Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 8 [10] September 2019 : 52-57

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Impact of crop diversification on farm income and Resource use pattern under Paddy Farming system: An Empirical Analysis

David Chella Baskar[1*], Umanath[2], Usha Nandhini[1], Kavitha[1]
1 Karunya Institute of Technology and Science, Karunya University,Coimbatore-641114, Tamil Nadu, India
2 Madras Institute of Development Studies, Chennai-600 020, India
*Email: davidbaskar@karunya.edu

ABSTRACT
Conventional farming accounts major share in Indian agriculture wherein high use of inorganic fertilizers and pesticides, mechanization, and irrigation accessibility are main elements. Perhaps Green Revolution, directly, influenced on aforementioned farming and rose up the share of area under paddy, wheat and other cereal crops [1] in order to overwhelm the crisis of food security due to ever increasing population. As a result, rice and wheat, hold major share in the total cultivable area and also converted to mono-cropping system, which replaced the traditional diversified cropping system.Paddy farming particularly paddy-paddy cropping pattern have been developed across the nations as the crop has high positive correlation with fertilizer, pesticide, support price and credit allocation policies that are reinforces paddy as mono cropping in the country and consequently lead to pumper production and market glut. As a result, rice is not able to fetch appropriate price in both domestic and international markets [2]. Moreover, rice is facing stagnant or declining trend in the yield in many parts of the county due to mono cropping combined with indiscriminate use of chemical inputs. Given low rice prices, declining or stagnant yields and increasing input costs, the profitability of rice production has been steadily declining.
Key words: crop diversification, farm income, resource use pattern

Received 19.07.2019 Revised 15.08.2019 Accepted 01.09. 2019

INTRODUCTION

The continuous mono cropping of paddy have adversely affected ecology of agricultural production system and rises concern on adoption of diversified farming in the developing countries particularly in India. One of main aspect of sustainable agricultural practices (SCA) is crop diversification which means variety of crops can be grown in a given space. Crop diversification happen in the field through varietal changes, mixed cropping and intercropping, rotations, less water consumed crops, drought-resistant crops, agro forestry, and so on [3]. This practices enhances farm income, minimises risk in production and prices, improve soil fertility, optimising nutrients availability throughout seasons and marketing of products at competitive national and international markets, supporting food security and employment, supplying diversified nutrient rich food over its demand, etc. [4]; [5]. Perhaps it would also significantly support for recent initiatives brought by the Government of India on sustainable agriculture, adopting climate resilient crops and more importantly doubling farmers' income. In addition, under multiple cropping system, farmers can generate their own inputs within farm and can replace market-driven synthetic inputs that, in turn, reduces input expenditure and environmental pollution.

Existing studies noted that small and marginal farmers have adopted crop diversification in larger proportion than large famers within the given area [6]. On the other hand, the cropping pattern has been changed from low value crops to high value crops, in particular from cereals to fruits and vegetables crops [8] and from grain crops to commercial crops with the perception of higher price realization. The Government has also made series of attempts to change the cropping system. Of which, National Food Security Mission (NFSM), National Mission on Oilseeds and Oil Palm (NMOOP), Direct Seeded Rice (DSR),

System of Rice Intensification (SRI) are the couple of supportive policy initiations for diversifying paddy farming to pulses, oilseeds and agro-forestry.

MATERIAL AND METHODS

Data

The household data on agricultural situation assessment collected by the National Sample Survey Organization (NSSO), Government of India at national level, particularly pertaining to the period 2012-13 (70^{th}round) were used for this study to capture the spatial variation in the farm household characteristics. These comprehensive National Sample Survey (NSS) data with a sample size of over 35200 households covering both rural and urban areas has a high acceptance in research and policy. Since the present study focuses level diversification and its impact on farm welfare, we ignored the sample farmers who are not cultivating paddy in this survey round. Thus, the final sample size comprises 17142 farmers. Among them, 10217 farmers have grown only paddy and rest of the farmers have grown more than one crop with existing paddy cropping pattern.

