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Agricultural Skilling and Its Impact on Agricultural Commercialisation, Crop Diversification and Employment Choice of Small Holder Agricultural Households: A Study Based on 70th Round of NSSO

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ABSTRACT

This paper has used unit level data available from the 70th Round of NSSO survey on *Situation Assessment of Agricultural Households* to study the impact of agricultural training and extension services on three important dimensions of small holder farming, viz., commercialisation of staples, viz., rice and wheat, crop diversification and employment choice. A Household Commercialisation Index is constructed to determine the intensity of household participation in the output market by small holders. Using a two-step Heckman Selection model, the research shows that training and extension services have a key role in motivating small holder farmers in participating in the output market; however, these factors did not have any significant impact on determining the intensity of commercialisation. Training and extension services have also been found effective in promoting crop diversification among small holder households. Besides bringing out the role of skilling in securing integration of small holders in the output market of rice and wheat and in promoting crop diversification, the study also sheds light on the other determinants of small holder commercialisation and diversification. The Treatment Effect Models show that both commercialisation and diversification have beneficial effects on small holder welfare as they serve to increase the monthly per capita expenditure of these households. Further, using a Heckman Probit Model to control for selectivity in participation in labour market, the study finds that agricultural skilling reduces the probability of a worker belonging to small holder household in engaging in casual daily wage based employment and in unpaid family labour in agriculture; on the other hand the probability of engagement in self-employment activities in agriculture is enhanced by exposure to agricultural training programmes. The findings of the study underscore the need for massive expansion in agricultural skill development and extension services for enabling small holder farmers in India to emerge from the shackles of subsistence farming and in generating sustainable agricultural livelihoods.

Keywords: Agricultural skill development, Agricultural commercialisation, Crop diversification, Employment, Heckman selection model, Herfindahl Index, Heckman probit model, Tobit model, Treatment effect model

JEL: E24, J21, J24, J43, Q16

I

INTRODUCTION

Increasing smallholder incomes and ensuring livelihood security of small and marginal farmers has been a much sought after yet elusive goal of development policy in India. A paradox of India's development experience has been that a decline in agricultural share in gross domestic product (GDP) has not been accompanied by a concomitant decrease in the share of labour force engaged in the primary sector. Low

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productivity of labour in the farm sector has not only posed a serious hindrance to rural poverty alleviation; it has also been accompanied by rising inequality between rural and urban incomes and living standards. Further, pressure of a burgeoning population has resulted in increased fragmentation of agricultural holdings. A study on India's agricultural sector conducted by Singh *et al.,* (2002) has mentioned that small-holder families constitute nearly half of the country's population; but they also comprise more than half of India's poor and malnourished population. According to the Tenth Agricultural Census conducted in 2015-16, the small holder and marginal farmers who own less than 2 hectares of land constitute 86.2 per cent of all farmers but own just 47.3 per cent of the arable land (Bisht *et al.*, 2020). With income from marginal and small holdings not being large enough to sustain livelihoods, there has also been an increasing trend of casualisation of rural farm labour. It is being increasingly realised that raising smallholder incomes is critical for ensuring inclusive growth, tackling rural poverty and meeting broad macro targets of food and nutritional security. Doubling farmer's income has been an oft quoted policy slogan in recent times. The policy envisioned by the Central Government seeks to double income of farmers by the year 2022 taking 2015-16 as the base. Among the various measures that are considered pivotal for raising farm incomes are increase in agricultural productivity, improvement in total factor productivity, diversification towards high value crops, increase in cropping intensity, improvement in terms of trade and shifting cultivators to non-farm and subsidiary activities (Chand, 2017). However, fulfilment of these objectives is critically linked to enhancement of the skill base of farmers in various aspects of agricultural practices and procedures, post-harvest management, value-addition and food-processing. As mentioned by Ganguly *et al*. (2019), "use of modern technologies requires skills that may be different from those necessary for subsistence traditional agriculture. This requires policy attention and institutional support to provide appropriate skills and vocational training to people engaged in not only production activities in agriculture, but all along the agricultural value chains and food-processing sector". This paper therefore, examines the impact of agricultural training and extension services on three aspects of small-holder farming, viz., agricultural commercialisation of staples (rice and wheat), crop diversification and employment choice among small holders. Here, it may be mentioned that commercialisation of smallholder agriculture has been considered essential to improve incomes and better access to diversified and nutritious food (Pingali *et al*., 2019. According to Barrett (2008), "The transition from low productivity semi-subsistence agriculture to high productivity commercialised agriculture has been a core theme of development and agricultural economics for half a century or more". Given the importance of staples from the point of view of food and nutritional security at the micro and macro-levels, transformation from subsistence to commercialised farming of staples is of utmost relevance (Abdullah *et al*., 2017). At the same time, diversification towards high value crops also becomes significant to meet the increasing demand for these items in the domestic and export

markets (Birthal *et al*., 2007). Research reveals that diversification into high value crops can reduce poverty among agricultural households with the biggest impact being for small holders (Birthal *et al*., 2015). Besides, crop diversification is being increasingly looked upon as an important strategy for Climate Smart Agriculture (CSA) (Makate *et al*., 2016).Against this backdrop, this paper uses the Situation Assessment Survey conducted by the NSSO (70th Round) to evaluate the status and intensity of agricultural commercialisation of small holder rice and wheat growers in India and their determinants with special emphasis on agricultural training and extension. Besides, the role of skilling in the adoption of diversified farming practices is also evaluated. Further, the relevance of agricultural training in altering occupational choices of workers belonging to small-holder agricultural households is assessed. The objectives of the paper may be stated as follows: (a) To assess the extent of agricultural commercialisation among small holder rice and wheat growers in India and to determine the factors influencing the decision to participate in output markets and further, the intensity of participation (with special focus on the role of agricultural training), (b) To evaluate the role of agricultural skilling in promoting crop diversification among small holders.(c) To ascertain the effects of agricultural commercialisation and crop diversification on the economic welfare of small holder agricultural households and (d) To study the effects of agricultural training (skilling) on the occupational choices of workers belonging to small holder agricultural households. The paper is organised in four sections including the introduction. Data and methodology issues are outlined in Section II. The main analytical findings are reported in Section III. The last section summarises and concludes the findings.

