Agricultural Economics Research Review 2018, 31 (2), 259-269
DOI: 10.5958/0974-0279.2018.00043.5

Technology adoption by small-scale full-time and part-time family farm households in the subtropics of Jammu & Kashmir

Rajinder Peshin*, Rakesh Sharma, Raj Kumar, Laxmi K Sharma, Sudhakar Dwivedi, Rakesh Nanda, Vinod Gupta, Kernel S Risam

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, Jammu-180009, Jammu and Kashmir, India

Abstract This paper has assessed technology adoption and its impact on the agricultural productivity for small-scale full-time and part-time farm households in the subtropical region of Jammu & Kashmir (J&K). We find only 24% of the farm households being exclusively dependent on farming for their livelihoods. For the remaining households, agriculture is a secondary economic activity. They are engaged in nonfarm economic activities, and use more of external inputs, such as fertilizers and pesticides than do the full-time farm households. The high-yielding varieties, irrigation, herbicides and nitrogenous fertilizers are identified as important determinants of crop yield.

Keywords Family farms, On-farm income, Nonfarm income, Input use, Productivity

JEL classification Q10, Q12, Q16

1 Introduction

Globally, there are more than 500 million family farms, occupying approximately 70%–80% of the farmland and producing more than 80% of the food, in terms of value (FAO 2014). Of these, 138.35 million farms are in India (MoA 2014), 85% of which are of size less than or equal to 2 hectares. These small family farms have steered the Green Revolution, leading the country into an era of self-sufficiency in food—between 1966 and 2017 the food grain production increased almost three-fold from 72 million tons to 285 million tons.

Farm families are also engaged in nonfarm economic activities (FAO 2014). In India, although agriculture is considered the main source of income for farm households, nonfarm economic activities also contribute significantly (44%) to their incomes (Birthal et al. 2014). Such a diversification toward nonfarm activities is considered important to provide economic sustainability to the livelihoods of farm households (Lanjouw & Shariff 2004; de Janvry et al. 2005) as the small-scale farming alone cannot provide economic prosperity. The evidence from a survey of 5000 farm households across India in 2014, conducted by the Center for the Study of Developing Societies and Lokniti, shows that three-fourths of the farmers prefer occupations other than agriculture, and 60% of them wish their children to migrate to cities rather remaining in agriculture (CSDS 2014).

The Himalayan state of Jammu and Kashmir (J&K) has 1.45 million family farms with an average landholding of 0.62 ha. More than 95% of these are small farms measuring less than or equal to 2ha (GoJ&K 2017). As expected, these small farms alone cannot provide an adequate livelihood, and supplement their livelihoods through several other non-farm economic activities. This is also likely to influence agricultural productivity via adoption of modern technologies and inputs. In this paper, our aim is to identify households engaged simultaneously in agriculture and nonfarm activities and compare their farm performance with those exclusively engaged in agriculture.

*Corresponding author: rpeshin@rediffmail.com

2 Data

The Jammu region of J&K state has three types of climate: temperate, intermediate, and subtropical. This study pertains to the subtropical region covering districts of Jammu, Samba, Kathua, and Udhampur. The district of Jammu located between 74°24′ and 75°18′ E and 32°50′ and 33°30′ N covers an area of 3,097 km^2. Kathua district spans from 32°17′ to 32°55′ N and 75°70′ to 76°16′ E and occupies an area of 2,651 km^2. Udhampur is located between 32°34′ to 39°30′ N and 74°16′ to 75°38′ E spreading over an area of 2,380 km^2. Samba district is located between 75°70′ E and 32°33′ N and covers an area of 1,002 km^2.

The characteristic features of the subtropical region are: the high mountain ranges (300–800 m above mean sea level), hot summers and relatively dry winters, and preponderance of alluvial soils. Most landholdings in these districts are small (90%) and the average area of landholdings is 0.84 ha.