Estimation Procedure

The propensity score matching approach is used to examine the impact of crop diversification on farm income and input expenditure. The method compares the welfare of diversified cropping farmers (treatment group) with their counterfactual group who practicing paddy mono-cropping (control group) in the farm. The propensity score is defined $P(T_i)$ as the conditional probability of receiving treatment and given pre-treatment characteristics.

$$P(T_I) \equiv prob(D_I = 1 / T_I) = E(D / T_I) = F(T_I)$$

where T_I denotes a vector of pre-treatment characteristics of household i: E is the expectation operator; and $F(T_I)$ represents normal or logistic cumulative distribution frequency.

The propensity score are predicted with logit model. The assumption of the conditional independence of the score result extends the use of the propensity scores for the computation of the conditional treatment effect. The predicted propensity scores are used to estimate the treatment effect.

According to Becker and Ichino (2002), average treatment effect on the treated (ATT) is the parameter of interest in propensity score matching analysis. Thus, we use ATT to assess the effect of crop diversification on income and input expenditure of farm households. ATT is computed by matching diversified and non-diversified households that are closest in terms of their propensity scores. In this study, the treated groups are referred to as crop-diversified households and the ATT is calculated as follows:

$$ATT = E(\mathrm{T}/\mathrm{I}=1) = E(Y/1)/D=1) - E(Y(0)/D=1$$

Where $E(Y/1)/D=1$ represents the expected outcome of diversified farm households and $E(Y(0)/D$ denotes the counterfactual outcome of mono-cropping households. The counterfactual estimates represent what the welfare outcome of diversified farm households would be, if they have not engaged in diversified cropping activities.

RESULTS AND DISCUSSION

Increasing income and reduce the risk of income loss due to failure in weather and market glut for a crop are the matter of concern in many of the developing countries. On the other hand, crop diversification is practice for decreasing the use of externally purchased inputs and increasing the internally produced inputs like green and farm yard manure. Besides, household's monthly expenditure and consumption of home produced products were taken as a proxy for welfare measure.

Descriptive statistics of output variables:

In this study, we have taken a total of 13 outcome variables, including area under paddy, paddy yield, expenditure on different inputs, net income and cost and return from the livestock rearing and consumption expenditure to test the improvement due to crop diversification over paddy mono-cropping in the farm field.

The descriptive statistics of output variables are given in Table 1. It is described that area under paddy in all category farm levels in mono-cropping paddy cultivation is larger than the diversified cropping system, whereas it is opposite in the case of paddy yield *i.e*., diversified cropping farmers are getting extra by around one tonne in all the category when compared to their counterpart in the mono-cropping system. Regarding the expenditure on farm input use, the farmers of mono-cropping system have spent less on the fertilizers and plant protection chemicals and spent more on the labour, machine and irrigation when compared to the diversified farmers. Further, mono-cropping farmers have spent less on

livestock inputs and received less profit but diversified farmers's cost and return was more in livestock rearing.

Table 1. Descriptive statistics of output variables

Variable	Mono-cropping (Control)			Crop diversification (Treatment)		
	Small farmers	Medium farmers	Large farmers	Small farmers	Medium farmers	Large farmers
Area under paddy in ha	0.450	1.364	3.879	0.335	0.817	2.004
Paddy yield in tonnes	1.643	1.505	1.617	2.246	2.344	2.413
Fertilizer cost in Rs.	1518.588	4327.047	11356.430	1854.840	4368.197	12577.060
Plant protection cost in Rs.	325.970	1105.002	3832.418	460.209	1367.802	6032.275
Labour cost in Rs.	2074.782	6725.836	17145.420	2153.798	5650.502	16040.040
Irrigation cost in Rs.	340.095	658.441	1033.218	314.709	451.651	657.012
Machinery cost in Rs.	912.179	2434.407	5072.939	871.710	2036.997	4801.265
Total crop input cost in Rs.	14412.090	42492.090	112849.600	16509.660	40881.160	136092.000
Net crop income in Rs.	69099.880	57809.190	78510.770	78210.150	76976.380	88389.680
Livestock input cost in Rs.	919.491	1171.310	2013.730	1243.164	1962.670	3636.013
Net livestock income in Rs.	2174.760	4279.922	6451.888	3258.959	5574.203	8929.190
Household's monthly consumption expenditure in Rs.	44.936	82.863	236.899	99.773	161.564	222.957
Home produced consumption in Rs.	5436.685	36469.420	16.492	22.126	26.982	21.017

