An Analysis of the Extent and Determinants of Crop Diversification Among Marginal and Small Farmers in Karnataka.

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Abstract

This study examines the extent and determinants of crop diversification among marginal and small-scale farmers in Karnataka, India. Data used for the study were obtained from primary source using a multi-stage sampling technique with structured questionnaires administered to 612 randomly selected from six major crops such as Paddy, Cotton, Redgram, Sorghum, Groundnut and Sugarcane cultivating farmers from the study area. The study uses Herfindahl Index (HI) to measure extent of crop diversification among the farmers in the study area while ordinary least square (OLS) regression analysis was used to determine the factors affecting crop diversification and effect of crop diversification on crop production in the study area. The study revealed the mean computed Herfindahl index by adopters and non adopters of technology adopters. It can be observed from the results that, inclination towards diversification is high among the adopters as compared to the non-adopters as the estimates of Herfindahl index (HI) are inclining towards zero in the case of adopters. However, this is contrary in the case of paddy and sugarcane farmers. Among both the categories of agricultural technology adopters and non-adopters, specialisation was seen in the cultivation of these crops. The study further revealed that farming experience, extension contact, farm size and land ownership positively and significantly affected diversification among the farmers in the study area. The study therefore recommended that extension agents should create more awareness on the importance of crop diversification on the output of the farmers in the study area. This will further encourage the farmers to improve on the right selection and cultivation of different crop types on their farms which will eventually lead to increase in crop outputs and food security.

Keywords: Crop diversification, Herfindahl index (HI), Marginal and Small holder, food crop production.

I. Introduction

Marginal and small farmers contribute substantially to the agriculture sector. However, the small and marginal farmers also face difficulties in implanting the newer technologies introduced due to credit risk, incomplete information and small holdings. These sections of farmers are highly prone to constantly varying market prices. One of the ways to mitigate this issue is to diversify the crops. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a farm taking into account the different returns from value-added crops with complementary marketing opportunities. Such a diversification can ensure better income to the farmers also can ensure food security to the farming households. With this background, the present study was taken up to understand the crop diversification among the technology adopters and non adopters in Karnataka state. Technology adopters or intervention are the farmers who have been using scientific methods of cultivation practices like use of right dosage of fertilisers, high yielding verities, and have been following the package of practices recommended by University of Agricultural Sciences and Krishi Vignana Kendra's (SAU's and KVK's) for crop production, whereas, non adopters are those who did not grow any of the improved verities or have not been following scientific methods. The study also tries to examine the factors influencing crop diversification among adopters and non-adopters across major crops.

II. Methodology

Karnataka with its diversified agro climatic conditions is home for the production of variety of agriculture crops such as Paddy, Tur, Sorghum, Sugarcane, Bengal gram, Soya bean, Groundnut, Green gram, Black gram,

Safflower, Cotton etc. The major crops selected for the study were Paddy, Sorghum, Redgram, Groundnut, Cotton and Sugarcane. The crops were selected based on the highest cultivated area under the crops**.** Among cereals, Paddy and Sorghum occupies the highest area with 13.26 lakh hectares and 10.47 lakh hectares in 2014-15 respectively. Regarding pulses, redgram was seen to have the largest area of 7.28 lakh hectares. Among oilseeds, Groundnut had highest area with 6.54 lakh hectares during 2014-15. In commercial crops, cotton and sugarcane were selected as these had the highest area of 8.75 lakh hectares and 6.91 lakh hectares respectively. The districts and taluka were selected based on the distribution of cultivated area under the selected crops across the districts. Kalaburagi was having highest area under redgram with 3,88,950 hectares and Sorghum with 2,04,422 hectares, while in the case of Paddy, Raichur had the highest area of 1,26,675 hectares. Also, Chitradurga was selected as sample district as it exhibited the highest area under Groundnut (1,29,484 hectares). With respect to commercial crops, Belagavi was selected for sugarcane (1,63,511 hectares) while Yadgir was selected for Cotton (1,75,117 acres). Similarly taluka from each district were selected based on the highest area of selected crop for the study Villages/Blocks were selected after discussion with Agriculture officers.