Wheat is the main crop in the region, hence our focus is on wheat-growing households. A multistage stratified random sampling technique was used to select wheat-growing households to collect the required information. In the first stage, we selected districts from the subtropical belt, and from the selected districts, agricultural sub-divisions where wheat is the main winter crop were selected. These subdivisions are: Akhnoor, Marh, R S Pura in Jammu district, Hira Nagar in Kathua, Samba in Samba district, and Udhampur in Udhampur district. A list of farm households that sold wheat to government agencies, mainly the Food Corporation of India, was prepared for selecting a sample of 144 farm households from a total of 1,559 households in 60 villages. In addition, a sample of 91 farm households that did not sell their surplus wheat to the government agencies was also selected from a total of 666 households in 10 villages.

As to know whether farmers exclusively earn their livelihoods from farming or are also engaged in nonfarm economic activities, the sample farm households were divided into two categories: only on-farm households (OFH) that earn livelihood exclusively from farming, and nonfarm households (NHF) that pursue agriculture as a secondary occupation or are economically supported primarily by nonfarm economic activities.

The data were collected in a pre-tested structured interview schedule that comprised of three sections. The first section contained information on demography (age, education, family size, and experience in farming), economic activities (number of on-farm and off-farm working family members), biophysical information (farm size, leased-in and leased-out areas, irrigated or unirrigated area, and sources of irrigation), and market infrastructure (distance from market, and seed and agrochemical shops). The second section contained information on the use of inputs (seeds, fertilizers, herbicides, fungicides, insecticides, and irrigation), cultivation practices, paid-out costs, and crop yield. The third section contained information on marketed surplus wheat and market price. The data pertain to 2013-14.

3 Empirical methods

A linear production function of the following form was estimated to measure variation in crop yield caused by use of inputs and other control variables.

$$Y = \mathrm{b}_0 + b_i x_i + u_i \qquad \ldots(1)$$

In Equation (1), Y is yield in kg/ha, b_0 is intercept, and x is a vector of explanatory variables that includes seed rate (kg/ha), seed generation or progeny of seed sown, higher yielding variety, nutrient applications (N, P, K, and zinc sulfate in kg/ha) and their frequency of application), frequency of herbicide and fungicide applications, frequency of irrigations, and farm size (ha). Equation (1) has been estimated stepwise, where one variable is added to at each step, and the added variable is the one that induces the maximum reduction in error sum of squares. It is also the variable that has the maximum partial correlation with the dependent variable.

To assess effects of key socio-personal, economic, biophysical and market variables on farmers' decision regarding input use a binary logistic regression has been estimated. Scores of "1" and "0" are assigned for "input use" and "no input use," respectively. A forward stepwise criterion is followed to select the variables with highest predicting powers. At each step, the predictor that makes largest contribution to the prediction is added. For including the predictors in the model, a default value of 5% significance level is adopted. The logit model defined as a natural log of odds, i.e. p/1-p can be written as:

$$\mathrm{Ln}[p/1\text{-}p] = b_0 + b_1x_1 + b_2x_2 + b_3x_3 \ldots b_kx_k \qquad \ldots(2)$$

In Equation (2), p is the probability of outcome, b_0 is the intercept, and x_1 to x_k represent the predictors, namely age of the family member actively involved in farming (in years), education of the family member actively involved in farming (years), farming experience of the family member actively involved in farming (years), size of the family (number of family members), farm size (ha), owned land (ha), leased-in land (ha), leased-out land (ha), irrigated area (ha), area under wheat crop (ha), unirrigated farm (ha), canal irrigation (1 for canal irrigation, 0 for no canal irrigation), minor irrigation (1 for tube-well, 0 for no tube-well), source of income (1 for nonfarm income, 0 for exclusively on-farm income), market distance (km), telephone connectivity (1 for telephone or mobile, 0 for no connectivity), and membership of any organization (1 for membership, 0 for no membership). For validation of the model, the chi-square and Hosmer and Lemeshow's goodness-of-fit tests are used, and only the cases that are correctly classified have been considered. The Nagelkerke R^2 is used as a measure of determination of variation caused by the predictors.