II

DATA AND METHODOLOGY

The study is based on unit level data available from the 70th Round on the NSSO survey on Situation Assessment Survey of Agricultural Households. The survey was conducted in two rounds: the first round was carried out between January 2013 and July 2013 while the second round was conducted between August 2012 and 31st December, 2013. The first round collected information relating to agricultural production and practices for the agricultural season in the preceding six months that is July 2012 to December 2012. The second round extracted information on various aspects of farming during January 2013 to June 2013. A household was considered to be an agricultural household if it had a value of agricultural produce not less than that of Rs.3000 and also had at least one household member who was self-employed in agriculture either in principal status or subsidiary status during the past 365 days. The data set consists of a short panel with 35,200 households being surveyed in the first visit and 34,907 of the same households being surveyed during the second visit. Apart from data on farming expenses and receipts, the survey also collected information on the other aspects of agricultural households such as indebtedness,

crop insurance, monthly consumption expenditure, extension services etc. The survey was carried out in rural areas only.

A small holder agricultural household in the study is defined as a household owning up to 2 hectares of land. For studying commercialisation of staples among smallholders, households growing rice (or wheat) as one of the crops either in the *kharif* or *rabi* seasons were considered. The analysis was carried out separately for rice and wheat crops. Here, it may be noted that market participation or commercialisation of agriculture may be considered from an input as well as output perspective. Commercialisation on the input side entails greater use of quality inputs that are procured from the market. However, in the present study, we focus on output commercialisation. Accordingly, a Household Commercialisation Index (HCI) is compiled for each household as follows:

$$HCI = \frac{Quantity\ of\ \ i^{th} crop\ sold\ during\ the\ year}{Quantity of\ the\ i^{th} crop\ produced\ during\ the\ year} \quad ....(1)$$

The range of HCI varies between zero and one with zero indicating complete lack of market participation and one, indicating perfect integration. In order to ascertain the determinants of household commercialisation we employ a Heckman Selection Model (HSM). The choice of HSM is explained by the fact that the intensity of household commercialisation can be studied only for those households who participate in the output market giving rise to the problem of self-selection. The HSM involves a two-step procedure.[1]In the first step, the probability of a household participating in the output market is modelled using a selection (Probit) model as follows:

$$Y_i = 1(Household\ participates\ in\ the\ output\ market\ of\ i-thcrop)$$
$$if Y_i^* = x_i\beta_i + \mu_i > 0$$
$$= 0\ (Household\ does\ not\ participate\ in\ the\ output\ market), otherwise$$

where, Y_i and Y_i* are, respectively, the observed and latent variables corresponding to the household's decision to participate in the output market of the i-th crop, *x* is the vector of covariates, and $\mu$is the stochastic error term.

The outcome equation for assessing the determinants of the intensity of household commercialisation is

$$HCI_i = x_i\lambda_i + \delta_i \quad ....(2)$$

where, HCI is the Household Commercialisation Index, x is a vector of covariates, δ is the stochastic error term and i refers to the i-th crop. The dependent variable in the outcome equation being continuous, a linear model is estimated.[2]

The extent and determinants of crop diversification are assessed with a Crop Diversification Index (CDI) based on the share of cultivated area devoted to various crops. Accordingly, we have

$$CDI = 1 - HI \quad \text{....(3)}$$

where, HI is the Herfindahl Index and is computed as follows

$$HI = \sum_{i=1}^{n} s_i^2$$

here, s_i represents the proportion of cultivated area under the i-th crop and is computed as $s_i = \frac{A_i}{\sum_i^n A_i}$, where A_i is the area under the i-th crop. The value of the HDI ranges from 0 to 1, with 0 indicating complete specialisation and one indicating complete diversification. Hence, the value of HDI being censored, we use a Tobit model to evaluate the determinants of crop diversification.

To assess the impact of commercialisation and crop diversification on household welfare, Treatment Effect Model (TEM) has been used. Household welfare has been measured in terms of Monthly Per Capita Expenditure (MPCE). The use of TEM is warranted as difference is baseline characteristics of households can lead to biased estimates of Ordinary Least Squares (OLS) regression.

Evaluation of the impact of agricultural skilling on employment choice of workers has been made using a Heckman Probit Model (HPM). Since employment status is observed for only those people who participate in the labour market, the decision to seek employment in a given activity is not independent of the decision to participate in the labour market that is, there is selectivity bias. The equation for Labour Force Participation is

$$LFPR = 1(Individual\ is\ in\ the\ labour\ force)\ if LFPR^* = x\gamma + € > 0 \quad \text{....(4)}$$
$$= 0\ (individual\ is\ not\ in\ the\ labour\ force), otherwise$$

where, LFPR and LFPR* are, respectively, the observed and latent variables corresponding to the labour force participation decision of the individual , x is the vector of covariates including the treatment and € is the stochastic error term.

The outcome equation for evaluating the factors influencing the decision to participate in the i-th employment is

$$EMP_i = 1(Individual\ is\ in\ the\ i^{th}\ employment)\ if EMP_i^* = x\alpha + \theta > 0$$
$$= 0, otherwise \quad \text{....(5)}$$

As employment status of individuals is observed only if $x\gamma + \epsilon > 0$, the HPM simultaneously estimates Equations (4) and (5) and then tests for independence of the two equations. Equation (5) is estimated for five alternative employment scenarios viz., (a) self-employed in agricultural sector (b) Employer in agricultural sector (c) Unpaid family worker in agricultural sector (d) Salaried worker and (e) Casual daily wage labourer. The alternative scenario in each of these cases is that the worker is employed in some other employment than the category under consideration. Further, in both HSM and HPM, suitable exclusion criterion was used. The exclusion criterion of HSM and HPM entail that all variables in the outcome model should be included in the selection equation; further the selection equation should contain at least one variable that is excluded from the outcome model (Wooldridge, 2013).

III

RESULTS AND DISCUSSION

3.1 *Descriptive Statistics of Sample Households*

Descriptive statistics relating to sample households are presented in Table 1. Of the 35,200 sample households who were surveyed during the first visit 73.83 per cent were small holder households. Households with semi-medium land holdings comprise 18.92 per cent of the sample. About 5 per cent of the sample households had medium landholdings and large landowners formed only 2.29 per cent of the

TABLE 1. DESCRIPTIVE STATISTICS OF SAMPLE HOUSEHOLDS

(1)	(2)
Percentage of small holder households (<= 2 ha.)	73.83
Percentage of households with semi-medium land holdings (>2ha &<= 4ha)	18.92
Percentage of households with medium land holdings (>4ha &<=10ha)	4.96
Percentage of households with large land holdings (> 10 ha)	2.29
Percentage of SC households	13.24
Percentage of ST households	18.96
Percentage of OBC households	40.32
Percentage of Forward Caste Households	27.48
Percentage of households with off-farm income	93.01
Percentage of female-headed households	8.42
Average size of land owned by households (in ha.)	1.4
Percentage of household heads with no education	34.41
Average household size	5.4
Percentage of Labour Force (15-64 years) receiving agricultural training	2.4
Percentage of non-agricultural workers in the sample	13.52
Percentage of workers with no education	32.62
Percentage of workers with less than primary education	10.63
Percentage of workers with primary education	12.63
Percentage of workers with middle school education	19.27
Percentage of workers with secondary school education	12.81
Percentage of workers with higher secondary education & above	12.87
Percentage of households who accessed agricultural extension services	60.54