Table 2.Descriptive statistics of determinants of crop diversification in paddy plus cropping pattern

Variables	Small		Medium		Large		All farmers	
	Control	Treated	Control	Treated	Control	Treated	Control	Treated
Farm size in ha	0.902	1.137	2.741	2.783	7.822	6.710	2.220	3.010
Off farm income generation	0.890	0.824	0.892	0.782	0.889	0.821	0.890	0.809
No off farm income	0.110	0.176	0.108	0.218	0.111	0.179	0.110	0.191
Non-farm income generation	0.848	0.836	0.859	0.862	0.855	0.880	0.852	0.856
No non-farm income	0.152	0.164	0.141	0.138	0.145	0.120	0.148	0.144
Livestock rearing	0.399	0.243	0.327	0.204	0.332	0.168	0.373	0.211
Not rearing	0.601	0.757	0.673	0.796	0.668	0.832	0.627	0.789
Tenurial status	0.786	0.826	0.801	0.854	0.786	0.782	0.789	0.825
No tenurial	0.214	0.174	0.199	0.146	0.214	0.218	0.211	0.175
Training attended	0.971	0.969	0.966	0.948	0.965	0.948	0.969	0.957
Not attended	0.029	0.031	0.034	0.052	0.035	0.052	0.031	0.043
Credit availing	0.596	0.575	0.564	0.536	0.495	0.422	0.576	0.524
Not availing	0.404	0.425	0.436	0.464	0.505	0.578	0.424	0.476
Sex: male	0.087	0.087	0.074	0.052	0.945	0.056	0.080	0.068
Female	0.913	0.913	0.926	0.948	0.055	0.944	0.920	0.932
Social group: ST	0.226	0.283	0.284	0.314	0.224	0.239	0.224	0.283
SC	0.165	0.104	0.220	0.062	0.071	0.063	0.137	0.080
OBC	0.361	0.329	0.098	0.328	0.418	0.341	0.377	0.332
Others	0.248	0.284	0.398	0.295	0.287	0.356	0.261	0.305
Education: illiterate	0.362	0.330	0.275	0.291	0.244	0.282	0.326	0.305
Non-institutional	0.012	0.014	0.008	0.012	0.012	0.008	0.011	0.012
Primary	0.259	0.257	0.245	0.268	0.238	0.239	0.253	0.256
High school	0.262	0.290	0.320	0.285	0.304	0.311	0.281	0.294
Higher secondary	0.056	0.060	0.073	0.073	0.095	0.076	0.065	0.068
Collegiate	0.049	0.048	0.080	0.071	0.107	0.084	0.064	0.065
Age level: youger	0.081	0.072	0.049	0.039	0.040	0.027	0.068	0.050
Middle age	0.511	0.474	0.426	0.418	0.367	0.394	0.473	0.436
Elders	0.407	0.454	0.525	0.543	0.593	0.579	0.459	0.515
Household size in numbers	5.053	5.441	5.906	6.127	6.260	6.648	5.411	5.957
Rainfall in mm	1,410.511	1,451.863	1,362.719	1,421.480	1,309.088	1,302.433	1,386.164	1,406.255

To estimate propensity score, we have selected the covariates which are simultaneously affect both participation in treatment (crop diversification) and outcome variables. These covariates include farm,

household level and institutional characters, which are considered as the potential confounders of afore mentioned outcome variables.