The sample size was determined based on the Bill Godden (2004) formula. The formula for infinite population is as follows

$$SS = \frac{Z^2 * (p) * (1-P)}{C^2}$$

SS = Sample Size

Z = Z-value A (e.g., 1.96 for a 95 per cent confidence level)

P = Percentage of population picking a choice, expressed as decimal

C = Confidence interval, expressed as decimal (e.g., .04 = +/- 4 percentage points)

$$\mathbf{SS} = \frac{3.8416 * (0.5) * (1-0.5)}{(0.03)^2}$$

=600

Derive sample size from the value obtained for infinite

$$\text{SS for finite} = \frac{SS}{(1+(\frac{S-1}{\text{Population}}))}$$

Population is the size of the finite population, 31055 households in this case

Thus, SS for finite is

$$\frac{600}{(1+\frac{(600-1)}{31055*})} = 588$$

The total sample size was 588. However, the sample size is rounded to 612 so as to get equal number of samples across all selected villages. 34 farm households were randomly selected from each of 3 villages or blocks in each taluk consisting of 17 technology adopters and 17 technology non adopters. The total sample was distributed equally among the six talukas. Thee total sample size was 612 farmers consisting of 306 technology adopters and 306 technology non adopters. For each crop, 102 farmers are interviewed, out of 102 61 farmers are technology adopters and 61 of them are technology non- adopters. The following statistical techniques were employed

2.1 Herfindahl Index (HI)

Herfindahl Index (HI) method was used to measure the extent of crop diversification for those farmers who diversified their crops. This index was selected due to its wider application in measuring the concentration and diversification of crop. The measure of HI was originally proposed by two economists “Orris C. Herfindahl and Albert O. Hirschman” Herfindahl index (H.I.) defined as the sum of squares of all n proportions is a measure of crop concentration. This measure is used to measure crop diversification on acreage proportion. The value of “H.I.” varies from zero to one. It takes the value of one when there is complete specialization and approaches zero when the number of enterprises is more showing perfect diversification. The Method is basically equivalent to the Simpson Diversity Index widely used in the field of ecology (Hirschman and Albert, 1964). The method was also widely applied by agricultural economists to measure the level of diversification of a given farm. The HI index was calculated separately for adopters and non adopters.

The index is computed as;

$$P_i = \frac{A_i}{\sum_{i=1}^{n} A_i}$$

Where,
Pi= proportion of ith crop
Ai= area under ith crop (ac)
∑Ai = total cropped area (ac)
i= 1, 2, 3, ..., n (number of crops)
Herfindahl index (HI) = ∑Pi2
Where,
Pi = proportion of ith crop
I = 1, 2, 3, ..., n (number of crops)

2.2 Multiple Regression

To identify the factors affecting diversification among adopters and non-adopters, multiple regression analysis was carried out with Herfindahl index (Y) as the function of independent variables.

Y = a+ b1X1+ b2X2 + b3X3 +……..+bnXn+ U

The explanatory variables are as under

X1 = Age (Years)

X2 = Education (years)/No of years in schooling

X3 = Number of livestock

X4= Off Farm income (Rupees per annum)

X5 = Farm size (acres)

X6 = Farm income (Rupees per annum)

X7= Experience in farming (Years)

X8 = No of extension visits

X9 = Extension contact (Yes=1; No = 0)

X 10= Credit availability (Yes=1; No = 0)

X11= Distance from the Agricultural Development Centre (Km)

X 12= Mobile (Yes=1; No=0)

III. Results and Discussion

3.1 Extent of crop diversification by agricultural technology adopters and non-adopters

Agriculture crop diversification index is estimated for the selected crops as well as the districts for the period of study. Diversification may be broadly defined as a shift of resources from low value agriculture crops to high value agriculture crops as indicated by Hayami and Otsuka (1992). Crop diversification based on proportion of area under different crop in selected sample farmers and crops measured and quantified using Herfindahl Index. Trends of crop diversification results among agricultural technology adopters and non-adopters is represented in **Table 1.** It can be observed from the table that, inclination towards diversification is high among the adopters as compared to the non-adopters as the estimates of Herfindahl index (HI) are inclining towards zero in the case of adopters. However, this is contrary in the case of paddy and sugarcane farmers. Among both the categories of agricultural technology adopters and non-adopters, specialisation was seen in the cultivation of these crops. These crops are abundantly grown in Raichur and Belagavi, due to the availability of enough canal water. In the case of paddy, Raichur is a prominent area and the farmers are specialised in the cultivation of paddy since decades due to the availability of canal water. In addition, due to extensive paddy cultivation, the soil is leached out of necessary nutrients and also the water-logged condition is more suitable for paddy cultivation. Abundance of Paddy mills present in the area encourages the farmers to grow paddy as it is more convenient to process and market it.