Source: Based on author's calculation from NSSO data.

sample. The average size of land owned by the households is 1.4 hectares. OBC households comprised the largest caste group with 40 percent of the sample households belonging to this category. The percentage of Forward caste, Scheduled Caste (SC) and Scheduled Tribe (ST) households in the sample were 27.48, 13.24 and 18.96 respectively. Female-headed households made up 8.42 per cent of the total sample households. More than 34 per cent of the household heads were illiterate. Interestingly, 93 per cent of the sample households had access to income outside cultivation. The average household size is 5.4. Only 2.4 per cent of the sample individuals in the age group of 15-64 years who were in the labour force reported that they received training in agriculture. Nearly, 61 per cent of the sample households reported that they availed agricultural extension services at least once during the agricultural year. About 33 percent of the workers in the age group (15-64) years were illiterate. Only 13.52 percent of the workers in the sample were engaged in non-agricultural activities. Further, out of the 35,200 households in the sample, 19,098 households cultivated rice at least once during the agricultural year of which 14,182 households were small holders. Also, out of the 11,009 households that cultivate wheat as one of the crops, 7688 households were small holders.

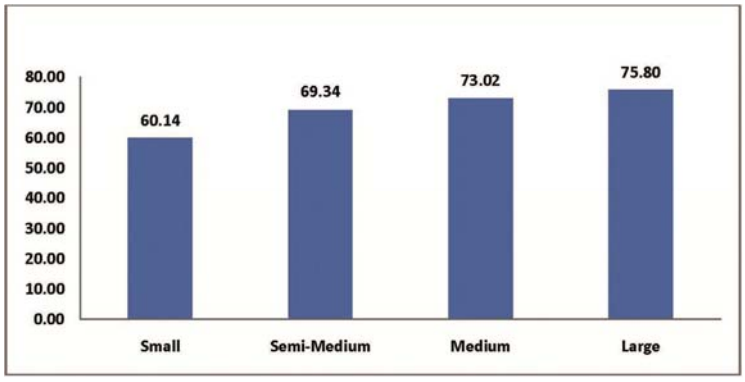
A description of variables used for the regression analysis is given in Table 2. It may be noted that in case of education, individuals with either no education or those who have not attended formal schooling are taken as the base category. Four caste categories, viz., SC, ST, OBC and Forward Caste have been used in the analysis with forward caste households constituting the base category. With regard to religion, other religions apart from Hindu and Muslims were taken as the base. The rest of the information contained in Table 2 is self-explanatory and does not warrant further discussion.

3.2 *Impact of Agricultural Skilling on Commercialisation*

Since the first objective of the study is to evaluate the factors associated with the commercialisation of staples consisting of rice and wheat growers, only those households that cultivate rice or wheat as one of the crops in either of the two agricultural seasons have been considered for the purpose of compilation of the Household Commercialisation Index (HCI). Therefore, taking rice into consideration, those agricultural households that did not cultivate rice either during the *kharif* or *rabi* season were not considered in the analysis; the same procedure was followed for wheat. Figure 1 shows the HCI of rice calculated as the percentage of total quantity marketed to total quantity produced by size class of land owned. It is observed that the value of the HCI is the lowest for small holders and rises monotonically as the size of land holding increases implying that there is significant scope for increasing the rate of market participation for small holders. Thus, small land owning households on an average are found to be selling only 60 per cent of their rice output in the market whereas for large land owners, the corresponding figure is at 76 per cent. Similarly, in the case of wheat, the average value of the HCI is very low for

TABLE 2. DESCRIPTION OF VARIABLES USED IN REGRESSION ANALYSIS

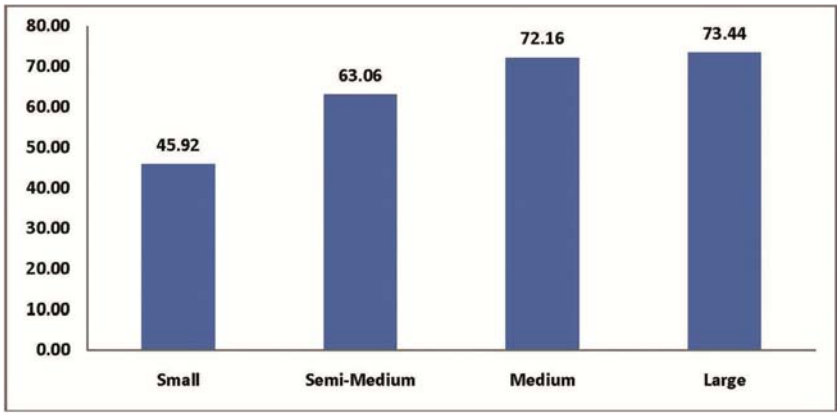
Variable (1)	Description (2)
AGE_HH	Age of Household Head (in completed years)
AGE2_HH	Square of age of Household Head
AGE	Age of individual (in completed years)
AGE2	Square of age of individual
SEX_HH	Sex of household head (Dummy=1, if household head is male, 0 otherwise)
SEX	Sex of worker(Dummy=1, if male; 0 otherwise)
SC	Caste dummy(=1, if household/ individual belongs to SC category, 0 otherwise)
ST	Caste dummy(=1, if household/ individual belongs to ST category, 0 otherwise)
OBC	Caste dummy(=1, if household/ individual belongs to OBC category, 0 otherwise)
HHS	Household size
DR	Dependency rate
TRAINDUM1	Dummy=1, if any member of the household received agricultural training, 0 otherwise
TRAINDUM2	Dummy=1, if individual has received agricultural training, 0 otherwise
EXTENDUM	Dummy=1, if household accessed agricultural extension services any time of the year
PCLAND	Size of land owned per capita(in hectare)
LANDCUL	Size of cultivated land (in hectares)
IRR	Dummy=1, if household has access to irrigation, 0 otherwise
BPRIM_HH	Dummy=1, if household head had below primary education; 0 otherwise
PRIM_HH	Dummy=1 , if household head has read up to primary school, 0 otherwise
MIDDLE_HH	Dummy=1, if household head has read up to middle school; 0 otherwise
SEC_HH	Dummy=1, if household head has secondary education; 0 otherwise
HS_HH	Dummy=1, if household head has high school education and above; 0 otherwise
BPRIM	Dummy=1, if individual had below primary education; 0 otherwise
PRIM	Dummy=1 , if individual has read up to primary school, 0 otherwise
SEC	Dummy=1, if individual has read up to middle school; 0 otherwise
MIDDLE	Dummy=1, if individual has secondary education; 0 otherwise
HS	Dummy=1, if individual has high school education and above; 0 otherwise
HIN	Dummy=1, if household/ individual is Hindu; 0 otherwise
MUS	Dummy=1, if household/ individual is Muslim; 0 otherwise
OFFARM	Dummy=1, if household has access to off-farm income
YIELD	Yield per hectare of cultivated land
NOCROP_OTHRICE	Number of crops grown other than rice
NOCROP_OTHWHEAT	Number of crops grown other than wheat
SEASON	Dummy=1, if *kharif* season; 0 otherwise
OPER_AGRILAND	Dummy=1, if the households to which the worker belongs operated any land for cultivation