4 Results

4.1 Descriptive statistics

Table 1 compares key characteristics of NFH and OFH households. We do not observe any significant difference in the level of formal schooling, farm size, and leased-in land between the NFH and OFH. The NFH families lease-out larger land areas than do the OFH farm families. On average, farm households in the NFH group have significantly larger unirrigated areas than the OHF group ($p = 0.068$). The family size is larger in the NFH group than in the OHF group.

Table 1. Descriptive statistics of the respondent farmers

Particular	NFH (n = 171)	OFH (n = 54)	Difference	p-value
Average age (years)	52.25 ± 13.13	47.46 ± 12.82	4.79**	0.020
Average formal schooling years	8.78 ± 4.03	8.28 ± 3.71	0.50	0.416
Education level (% farmers)				
Illiterate	12	11	01	0.842
Up to primary	11	06	05	0.281
Up to middle	13	31	18**	0.002
Up to matriculate	39	39	00	1.000
10 + 2 (senior secondary)	13	07	06	0.230
Graduation and above	12	06	06	0.211
Average operational landholding (ha)	2.44 ± 3.94	2.32 ± 1.90	0.12	0.841
Own land (ha)	2.01 ± 2.97	1.99 ± 1.54	0.02	0.936
Leased in (ha)	0.45 ± 1.48	0.33 ± 0.87	0.12	0.632
Leased out (ha)	0.02 ± 0.13	00 ± 00	0.02**	0.046
Irrigated (ha)	1.94 ± 3.13	2.04 ± 1.91	0.10	0.831
Unirrigated (ha)	0.50 ± 1.38	0.28 ± 0.59	0.22*	0.068
Farm size (% farmers)				
< 1ha (Marginal)	36	31	05	0.501
1–2ha (Small)	28	19	09	0.188
2–4 ha (Semi-medium)	21	28	07	0.284
4–10 (Medium)	12	22	10*	0.068
> 10 ha (Large)	03	00	03	0.197
Average farming experience (years)	22.61 ± 14.09	22.09 ± 12.06	0.52	0.790
Average family size (number)	7.47 ± 4.40	5.34 ± 2.16	2.13**	0.001
Distance from the nearest market (km)	2.89 ± 2.84	3.98 ± 3.65	1.09**	0.048

**Significant at <5% level, *Significant at <10% level. Decimals in case of percent of farmers have been rounded up to the nearest whole number, ± standard deviation

Table 2. Sources of income of sampled farm households

Source of income	No.	%
Farm households having farm income	225	100
Farm households exclusively dependent on-farm income[1]	54	24
Crop income	54	100
Livestock income	06	11
Farming as the major source of income	65	29
Farm households having nonfarm income[1]	171	76
Off-farm employment income (government sector)[1]	92	54
a. Active employment	92	54
b. Retired with pension	31	18
Off-farm employment income (private sector)	44	26
Agricultural wage income	07	04
Non-agricultural wage income	14	08
Self-employed income	55	32
Other sources	07	04

[1]Multiple responses.

4.2 Economic activities

Contrary to our expectation, only a small proportion (24%) of the total farm households are found exclusively dependent on farming activities (OFH group). The remaining households are more involved in nonfarm economic activities (NFH group) (Table 2). The nonfarm economic activities of NFH include: government employment, pensions, private sector employment, and self-employment (including retail shop keeping and running agri-enterprises). The average family size is 7.47 and 5.34 persons in the NFH and OFH groups, respectively.

Farm households engaged in nonfarm activities are studied using binary logistic regression model to understand the factors underlying their participation in nonfarm activities. Overall, participation in the nonfarm work is positively impacted by family size (Table 3). The employment income (employment in the organized or government sector) is positively influenced by family size, education, and age. Self-employment is positively influenced by farm size, and wage income is negatively associated with education. Of the total 1569 family members in 225 farm households 47% have participated in work, and of these 27% participated in farm activities.

4.3 Production practices and input use

Table 4 compares use of inputs by the OFH and NFH groups. The use of agrochemicals is not significantly different in the two groups. The use of fertilizers, namely, nitrogenous, diammonium phosphate (DAP), and herbicide use is widespread. However, the use of murate of potash (MOP) and the recommended micronutrient, that is, zinc sulfate is low. Fungicides are used by farmers for managing wheat rust. None of the farmers from either group has applied insecticides. Herbicides are not applied by those who have no access to irrigation (27%).