The results of regression model of the factors affecting diversification among adopters and non - adopters, is presented in **Table 2 and 3.** The variables contributing positively to diversification were education in years, Experience in farming, number of extension visits, extension contact, distance of agriculture development centre, owning a mobile hand set and availability of credit. However, the significance of these variables varied across crops. The experience in farming, the farmer would have learned to withstand risk through multi cropping. Further, with the increased contact with the extension agents, the diversification was seen to increase. The role of the extension agents is prominent as they extend the scientific farming methods to the farmers. Extension agents would disseminate knowledge of reducing crop loss and managing risk through crop diversification.

Introduction of new technology in crop cultivation like high yielding varieties, pest and disease resistant varieties, early maturity varieties, advanced machineries, bio pesticides, best practice adoption, and the ideas on current trends in crop cultivation will also be extended to the farmers through the extension agents. Owning a mobile set has also significantly contributed to crop diversification among the redgram farmers. Access to mobile phone enhances the communication network, thus it is more convenient to contact the extension agents and other agricultural service providers.

Increase in age was negatively influencing crop diversification in the case of paddy, redgram and sorghum among the adopters. Further off farm income was also seen to negatively impact on crop diversification in the case of paddy. When the non farm income is higher, the farmers tend to move out farming and thus don't concentrate on diversifying the crops.

Among the non-adopters, the factors influencing diversification remained the same as the adopters which included age, education in years, off farm income, experience in farming, number of extension visits, extension contact, and distance from the agriculture development centre. However, the magnitude of influence varied considerably. Education was seen to positively influence crop diversification among adopters and non-adopters as well. However, among non-adopters the co efficient remained lesser than 0.07 whereas in the case of adopters it was higher, with coefficient between, 0.96 and 2.13. In case of groundnut, increase in a number of livestock was found to increase crop diversification by 0.022 per cent . Similar results were also reported by Feiten *et al* ., (2009).

In case of off farm income, among the adopters, increase in off farm income has led to decrease in diversification by 1.56 times in paddy, and 1.34 times in groundnut. In case of non-adopters, increase in off farm income by 1000 INR, was seen to decline the crop diversification by 2.2 per cent among paddy farmers whereas it was seen to decline at 4 per cent in case of redgram farmers. This implies that as the off farm income increases, the farmers tend to concentrate more on non-agricultural activities. Similar trend was observed in the remaining factors as well. The R^2 was slightly higher among the adopters than the non-adopters which indicates the influence of the variables not included in the model.

The results of the study indicating the factors influencing are in line with the results by Ojo *et al.*, (2014) who reported that farming experience, extension contact, and farm size positively and significantly affect the diversification in farming. Bravo Ureta et al.,(2006) and Pitipunya (1995) also state that receiving routine extension information would increase crop diversification by 5.7%. Muhmmed *et al*., (2008) also indicated that diversification is evident among the farmers with more number of farming experience. The study by Ojo *et al.*, (2014) also revealed that the off farm income, and age negatively impacted on diversification which is in line with the results of present study. The study by Katchova (2008) and Abro (2012) also indicates the same.

Education of the farmers appears to be positively impacting on crop diversification, as the farmer is able to make more of constructive decision and be open to new ideas (Monika *et al*.,). The study by Pope and Prescott *et al.*, (1980), Bravo-Ureta (2006), reveals similar results with regard to impact of education on crop diversification. Perusal into literature exposes studies with results in line with the present study. Fetien *et al*., (2009) found that barley variety diversity was affected by age, farm size, and extension. Nagarajan *et al.*, (2007) revealed that education, livestock, number of plots, road density, off-farm employment, distance to seed source, seed replacement rate, seed-to-grain paddy ratios, seed traders and farm location were significant determinants of the Indian household and community level millet variety diversification. To come across the determinants of crop diversification in Pakistan, Ashfaq's *et al.,* (2008) applied multiple regression model and discovered that farming experience, education, land size, farm distance from main road and farm machinery are the significant factors. Rehima *et al.,* (2003) found that the crop diversification was positively influenced by education, farm size and market distance

Increasing diversification is associated with falling average size of farms and deteriorating access to public investment on irrigation across the selected areas for the study. Diversification is where farmers become capable of prevention risk only by undertaking investment for development of access to irrigation. In such cases, diversification and high-value crop production are induced by the motivation of increasing income only

in the presence of good infrastructure, resulting in relative efficiency and profitability. In such cases, farmers can increase their income and consumption level to reach close to the minimum specified level of nutrition and food security. In both cases, farmers have to put in a huge amount of labour of the family members to maintain a certain minimum level of income and avoid the situation of extreme poverty and vulnerability.