Source: Based on Author's calculation of NSSO data

Figure 1. HCI of Rice by Size Class of Land Owned.

small holders at 45.92 indicating that small holder wheat cultivating households on an average sell 45 per cent of their wheat output in the market compared to 73 per cent for large landowners. Clearly, as in the case of rice, the proportion of wheat offloaded in the market increases with increase in size of land owned (Figure 2).



Source: Based on author's calculation from NSSO data.

Figure 2. HCI of Wheat by Size Class of Land Owned.

The incidence of subsistence farming among rice and wheat growers for various categories of owned land is shown in Table 3. It is observed that 53per cent of the small holder rice growers and 61 per cent of small holder wheat growers were engaged in subsistence farming that is, they did not sell any part of their produce. The prevalence of subsistence farming is lower among semi-medium and medium landowners. However, there appears to be a U shaped pattern in the prevalence subsistence farming among land owning groups with large land owners having a higher incidence of subsistence farming. This perhaps can be explained by the fact that large landowners lease out sizeable portions of their cultivable lands and a greater portion of production from self-cultivated land is retained for meeting the consumption requirements of the household.

TABLE 3. PERCENTAGE OF SUBSISTENCE FARMERS BY SIZE CLASS OF LAND OWNED

Land Size	Rice	Wheat
(1)	(2)	(3)
Small holders	53.37	60.48
Semi-Medium	36.36	30.85
Medium	35.18	24.44
Large	49.38	47.52
Total	48.19	51.37

Source: Based on author's calculation from NSSO data.

Table 4 presents the result of the HSM for determining the factors that influence the decision by small holder rice growers to participate in the output market and also the factors affecting the intensity of such participation. The estimates of the selection

TABLE 4. RESULTS OF HECKMAN SELECTION MODEL-RICE

	Outcome equation (HCI)			Selection equation (Y_1)		
	Coefficient	z	P value	Coefficient	z	P value
(1)	(2)	(3)	(4)	(5)	(6)	(7)
AGE_HH	-0.002	-1.18	0.237	0.009	1.63	0.102
Age2_HH	0.000	0.89	0.374	0.000*	-1.87	0.061
Sex_HH	0.007	0.52	0.601	0.068	1.63	0.103
SC	-0.038***	-3.77	0	-0.042	-1.13	0.257
ST	-0.110***	-11.36	0	-0.167***	-4.73	0
OBC	-0.005	-0.61	0.543	-0.054*	-1.91	0.056
HHS	-0.007***	-5.35	0	-0.062***	-12.88	0
DR	-0.044***	-2.92	0.003	-0.015	-0.28	0.782
TRAINDUM1	0.021	1.62	0.105	0.124**	2.35	0.019
EXTENDUM	-0.002	-0.34	0.737	0.244***	11.04	0
LANCUL	0.028***	6.05	0	1.281***	48.78	0
IRR	0.126***	17.37	0	0.415***	17.18	0
BPRIM_HH	-0.050***	-5.13	0	0.051	1.46	0.145
PRIM_HH	-0.050***	-5.26	0	0.058*	1.67	0.094
SEC_HH	-0.015	-1.47	0.141	0.083***	2.57	0.01
MIDDLE_HH	-0.048***	-5.32	0	0.095**	2.46	0.014
HS_HH	-0.027**	-2.56	0.011	-0.020	-0.52	0.605
HIN	-0.080***	-7.51	0	0.095**	2.41	0.016
MUS	-0.149***	-10.9	0	0.253**	4.88	0
SEASON	0.064***	8.4	0	0.543***	18.94	0
OFFARM	-0.049***	-4.76	0	-0.021	-0.54	0.592
Constant	0.803***	16.23	0	-1.366***	-8.33	0
YIELD				0.000***	5.83	0
NOCROP_OTHRICE				0.068***	5.64	0
Mills lambda	-0.027**	-2.1	0.036			
Wald Chi	831.95***					

Source: Based on author's calculation from NSSO data.

***, ** and* Significant at 1, 5 and 10per cent level, respectively.

equation shows that the probability of a small holder household participating in the rice output market is positively impacted if the household has at least one member who has undergone training in agriculture. This is indicated by the positive and significant value of the coefficient of the training dummy (TRAINDUM1). Availability of agricultural extension services also increases the likelihood of small holder participation in the output market for rice. In fact the coefficient for extension services is nearly double the coefficient for training and is significant at one per cent indicating that extension services have a greater impact on the probability of market integration than training. Availability of irrigation facilities exert a potent influence in determining smallholder's access to output markets as does the size of land cultivated by the household. The scope for commercialisation is higher in the *kharif* season given that rice in India is primarily a *kharif* crop. While age and sex of the household head do not seem to be related to household's decision to engage in the output market, education of the household head is found to be exerting a crucial influence. Thus, taking illiterate household heads as the base category, as education level of the household head improves; the likelihood of market participation also increases. However, the dummy relating to higher education was not found to be significant.

Hindu and Muslim households are more likely to be involved in rice output market than households belonging to other religious groups. The probability of participation in the output market declines if the household belong to the ST category and also when the household size increases. The variables YIELD and NOCROP_OTHRICE were introduced in the selection equation to meet the exclusion criterion of HPM. Both the variables have been found to be statistically significant although the co-efficient of YIELD is very small. The availability of off-farm income was not found to be important in explaining the smallholder rice growing households' decision to participate in the product market.[3]

The outcome equation for determining the factors that influence the intensity of commercialisation of rice by small holders reveals that training and extension do not have a significant impact on the value of HCI. Nor were factors relating to age and sex of household head found to be relevant in determining the intensity of commercialisation However, increase in educational attainments of household head were found to lower the extent of rice commercialisation of small holder households. Households belonging to SC and ST communities have a lower average value of HCI compared to forward caste households. Ironically, while Hindu and Muslim households are more likely to engage in the output market for rice compared to other religious groups (as depicted by the selection equation), their intensity of participation in terms of proportion of output marketed is found to be lower than the base category. Increase in the size of land cultivated by small holders and availability of irrigation increases the value of the HCI. On the contrary, increase in household size and dependency rate lowers HCI for small holders. Off-farm income was found to be associated with lower values of HCI. The value of HCI was likely to be higher during the *kharif* season. The coefficient for Mills Lamda is significant implying that the selection equation and outcome equation are not independent. The Wald chi square is significant showing that all regression coefficients in the model are not simultaneously zero. This demonstrates the utility of the model in explaining the determinants of the intensity of commercialisation by small holder households.