The use of other inputs also does not differ significantly between NFH and OFH groups, except that of zinc sulfate (Table 4). In irrigated wheat, all the farmers in both the groups have applied herbicides (namely, isoproturon 75WP, metribuzin 70WP, clodinafop 15WP, and sulfosulfuron 75WG) mainly to control *Phalaris minor*. Against broadleaf weeds, 2,4-D ethyl ester 38EC (2-4 D), mesosulfuron + iodosulfuron 3.6 WDG, and metsulfuron methyl 20WG are also applied. The use of isoproturon, which was the herbicide of choice in the 1990s, reduced, and it has been replaced by low-volume herbicides. However, 2,4-D is still a widely used herbicide against broadleaf weeds.

4.4 Factors affecting input use

Few differences are available in the input use between the NFH and OFH groups, we delineated the factors affecting input use (Table 5). In case of nitrogenous fertilizers, although the difference between OFH and NFH is not significant, employment income caused a

Table 3. Factors affecting diversification towards nonfarm employment

	B	S.E	Wald	p-value	Model summaries
				Overall	
Constant	-0.155	0.412	0.142	0.706	–2loglikilihood= 232.444, R^2=0.094, χ^2=14.439, df=1, p value=0.00, predicted %=74.9
Family size	0.209	0.067	9.641	0.002	
				Nonfarm employment income	
Constant	-4.501	0.914	24.234	0.000	–2loglikilihood=267.909, R^2=0.196, χ^2=35.067 df=1, p value=0.00, predicted %= 71.3
Age	0.058	0.012	9.759	0.002	
Education	0.115	0.041	7.760	0.005	
Family size	0.174	0.044	15.418	0.000	
				Self-employment income	
Constant	-1.455	0.212	47.226	0.000	–2loglikilihood=241.266, R^2=0.052, χ^2=7.874 df =1, p value=0.005, predicted %= 76.2
Farm size	0.132	0.054	5.893	0.015	
				Wage income	
Constant	-1.290	0.458	7.929	0.005	–2loglikilihood=87.720, R^2=0.150, χ^2=11.757 df =1, p value=0.001, predicted %=94.6
Education	-0.232	0.069	11.414	0.001	

Table 4. Mean input use and extent of use of inputs in wheat crop

Input	NFH (*n* = 171)		OFH (*n* = 54)		Difference in input use	*p* value
	Input use (kg per ha/no.)	Farmers (%)	Input use (kg per ha/no.)	Farmers (%)		
Urea	130.450 (±4.76)	99	130.400 (±6.92)	98	0.050	0.996
DAP	100.870 (±2.69)	95	106.060 (±4.30)	96	5.190	0.333
MOP	11.023 (±1.71)	23	12.963 (±3.42)	26	1.940	0.590
N_2O	78.164 (±2.28)	99	79.075 (± 3.52)	98	0.911	0.672
P_2O_5	46.400 (±1.17)	95	48.788 (±2.01)	96	2.388	0.458
K_2O	6.614 (±1.07)	23	7.778 (± 1.90)	26	1.164	0.295
Seed rate	121.400 (±1.89)	100	116.666 (±2.64)	100	4.734	0.147
Seed replacement	-	44	-	47	-	-
$ZnSO_4$	4.225 (±0.760)	18	1.574 (±0.770)	11	2.651**	0.016
Herbicide	0.302 (±0.023)	72	0.339 (±0.034)	78	0.037	0.235
Fungicide	0.041 (±0.005)	28	0.054 (±0.009)	39	0.013	0.209
Number of irrigations	2.04 (±0.06)	-	2.03 (±0.13)	-	0.01	0.978

**Significant at <5% level. Figures in the parentheses are standard errors. Urea = nitrogenous fertilizer, DAP = diammonium phosphate, MOP = murate of potash, $ZnSO_4$= zinc sulfate