Descriptive statistics of determinants of crop diversification and variables of propensity score estimation are presented in Table 2. Age and education of the head of the farm household are the important drivers in farm level decision making process. Elderly farmers and less educated farmers may considered that farming is just a way of life while young and educated farmers are more business oriented. In both treated and control groups, number of youngster are very less, whereas both middle and old age group occupied more than 40 per cent of the farmers. Likewise, about 30 per cent of the total farmers are illiterate and more than 25 per cent of the farmers are having primary and high school level education, respectively. Since family members in the household affected the labour use in the farms, especially in the small and medium farm level, household size is included the model. On an average, the household size varies around 5 and 6 in both control and treatment groups, respectively. Gender of the household can affect the decision regarding the number of crops grown in the farm. Here, around 90 per cent of the farmers are male in both control and treatment groups. Social status in the society may affect the crop choice. Only 13.7 per cent in the control group and 8 per cent in the treatment groups are coming from the Scheduled caste (SC) category followed by Scheduled tribes (ST), other backward class (OBC) and other category (OC).

Determinants of Crop Diversification under Paddy based Cropping System

About 58 per cent of the total farmers in the study region are still practicing paddy monocropping with the area of 27 per cent of total cropped area. The rest of the farmers are grown more than one crop including paddy. Here the question is what are all the factors determining the adoption and non-adoption of crop diversification in the farm. Hence, we divide the entire farmers into two groups 1. Farmers who are practicing paddy mono cropping and 2. Farmers who are cultivating more than one crop along with paddy. Logistic regression function was employed to estimate the determinants of crop diversification for each small, medium, large and all farm farmers separately.

Table 3: Determinants of crop diversification under small, medium large and all farmers land holdings

Variables	Small farmers	Medium farmers	Large farmers	All farmers
Area holding	0.674***	0.029	-0.001	-0.000
	(0.043)	(0.053)	(0.001)	(0.001)
Off farm income generation	0.387***	0.713***	0.476***	0.521***
	(0.066)	(0.087)	(0.117)	(0.047)
Non farm income generation	0.155**	-0.006	-0.159	0.019
	(0.064)	(0.089)	(0.118)	(0.047)
Livestock rearing	0.702***	0.599***	0.765***	0.716***
	(0.053)	(0.072)	(0.097)	(0.038)
Tenurial status	-0.174***	-0.393***	-0.253**	-0.225***
	(0.061)	(0.084)	(0.104)	(0.043)
Training attended	0.090	-0.496***	-0.505**	-0.244***
	(0.136)	(0.154)	(0.201)	(0.087)
Credit availing	0.096**	0.158**	0.076	0.124***
	(0.049)	(0.064)	(0.085)	(0.035)
Education: non intuitional	0.228	0.209	-0.489	0.119
	(0.201)	(0.314)	(0.405)	(0.155)
Primary	0.063	0.012	0.049	0.085*
	(0.062)	(0.085)	(0.116)	(0.045)
High school	0.163***	-0.199**	0.024	0.096**
	(0.063)	(0.085)	(0.115)	(0.045)
Higher secondary	0.150	0.049	-0.181	0.118
	(0.106)	(0.129)	(0.165)	(0.072)
Collegiate	0.114	-0.013	-0.110	0.104
	(0.115)	(0.130)	(0.161)	(0.074)
Sex: male	0.228***	-0.469***	-0.032	-0.018
	(0.085)	(0.131)	(0.178)	(0.065)

Social group: SC	-0.426***	-0.760***	-0.265	-0.618***
	(0.084)	(0.128)	(0.177)	(0.063)
OBC	-0.275***	-0.570***	-0.320***	-0.458***
	(0.063)	(0.082)	(0.110)	(0.045)
Other caste	-0.026	-0.377***	-0.127	-0.194***
	(0.067)	(0.087)	(0.122)	(0.047)
Age	0.000	0.009	0.023	0.014*
	(0.011)	(0.015)	(0.020)	(0.008)
Age square	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Household size	0.038***	0.022**	0.036***	0.037***
	(0.010)	(0.011)	(0.012)	(0.006)
Rainfall	-0.001***	-0.005***	-0.007***	-0.002***
	(0.000)	(0.000)	(0.001)	(0.000)
Rainfall square	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Medium farmers				0.604***
				(0.038)
Large farmers				0.841***
				(0.047)
Constant	-1.596***	3.411***	4.043***	-0.072
	(0.432)	(0.628)	(0.810)	(0.300)
Observations	9,400	4,805	2,947	17,152