We now examine the impact of commercialisation on the monthly per capita income of small holder rice growers. Two different treatment models are estimated. In the first model the treatment variable is a dummy that takes a value one if the household participates in the output market and zero otherwise. In the second model, the dependent variable is also a dummy variable that takes a value one if the HCI for a household is greater than 50 per cent and zero otherwise. Thus, while the first model captures the impact of commercialisation on MPCE, the second model helps us to understand the effects of the intensity of commercialisation on MPCE. Both models have been estimated using two alternative treatment methods, viz., Doubly Robust Estimators (DRE) and Nearest Neighbour Matching (NNM). The results are reproduced in Table 5. According to the DRE, the average treatment effect of the first model is INR 59.66 rupees and that of the second model is INR117.34. According, to NNM, the values of the ATE in the first and second models are INR 100.33 and

INR162.30 respectively. The difference in the estimates obtained from the two methods notwithstanding, the results of the TEM shows that commercialisation of rice increases the MPCE of small holder households. Further, the benefits from commercialisation are larger at higher levels of commercialisation.

TABLE 5. EFFECT OF COMMERCIALISATION OF RICE ON MPCE

	Model 1			Model 2		
Treatment method	Coefficient	z	P value	Coefficient	z	P value
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Doubly robust estimators	59.66***	2.78	0.005	117.34***	4.21	0
Nearest neighbour matching	100.33***	3.57	0	162.30***	3.82	0

Source: Based on author's calculation from NSSO data.
*** Significant at 1 per cent.

The results of the HSM for wheat are shown in Table 6. As in the case of rice, training and extension have been found to positively influence the decision to participate in the output market (selection equation) but these variables were not found to be having any significant impact on the intensity of commercialisation (outcome equation) of wheat output. Apart from training and extension, the other factors which had a positive impact on the decision to participate in the product

TABLE 6. RESULTS OF HECKMAN SELECTION MODEL-WHEAT

	Outcome equation (HCI)			Selection equation(Y_2)		
	Coefficient	z	p value	Coefficient	z	p value
(1)	(2)	(3)	(4)	(5)	(6)	(7)
AGE_HH	0.001	0.49	0.623	0.003	0.34	0.737
AGE2_HH	0.000	-0.8	0.426	0.000	-0.42	0.673
SEX_HH	-0.005	-0.28	0.776	0.123	1.86	0.062
SC	0.007	0.44	0.662	-0.139***	-2.41	0.016
ST	-0.033*	-1.96	0.05	0.140**	2.1	0.036
OBC	-0.034***	-3.51	0	-0.019	-0.47	0.639
HHS	-0.008***	-5.29	0	-0.046***	-7.32	0
DR	0.002	0.1	0.924	-0.129	-1.62	0.104
TRAINDUM	0.010	0.88	0.378	0.131**	2.21	0.027
EXTENDUM	0.015	1.87	0.061	0.203***	6.05	0
LANDCUL	0.054***	6.9	0	1.572***	37.25	0
IRR	0.027	1.26	0.207	0.699***	10.94	0
BPRIM_HH	0.023	1.6	0.109	-0.002	-0.03	0.974
PRIM_HH	0.011	0.75	0.453	-0.014	-0.23	0.815
SEC_HH	-0.006	-0.42	0.674	0.060	1.16	0.246
MIDDLE_HH	-0.016	-1.3	0.195	0.023	0.41	0.683
HS_HH	-0.007	-0.52	0.603	0.076	1.35	0.178
HIN	-0.113***	-6.93	0	-0.751***	-7.72	0
MUS	-0.068***	-3.3	0.001	-0.453***	-4.09	0
OFFARM	-0.014	-1.68	0.093	-0.243***	-7.22	0
CONSTANT	0.701***	11.25	0	-1.078***	-4.37	0
YIELD				0.000***	7.07	0
NOCOTH_WHT				0.102***	5.98	0
Mills Lamda	-0.0373**	-2.37	0.018			
Wald Chi2	180.8***					

Source: Based on author's calculation from NSSO data.
*** and ** Significant at 1 and 5 per cent level, respectively.

market are size of cultivated land, yield per hectare, number of crops grown other than wheat and availability of irrigation facilities.ST households also are more likely to engage in the output market for wheat compared to general caste households. The factors which reduce the probability of output market participation in case of wheat are household size and availability of off-farm income. Hindu and Muslim households also had lower probability of participating in the output market compared to other religious groups.[4]

The outcome equation of table which reports the determinants of the intensity of wheat commercialisation reports only a few significant factors. Thus, ST and OBC households are likely to have lower intensity of wheat commercialisation than forward caste. The value of HCI increases with every increase in the size of cultivated land and decreases with an increase in household size. Hindu and Muslim households are likely to have a lower value of HCI on an average than households of the base category. The Mills Lamda is significant indicating that the Selection and Outcome equations are not independent and that the use of the HSM is justified. The Wald chi square test statistic has also been found significant. Thus, the null hypothesis that all coefficients in the equation are simultaneously equal to zero is rejected.

The implications of market integration among small holder wheat growers for MPCE are depicted in Table 7. The specification of the TEM in case of wheat is the same as that of rice. Thus, two TEM are estimated. In the first model, the dependent variable is a dummy that takes the value one, if a household offloads a portion of its produce in the output market and is zero. In the second model, the dependent variable is also a dummy that takes the value one if a household sells more than 50 per cent of its produce and is zero otherwise, both models have be used employing two different methodologies to check for robustness. The DRE for the first TEM shows that if a household participates in the output market, its MPCE is likely to be higher by INR 60 on an average compared to a household that engages in the subsistence farming of wheat. The estimates of the same model using the NNM method, puts the value of the ATE at 67.27. In both the cases, the value of the ATE has been found to be significant. In case of the second TEM, the value of the ATE obtained by DRE technique is INR 90.82 and that obtained by NNM method is 102.43. Again, both coefficients are positive and significant. The comparison of the two models indicates that higher levels of market integration on the output side are associated with better welfare outcomes.