Agricultural diversification can help to reverse these trends by making the sector more profitable as it becomes flexible in meeting the local and international demands and enables poor people to do something new and remunerative yet within their sphere of competencies and resources. Although diversification is certainly not a new phenomenon, the nature of the dynamic and evolving global environment presents new challenges and opportunities to the agricultural sector. While these changes, in turn, induce a need to re-examine the role of diversification, diversification inevitably remains an integral part of the inescapable process of structural change in the global agriculture systems.

The study revealed that the crop sector in the selected districts, in general, has been diversifying towards high-value crops from the traditional ones especially redgram, sorghum and groundnut growers. However, there are considerable variations in terms of intensity of the diversification across the districts. The rest of the state, however, moves strongly towards the cultivation of high value crops. The regression results have brought out the importance of area under HYV varieties, rural literacy rate, and proportion of a marginal and small landholder, size of the urban population, crop insurance, and relative income of high value crops significant determinants of crop diversification, besides the agro-climatic factor like rainfall. The high-value crops have a significant comparative advantage over staple food crops as they are prone to higher production. Therefore, the crop insurance for all farmers should be encouraged to mitigate the crop risk. The promotion of agribusinesses holds the key for reducing the price risk. The present day agriculture is much more knowledge-intensive and skill-based. The adequately trained human resources is the need of the hour in agricultural sector. Therefore, the provision of training and skill-formation should be arranged on a larger scale for the farming community in the study area.

IV. Conclusion

Diversification initiatives require a multicomponent approach involving many specific investment areas. Policy and institutional environment, irrigation, science and technology, and rural infrastructure. All these investments will not come from the public sector. Government has to create the enabling environments for the private sector to provide inputs and services to farmers necessary for diversification; however, the government needs to invest to widen the scope of research institutes to cover emerging issues of diversification, improve the analytical capabilities of farmers to synthesize the diversification opportunity, and develop the efficient knowledge and information systems. For the diversification process to be pro-poor, extension systems can be designed especially to reach marginal and smallholders, and research systems can be responsive to the needs of the small and marginal farmers by providing technologies that are adaptable to small scales. The establishment of rural producer organizations can be useful for promoting the interests of smallholders, who are typically underrepresented in political decisions, sourcing inputs by bulk and at competitive prices, exploring market opportunities, pooling output to improve bargaining power, and forming beneficial partnerships with commercial enterprises, governmental agencies, research and extension entities, and other community groups. To improve small farmers' participation in producer organization on equitable basis, free flow of information on markets, opportunities, and transparent rules and regulations of producers' organization, are very important.

This study also suggests an integrated policy support system is required for promoting sustainable horizontal and vertical diversification of the rural economy in the state. The major constraints reported by small and marginal farmers for crop diversification towards high value crops were lack of proper irrigation facilities, lack of knowledge and information, and non-availability of timely credit. Further, in the livestock sector, most small and marginal farmers reported lack of access to veterinary hospital service centres to be a problem. Diversification into fisheries sector, was mostly constrained by lack of timely credit, inaccessibility to cold storages, poor road conditions and connectivity and transportation problems. Thus, in the crop, livestock and fisheries sector policies must be made such that the specific problems faced by small and marginal farmers can be mitigated. Improving the small farmers access to irrigation, credit, agricultural technology and veterinary care services would hold the key in this respect. Further, agriculture sector can hardly afford to sustain all its growing population and therefore vertical diversification especially of small and marginal farms is necessary. Small and marginal farmers have to be basically part-time farmers. But the investment and organizational requirements of such vertical diversification in the form of agro based industries, agri-business, agro-processing and agro based industry services would have to be even greater. it was seen that in the study area unbalanced use of fertilizers

especially in Paddy and Cotton was posing a constraint to horticultural diversification. Hence a balanced use of fertilizers was required, which could be achieved by providing proper training in horticultural management and practices to farmers. Districts such as Yadgir, Raichur, and part of Kalaburagi it was found that inappropriate water management and inadequate water supply was a major constraint towards horticultural diversification. Moreover, poor road conditions, bad road connectivity and transportation problems stood in the way of development of livestock and fisheries. Also, poor infrastructure of road and electricity hold back the development of non-farm sector on adequate scale. Hence development of basic infrastructure, both hard and soft including road connectivity, electricity, literacy training and skills would be required to help promote non-farm diversification.