The results of the logistic regression function are presented in Table 3. The coefficients of the variables such as farm size, off-farm income generation, availing credit and family size are positive and significant at one per cent level in small, medium, large and all farm categories, indicating that increased farm size, off-farm income generation, credit and larger family size are more likelihood of crop diversification. Similarly, primary and high school educated farmers and medium and large farmers are more favorable to crop diversification. However, tenurial status, training programme attended and rainfall show significant and negative relationship with crop diversification, indicating that all these three factors led to paddy specialization as expected. Similarly, farmers of SC caste, OBC classes are more favorable to paddy mono-cropping when compared the ST farmers.

CONCLUSION

This study presents the current status and determinants of agricultural diversification. This study also examines the impact of agricultural diversification on the rural poverty and monthly per capita consumption expenditure. Several policies recommendation emerges from this study. Out of which age and education of the head of the farm household plays an crucial role in the farm level decision making process. Even in the advent of decrease in the area of cultivation, crop diversification has contributed to net income to stabilize the socio income of the farming community.

Farmers can diversify if they do not have any training courses or classes which provides knowledge on a specific technology related to a specific crop. On the other hand, accessing any training can also be associated with dissemination and adoption of new technology which is favourable to crop diversification. Over 90 per cent of the total farmers are not accessing training facilities. Credit constraint can be reason behind the crop specialisation. It is expected that access to credit facilities may affect the degree of crop diversification since credit institution is always available for specific crop only. Here, less than 50 per cent of the farmers are availing credit facilities for various farming activities in all category of the farmers Any policies which is focused on diversification measures can be expected to accelerate towards the upliftment and up scaling in the welfare of farming community.

REFERENCES

1. K. Chakravarti. (1973). Green Revolution in India. Annals of the Association of American Geographers, Vol. 63, No. 3, pp.319-330.

2. Amit Kumar Basantaray and G. Nancharaiah. (2017). Relationship between Crop Diversification and Farm Income in Odisha — An Empirical Analysis. *Agricultural Economics Research Review,* Vol. 30:45-58. DOI: 10.5958/0974-0279.2017.00021.0
3. Kar, G., Singh, R., Verma, H.N., (2004). Alternative cropping strategies for assured and efficient crop production in upland rainfed rice areas of Eastern India based on rainfall analysis. Agricultural Water Management 67, 47–62.
4. Faurès JM, Bartley D, Bazza M, Burke J, Hoogeveen J, Soto D, Steduto P (2013) Climate smart agriculture sourcebook. FAO, Rome, p 557
5. Joshi, P.K., Gulati, Ashok, Birthal, P.S. and Tewari, L. (2004) Agriculture diversifi-cation in South Asia: Patterns, determinants and policy implications. Economic and Political Weekly, 39(24): 2457-2467.
6. Birthal, P.S., Joshi, P.K. and Gulati, Ashok (2005) Vertical Coordination in High Value Commodities: Implications for Smallholders. MTID Discussion Paper No. 85. International Food Research Institute, Washington, D.C.
7. A.K. Chakravarti. 1973. Green Revolution in India. Annals of the Association of American Geographers, Vol. 63, No. 3, pp.319-330.
8. Sukallaya Kasem, Gopal B. Thapa. (2011). Crop diversification in Thailand: Status, determinants, and effects on income and use of inputs.Land Use Policy,28: 618–628.
9. Sanjeev Kumar and Sakshi Gupta, (2015). Crop Diversification towards High-value Crops in India: A State Level Empirical Analysis. Agricultural Economics Research Review Vol. 28 (No.2) pp 339-350. DOI: 10.5958/0974-0279.2016.00012.4.

CITATION OF THIS ARTICLE

D C Baskar ,Umanath , Usha Nandhini , Kavitha. Impact of crop diversification on farm income and Resource use pattern under Paddy Farming system: An Empirical Analysis. Bull. Env. Pharmacol. Life Sci., Vol 8 [10] September 2019: 52-57