TABLE 7. EFFECT OF COMMERCIALISATION OF WHEAT ON MPCE

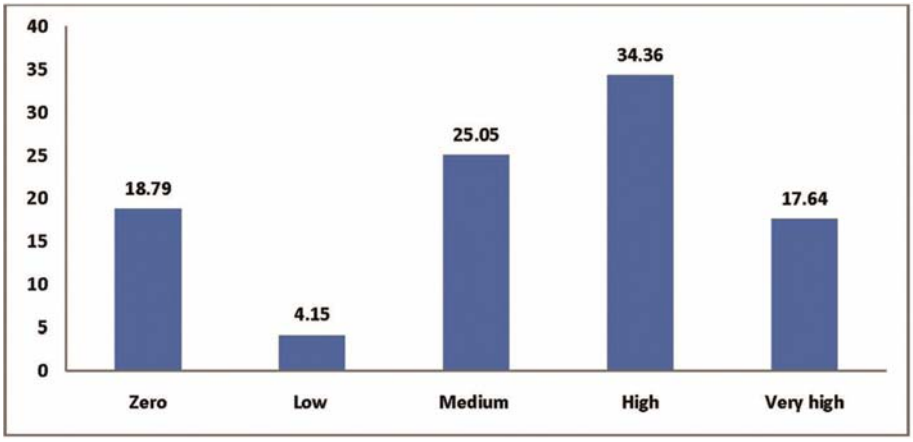
	Model 1			Model 2		
Treatment method	Coefficient	z	P value	Coefficient	z	P value
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Doubly robust estimators	51.64**	2.28	0.022	90.82***	3.40	0.01
Nearest neighbour matching	67.27***	2.62	0.009	102.43***	3.69	0

Source: Based on author's calculation from NSSO data.

*** and ** Significant at 1 and 5 per cent level, respectively.

3.3 *Impact of Agricultural Skilling on Crop Diversification*

The distribution of small landowners by various categories of CDI is shown in Figure 3.About 18.79 per cent of the small holders cultivate only one crop throughout the year, i.e., they have zero value of CDI. Less than 4 per cent of the small holders have CDI between zero and 0.25. About a quarter of the households have CDI in the medium range while 34 per cent of the households had high level of CDI. 17.64 per cent of the small holder households had CDI value of greater than .75 Thus, more than half of the small land owing households had CDI scores above .50.



Source: Based on author's calculation from NSSO data.

Figure 3.Distribution of CDI for Small Landowners.

The results of the Tobit regression shown in Table 8 depict the determinants of crop diversification among small holder households. It is observed that irrigation is the single most important factor influencing the CDI. Availability of irrigation on an average increases the CDI by 0.19. If the household has at least one member who has received formal training in agriculture the CDI increases by 0.034 units. Likewise availability of extension services increases CDI by 0.060 units. An increase in the educational attainment of the head of the household head increases the value of the CDI. Increase in per capita land owned and access to off-farm earnings also enhances the value of CDI by 0.048 and 0.045 units respectively. The CDI of female headed households is less than that of male headed households by 0.033 units indicating that female headed households are likely to be less diversified compared to male-headed households. The value of CDI tends to be lower for SC, ST and OBC households compared to general category households. Although the value of the coefficients of age and household size are statistically significant, the absolute size of coefficients is very small.

TABLE 8. DETERMINANTS OF CROSS DIVERSIFICATION: MARGINAL EFFECTS OF TOBIT REGRESSION

Variable	Coefficient	z	P value
(1)	(2)	(3)	(4)
AGE_HH	0.003***	2.57	0.01
AGE2_HH	0.000	-1.39	0.163
SEX_HH	-0.033***	-3.99	0
BPRIM_HH	0.022***	3.04	0.002
PRIM_HH	0.053***	7.21	0
MIDDLE_HH	0.052***	7.59	0
SEC_HH	0.031***	3.92	0
HS_HH	0.048***	5.97	0
HIN	-0.125***	-15.69	0
MUS	-0.056***	-5.36	0
HHS	0.007***	6.32	0
DR	0.012	1.12	0.265
IRR	0.191***	38.32	0
PCLAND	0.048***	3.36	0.001
TRAINDUM	0.034***	3.04	0.002
EXTENDUM	0.060***	13.04	0
SC	-0.037***	-4.8	0
ST	-0.014***	-1.91	0.056
OBC	-0.045***	-7.92	0
OFFARM	0.045***	5.13	0
LR Chi2	2407.84***		0

Source: Based on author's calculation from NSSO data.
*** denotes significant at 1 per cent

The outcome of treatment effect model for analysing the impact of crop diversification on monthly per capita expenditure of households is shown in Table 9. Here, it may be mentioned that CDI is calculated by considering gross cropped area of a household for the entire agricultural year. However, the data sets reports monthly household expenditure for two seasons, viz., *kharif* and *rabi* on a 30 day recall basis. Hence, for evaluating the impact of crop diversification on MPCHE, we take the average of the two values reported for each agricultural season. Two types of treatment are considered. In the first case, the treatment dummy takes a value 1 if the value of CDI for a household is greater than zero and is zero otherwise. In the second case, the treatment dummy takes a value 1 if the CDI of a household is greater than .5 and is zero otherwise. Thus while the first TEM helps in assessing the average impact of crop diversification on MPCE, the second model enables us to have an idea of the impact of higher diversification. As in the case of HCI, here also the two models are estimated using two different treatment methods. The doubly robust estimators show that after matching for baseline covariates, the MPCE of a household practicing crop diversification is likely to be higher than a household for which CDI is zero by INR 155. According to the estimates obtained using nearest neighbour matching method, the average gain in MPCE resulting from treatment is about INR185. Similarly, in case of the second model, it is found that the average treatment effects employing the doubly robust estimators and nearest neighbour estimators were INR 210 and INR 229 respectively. Hence, two conclusions can be drawn from the aforesaid analysis.

Firstly, notwithstanding the difference in estimates arising from different treatment methods, it may be concluded that small holder households opting for crop diversification are likely to have higher MPCE compared to those households who specialise in the production of a single crop. Secondly, the gains in MPCE are likely to increase with increase in the value of the CDI.[5]

TABLE 9. EFFECT OF CROP DIVERSIFICATION ON MPCE

	Model 1			Model 2		
Treatment method	Coefficient	z	P value	Coefficient	z	P value
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Doubly robust estimators	154.65***	10.53	0	210.21***	15.89	0
Nearest neighbour	185.14***	12.44	0	229.24***	16.58	0

Source: Based on author's calculation from NSSO data.
*** significant at 1 per cent.

3.4 *Effects of Skilling on Occupational Choice of Workers*

The effect of agricultural skilling on occupational choice of workers aged 15-64 years from small holder households has been analysed using five mutually exclusive occupational categories. Thus, five different outcome models have been estimated each for a specific type of employment. The selection equation for labour force participation is however the same in all cases. The specification of the outcome equations in the five cases are shown in Table 10.

