973	48380	171981	27895
Medium	158297	37574	231256	62166	181021	38846
Large	325125	81281	707365	190152	317160	68060

traditional WCT and tradional RBT types with ₹ 62,788 and 40,931 respectively. It is interesting to note that the per capita income was less than that of state per capita income (average state per capita income taken as ₹ 68747) in all the taluks. Within each type of cultivation, amongst different farming systems, the scenario was not alike except the case of A+Ru+D farming system, where the net per capita income was more than state per capita income.

Average annual net income of the farmers were computed for marginal, small, medium and large farmers separately irrespective of their farming

Table 10: Comparison of Average Net Per Capita Income of Households With State Per Capita Income and Per Capita BPL Income (in number)

Particulars	Traditional RBT		Traditional WCT		Non-traditional RBT		Total	
	Number	%	Number	%	Number	%	Number	%
Farms with per capita farm income below state per capita income	24	80	18	60	27	90	96	80
Farmers with per capita farm income less than BPL	4	13	0	0	2	7	8	7

Note: Per capita income taken at ₹ 68747 and BPL income as ₹ 12000.

systems in order to get more insight into the concept of surplus income. The results are presented in Table 9. The per capita income was found to increase with increase in the size of land holdings. The results indicated that, except for large farmers, the annual net per capita income of all other categories of farmers was less than the average state per capita income of ₹ 68747. The per capita income was highest in traditional WCT with the figures ₹ 25200, 48380, 62166 and 190152 for marginal, small, medium and large farmers respectively.

Comparison of Average Net Per Capita Income of Households with State Per Capita Income and Per Capita Below Poverty Line Income

Frequency distribution was constructed for the farmers' income to facilitate comparison with the state per capita income. The results presented in Table 10 indicates that on an average 80 per cent of the sample farmers had per capita income less than the state average and about 7 per cent of the households have earning less than the income level to categorise them as Below Poverty Line (BPL). Non-traditional RBT has highest number of sample farmers (90%), whose income was less than the state per capita income.

Least number of sample farmers with lesser income than state per capita income was found in traditional WCT type (60%) which can be attributed to the profitability associated with the arecanut and rubber crop in the region. The analysis clearly indicated that areca based farming systems provide income security to the farmers as in majority of cases, income from the farm helps them move above the poverty line.

CONCLUSION

We identified five major arecanut based farming systems in the study area which were spread across three major types of arecanut cultivations in the region, i.e. Traditional RBT and Traditional WCT as rainfed crop, and Non-traditional RBT as irrigated crop. With respect to net returns per rupee of cost there was no much difference between the farming systems identified. Net income after meeting out all the production expenses is considered as surplus income. The net/surplus income was highest in traditional WCT type followed by traditional RBT. Except the large farmers, annual net per capita income of none of the other categories was more than that of state per capita income (state per capita income taken at ₹ 68700).

The surplus income was found to be unstable as indicated by coefficient of variation. Extent of instability was higher in case of traditional regions (both traditional RBT and WCT) cultivating arecanut on account of biotic risks in production. Diversification in sources of income was identified as a factor reducing the instability in income. Thus farmers are advised to diversify their source of income from the farm and overcome the dependence on any one enterprise as a major source of income. Government may take measures to promote diversification within the areca based cropping system so as to impart stability to farmers' income. Our analysis also indicated that areca based farming systems provide income security to the farmers as in majority of cases, income from the farm helps them move above the poverty line.

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