Table 1: Trends in crop diversification by adopters and non adopters

Crop	**Herfindahl Index by Adopter Category**	
	Adopters	**Non-Adopters**
Paddy	0.88	0.91
Cotton	0.46	0.71
Sorghum	0.34	0.87
Red gram	0.33	0.74
Groundnut	0.33	0.86
Sugarcane	0.91	0.98

Table 2: Factors Influencing on the Crop Diversification among the Adopters

S. No	Particulars	Paddy		Cotton		Sorghum		Red gram		Groundnut		Sugarcane	
		Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value
1	Age	-1.24	0.062***	0.45	0.786	-0.67	0.058***	-0.78	0.052***	0.64	0.113	1.24	0.124
2	Education in years	2.33	0.023**	0.98	0.067***	0.47	0.764	0.67	0.604	0.86	0.045**	0.99	0.113
3	Number of livestock	0.21	0.813	1.23	0.433	1.45	0.832	1.32	0.174	1.32	0.022**	0.36	0.125
4	Off Farm income	-1.56	0.076***	-1.34	0.347	1.87	0.77	0.78	0.025	1.34	0.005**	0.47	0.206
5	Farm size	3.45	0.872	2.23	0.054***	0.64	0.643	1.98	0.057***	1.47	0.344	1.73	0.163
6	Farm income	0.76	0.864	1.23	0.023**	0.87	0.081	0.45	0.252	2.37	0.065***	1.67	0.018**
7	Experience in farming	1.56	0.057***	0.56	0.673	1.56	0.782	1.23	0.024**	0.98	0.005*	0.78	0.339
8	No of extension visits	2.67	0.078***	1.43	0.478	0.38	0.813	0.46	0.389	2.67	0.179	1.29	0.023**
9	Extension contact	0.78	0.098***	0.78	0.278	1.67	0.642	0.81	0.038**	0.74	0.086***	0.89	0.021
10	Credit availability	0.67	0.343	0.74	0.065***	0.35	0.389	1.34	0.156	1.47	0.473	0.72	0.573
11	Agricultural Development Centre Distance	0.67	0.056***	1.34	0.648	2.76	0.489	3.76	0.386	1.78	0.387	1.78	0.378
12	Mobile	0.56	0.971	0.78	0.578	0.53	0.367	2.78	0.078	0.64	0.367	0.73	0.247
R^2		**0.67**		**0.71**		**0.59**		**0.59**		**0.63**		**0.64**	

Note:*significant at 10%;

**significant at 5%;

*** significant at 1%

Table 3: Factors Influencing on the Crop Diversification among the Non-adopters.

Note:*significant at 10%;

S. No	Particulars	Paddy		Cotton		Sorghum		Red gram		Groundnut		Sugarcane	
		Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value
1	Age	-0.46	0.008	1.24	0.367	0.67	0.865	1.32	0.737	0.78	0.367	-2.56	0.099
2	Education in years	0.06	0.053**	0.008	0.726	0.03	0.080***	0.74	0.936	0.09	0.038**	1.67	0.301
3	Number of livestock	0.78	0.246	0.36	0.216	0.67	0.963	2.43	0.923	0.12	0.724	0.67	0.725
4	Off Farm income	-2.2	0.037**	0.78	0.197	0.53	0.978	-3.98	0.096***	1.35	0.278	0.28	0.213
5	Farm size	0.05	0.019**	0.17	0.061***	0.43	0.652	0.45	0.989	0.98	0.897	1.43	0.196
6	Farm income	0.34	0.184	0.56	0.899	0.08	0.616	0.28	0.743	0.36	0.476	0.05	0.063***
7	Experience in farming	0.92	0.132	0.76	0.564	1.49	0.059***	0.45	0.056***	0.17	0.045**	0.23	0.068***
8	No of extension visits	0.66	0.159	0.098	0.788	0.77	0.388	0.78	0.356	0.37	0.234	0.68	0.562
9	Extension contact	0.76	0.497	0.89	0.456	0.34	0.801	0.34	0.722	1.83	0.873	1.78	0.447
10	Credit availability	1.56	0.263	0.0067	0.266	1.43	0.313	1.34	0.733	2.54	0.178	1.47	0.987
11	Agricultural Development Centre Distance	1.67	0.498	0.45	0.429	0.46	0.345	0.84	0.905	0.79	0.372	0.39	0.786
12	Mobile	0.76	0.872	0.787	0.479	0.78	0.678	0.74	0.705	0.27	0.278	1.78	0.491
R^2		**0.55**		**0.57**		**0.58**		**0.61**		**0.62**		**0.54**	

**significant at 5%;

*** significant at 1%

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