TABLE 10. DESCRIPTION OFDEPENDENTVARIABLES IN THE OCCUPATION CHOICE MODELS

Model	Dependent variable
(1)	(2)
Model 1	Z_1=1, if the worker is self-employed in agriculture, 0 otherwise
Model 2	Z_2=1, if the worker is an employer engaged in agriculture, 0 otherwise
Model 3	Z_3=1, if the worker is an unpaid family worker engaged in agriculture, 0 otherwise
Model 4	Z_4=1, if the worker is engaged in regular/salaried jobs, 0 otherwise
Model 5	Z_5=1, if the worker is engaged in casual daily wage based employment, 0 otherwise

The LFPR (selection) equations estimated for each model contain the same variables and yield more or less the same conclusions (Table 11). The probability of a person participating in the labour market increases with an increase in age; however, the same probability decreases with further increase in the age of the individual. Males are more likely to seek employment than females. Individuals belonging to SC, ST and OBC households have higher probability of participating in the labour market compared to those from forward caste households. Taking illiteracy as the base education category, an increase in educational base of a person is accompanied by a reduction in the probability of seeking employment in the labour market. Interestingly, the absolute size of the co-efficient related to an educational dummy increases with every increase in the level of education. Probability of labour market participation also falls for every increase in household size. The co-efficient relating

TABLE 11. DETERMINANTS OF LABOUR FORCE PARTICIPATION - SELECTION EQUATION

	Model 1		Model 2		Model 3		Model 4		Model 5	
Variables	Coefficient	z	Coefficient	z	Coefficient	z	Coefficient	z	Coefficient	z
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
AGE	0.189***	116.97	0.188***	117.06	0.188***	116.9	0.188***	116.87	0.187***	115.54
AGE2	-0.002***	-100.59	-0.002***	-101.05	-0.002***	-100.27	-0.002***	-100.85	-0.002***	-99.67
SEX	1.386***	175.34	1.378***	175.58	1.401***	170.92	1.378***	175.51	1.371***	173.39
BPRIM	-0.156***	-11.41	-0.157***	-11.55	-0.163***	-12.05	-0.157***	-11.52	-0.152***	-11.19
PRIM	-0.113***	-8.9	-0.110***	-8.66	-0.124***	-9.84	-0.109***	-8.56	-0.102***	-8.08
MIDDLE	-0.179***	-16.05	-0.176***	-15.8	-0.204***	-18.26	-0.174***	-15.67	-0.167***	-15.05
SEC	-0.368***	-29.85	-0.363***	-29.49	-0.388***	-31.45	-0.361***	-29.33	-0.352***	-28.64
HS	-0.390***	-31.78	-0.380***	-31.27	-0.423***	-34.77	-0.378***	-31.07	-0.368***	-30.11
TRAINDUM2	0.589***	14.88	0.591***	14.93	0.563***	14.49	0.590***	14.88	0.597***	15.02
SC	0.186***	15.31	0.188***	15.43	0.183***	15.26	0.189***	15.52	0.189v	15.63
ST	0.543***	50.02	0.549***	50.72	0.517***	48.75	0.550***	50.68	0.548***	50.97
OBC	0.190***	22.31	0.191***	22.39	0.159***	18.87	0.193***	22.56	0.197***	23.16
PCLAND	0.456***	16.61	0.389***	14.76	0.748***	26.41	0.391***	14.76	0.359***	13.86
HHS	-0.007***	-4.76	-0.012***	-9.42	-0.024***	-21.78	-0.013***	-9.34	-0.019***	-13.56
HIN	0.228***	26.94	0.234***	27.33	0.216***	30.6	0.230***	26.5	0.237***	28.64
DR	-0.048***	-3.55	-0.016	-1.24	-0.058***	-5.26	-0.016	-1.18	-0.018	-1.4
OPER_AGRILAND	-0.064***	-3.71	-0.077***	-4.44	-0.176***	-9.8	-0.077***	-4.44	-0.062***	-3.6
CONSTANT	-4.068***	-113.18	-4.016***	-113.06	-4.150***	-117.62	-4.013***	-112.76	-3.972***	-110.87

*** significant at 1 percent; ** significant at 5 percent.

to dependency rate is negative across all equations but significant only in the first and third models. Compared to other religious groups, an individual from a Hindu household has higher probability of participation compared to other groups. The probability of a person entering the labour market is higher for an individual who has received training in agriculture compared to an individual with no agricultural training. An individual belonging to a household that operates agricultural land has lower probability of labour market engagement.

The results of the outcome model relating to employment choice given in Table 12 are summarised below.

(1) The probability of a person being self-employed in positively and significantly associated with training, age, size of land available per capita and involvement in agricultural operations. Among the factors that increase the possibility of a person pursuing self-employment activities in agriculture, the coefficient relating to the training dummy is quite large. Males and ST workers are also more likely to pursue this vocation. As educational base improves, the likelihood of self-employment in agriculture declines monotonically. This can be inferred from the growing absolute size of the coefficients of dummies pertaining to higher levels of education.

(2) Agricultural training also significantly enhances the probability of an individual being an employer within the agricultural sector. The coefficient relating to the training dummy in the second model is .224 and it has been found to be statistically significant. An improvement in the educational base of the workers also increases the scope for a person to act as an employer in agriculture. However, SC, ST and OBC households are less likely to act as employers as are female workers. Size of per capita land holding is the single most important factor influencing employment in this category.

(3) The results of the third model reveals that a person receiving training in agriculture is less likely to be employed as unpaid family worker in agriculture. SC, ST and OBC workers are also less likely to be involved in unpaid family work compared to workers from forward caste. Interestingly, a worker with better education is more likely to engage himself in unpaid agricultural work within the household compared to a person with no education. Per capita land and operation of agricultural holdings again stand out as very important factors that positively impact on employment in this category.

4) The probability of a person being engaged in regular salary/ wage based employment is lower if the individual has received agricultural training. The likelihood of pursuing this vocation is also negatively related to both the size of per capita land holding and the dummy for the operation of agricultural holdings. The last result reveals that if the worker belongs to a cultivating household he has lower probability of pursuing wage based employment. SC, ST and OBC workers also have lower possibility of being engaged in wage based employment as do female workers.

(5) The results of the last model displays the very important finding that a worker who has received agricultural training is less likely to pursue casual daily wage-based

TABLE 12. DETERMINANTS OF OCCUPATIONAL CHOICE - OUTCOME EQUATION

	Model 1		Model 2		Model 3		Model 4		Model 5	
Variables	Coefficient	z	Coefficient	z	Coefficient	z	Coefficient	z	Coefficient	z
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
AGE	0.170****	69.61	0.107****	15.69	-0.173****	-100.92	0.048****	7.25	-0.061****	-14.59
AGE2	-0.002****	-53.64	-0.001****	-11.95	0.002****	81.81	-0.001****	-7.64	0.001****	10.4
SEX	1.240****	92.99	0.643****	19.16	-1.616****	-190.36	0.208****	4.41	-0.108****	-3.32
BPRIM	-0.008	-0.56	0.126****	2.97	0.044****	3.41	0.216****	7.73	-0.092****	-5.56
PRIM	-0.019	-1.33	0.270****	6.83	-0.010	-0.82	0.387****	15.72	-0.152****	-9.77
MIDDLE	-0.164****	-12.44	0.298****	8.44	0.101****	9.14	0.563****	25.37	-0.254****	-16.48
SEC	-0.231****	-15.08	0.298****	7.74	0.185****	14.74	0.820****	32.54	-0.343****	-16.53
HS	-0.498****	-32.46	0.197****	5	0.112****	8.93	1.323****	55.48	-0.642****	-26.14
TRAINDUM2	0.297****	11.76	0.224****	4.65	-0.384****	-14.42	-0.178****	-4.35	-0.231****	-7.05
SC	-0.017	-1.08	-0.042	-1.02	-0.223****	-18	-0.098****	-4.29	0.248****	14.7
ST	0.087****	6.84	-0.654****	-12.2	-0.284****	-27.38	0.013	0.62	0.053****	3.11
OBC	0.006	0.53	-0.037	-1.53	-0.078****	-9.25	-0.085****	-5.43	0.016	1.29
PCLAND	0.682****	24.43	1.008****	21.09	0.285****	11.97	-0.710****	-13.37	-1.780****	-33.86
OPER_AGRILAND	0.232****	9.08	0.603****	4.41	0.600****	29.45	-0.258****	-9.16	-0.582****	-28.35
CONSTANT	-5.679****	-95.8	-6.459****	-31.44	4.177****	106.6	-2.664****	-14.27	1.757****	15.9

**** significant at 1 percent; *** significant at 5 percent.

occupations. This is evident from the negative and significant value of the training dummy. Expectedly, workers with higher levels of education are less likely to pursue casual jobs. However, SC, ST and OBC workers are more likely to be involved in these activities that entail great physical labour and drudgery. Individuals belonging to households that cultivate land for agricultural purposes are less likely to be engaged in these jobs. Likewise, the increase in per capita availability of land also lowers the possibility of employment based on daily wages. As indicated by the sex dummy, male workers are less likely to be employed in casual activities compared to female workers. As age increase the probability of employment in these jobs decline. However, the co-efficient of age (squared) is positive indicating that people beyond a certain age who participate in the labour market are perhaps compelled to work as daily wage based labourers in the absence of other assets.

IV

SUMMARY AND CONCLUSION

This paper has evaluated the determinants of three crucial aspects of small holder farming in India with special reference to the role of agricultural training and extension services. The household data shows that less than 2.5 per cent of the workers (in the age group 15-64 years) belonging to agricultural households have received formal training in agriculture. While access to extension services are more widespread, yet about 40 per cent of the sample households did not have access to any kind of extension facilities. There is also likely to be a wide variability in the availability of such services across the country. The prevalence of subsistence farming was comparatively higher among small holders; further, the average value of the HCI was also low among small holders indicating low intensity of commercialisation. The results of regression analysis show that agricultural training and extension have a positive influence on determining a small holder household's decision to participate in the output market for both rice and wheat crops. However, these factors were not found to be strong enough in explaining the intensity of participation as the coefficient attached to these factors although still positive were not statistically significant. Apart from training and extension services, other factors were also found to be important in explaining both the decision to participate as well as the intensity of such participation notable among which were the availability of irrigation facilities and size of cultivated land. The results of the TEM reveals that after adjusting for differences in household background characteristics, involvement in commercialisation of staples by small holders has a positive influence on the MPCE of these households. Further, the gains from commercialisation rise as the intensity of commercialisation increases. Training and extension services were found to be pivotal in influencing crop diversification among small holders. However, availability of irrigation was found to be the single most important factor in determining crop diversification. The factors such as education of the household

head, size of per capita land owned and availability of off-farm earnings were also found to be having a positive impact on the value of the diversification index. Possibly, the processes of commercialisation and diversification are not entirely independent of each other as diversified cropping systems may provide a sense of income security to small holder households to offload a greater part of the production of staples in the market. The HSM for both rice and wheat showed that the probability of participating in the output marker is higher for those households which grow other crops along with the staple crop during the course of the agricultural year. As in the case of commercialisation, crop diversification produces beneficial welfare effects in terms of gains in MPCE. Also, the size of these gains is higher at higher levels of diversification. The average increments in MPCE associated with crop diversification among small holders was found to be larger than those from commercialisation of staples. Lastly, skilling of workers were found to be increasing the likelihood of self-employment in agriculture besides enhancing the probability of an individual acting as an employer within the agricultural sector. Skilling also reduced the probability of an individual engagement in unpaid family work. However, the most important outcome of skilling was seen in terms of its effect on reducing the possibility of casual daily wage based employment among workers of small holder households. In view of the potential gains from skilling, it can therefore be argued that the scope of skill development in agriculture should be extended on a massive scale. This assumes added significance in view of the fact that only a miniscule portion of the workers in the rural areas have access to such training. The gaps in the availability of extension services also need to be closed. The setting up of the Agricultural Skill Council of India and current emphasis on revamping the extension services provided by Agricultural Universities and Krishi Vikas Kendras in the country is a welcome step in the right direction.

NOTES

1) The HSM incorporates a variable called Mills Lambda in the outcome equation to correct for self-selection A significant value of Mills lambda rejects the null hypothesis that the Selection and Outcome Models are independent.

2) Although the HCI is a censored variable with upper limit at one and lower limit at zero, the Heckman Selection Model in STATA does not permit the estimation of Tobit model in the outcome equation. Hence, linear model is used.

3) Factors such as availability of insurance, awareness about minimum support prices and credit can also have a significant impact on commercialisation of rice and wheat. These variables were however found to be highly correlated with both training and extension services. Hence, these factors were not incorporated directly into the regression analysis to avoid problem of multi-collinearilty as their combined effect can be represented by yhat of training and agricultural extension.

4) The dummy for seasonal variation was not included in the HSM model of wheat as there were no small holder households involved in wheat production during *kharif* season.

5) The CDI is calculated by taking into account the share of various crops in gross cropped area for the entire agricultural year from July 2012 to June 2013. However, the NSSO data reports monthly consumption expenditure on 30 day recall basis during both the visits. To evaluate the impact of crop diversification on MPCE, we take the mean monthly expenditure of a household from both schedules. In case of those households which were not included in the second schedule, the monthly consumption expenditure for the first visit was considered.

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