Table 5. Factors affecting the use of inputs in wheat cultivation

Input	Variable	Coefficient (B)	S.E	Wald	p value	Model summaries
Urea	Intercept	4.730	0.726	42.485	0.000	R^2=0.153 Predicted%= 98.1 –2 log likelihood = 34.182
	Off-farm employment income	1.517	0.581	6.827	0.09	χ^2= 5.655 (p = 0.017)
DAP	Intercept	2.593	0.367	50.062	0.000	R^2=0.086 Predicted%= 95.8 –2 log likelihood = 69.298
	Assured tube well irrigation	2.012	1.070	3.537	0.060	χ^2= 5.526 (p = 0.019)
MOP	Intercept	–3.352	0.608	30.354	0.000	R^2=0.305 Predicted% 78.2
	Interaction of age & education	0.004	0.001	17.225	0.000	–2 log likelihood = 191.212 χ^2= 6.093 (p = 0.000)
	Assured tube well irrigation	0.998	0.378	6.978	0.008	
	Wheat area	0.142	0.078	3.328	0.068	
	Off-farm employment income	–1.100	0.450	5.987	0.014	
Zinc sulfate	Intercept	–2.526	0.286	78.146	0.000	R^2=0.206 Predicted% 86.70 –2 log likelihood= 161.066
	Irrigated farm	0.329	0.071	21.426	0.000	χ^2= 7.148 (p = 0.414)
Herbicide	Intercept	–3.842	0.626	37.626	0.000	R^2 = 0.259
	Interaction of age & education	0.003	0.001	7.386	0.007	–2 log likelihood = 152.854
	Canal irrigation	0.309	0.074	17.585	0.000	Predicted% = 86.1 χ^2= 7.887 (p = 0.000)
Fungicide	Intercept	–1.762	0.263	45.039	0.000	R^2= 0.093 –2 log likelihood = 229.379
	Assured tube well irrigation	1.214	0.334	13.208	0.000	Predicted% = 80.1 χ^2= 14.123 (p = 0.000)
Seed replacement	Intercept	–1.177	0.313	14.094	0.000	R^2= 0.084
	Canal irrigation	0.893	0.317	7.938	0.005	–2 log likelihood = 283.217
	Assured tube-well irrigation	0.725	0.285	6.476	0.011	Predicted% = 61.1 χ^2= 6.604 (p = 0.010)
HYV	Intercept	–3.208	0.533	36.238	0.000	R^2= 0.163
	Interaction of age & education	0.002	0.001	4.450	0.035	–2 log likelihood = 175.250
	Farm size	0.090	0.049	3.363	0.067	Predicted% = 83.3
	Wheat area	0.237	0.083	8.038	0.005	χ^2= 4.614 (p = 0.032)

Urea = nitrogenous fertilizer, DAP =diammonium phosphate, MOP = muriate of potash, HYV = High-yielding varieties, S.E = Standard error of mean.

variation of 15% in their use (Table 5). Biophysical variables, namely, irrigation (canal irrigation/irrigated farms) and farm size; resource endowments, namely, farm households owning a tube-well for irrigation and nonfarm economic activities; socio-personal variables, namely, age, education, size of family, and membership of social organizations are not found to affect the farmers' input use decisions. However, the interaction between age and education influences their decision to use of herbicides and high-yielding varieties (HYVs) (Table 5). Irrigation significantly influences the use of agrochemicals and seed replacement rate. The irrigated

Table 6. Results of stepwise linear regression: Complete model

Predictors	Coefficient (B)	S.E	*t* value	*p*-value	Model summaries
Interaction between independent variables not entered in the model					
Constant	20.809	1.988	10.469	0.000	R^2=0.369
HYV	8.906	1.779	5.006	0.000	F = 25.249
Number of irrigations	2.826	0.696	4.058	0.000	df = 177
Herbicide use frequency	5.271	1.653	3.188	0.002	
Seed generation used	–1.117	0.403	–2.768	0.006	
Interaction between independent variables also entered in the model					
Constant	20.263	1.981	10.230	0.000	R^2= 0.386
HYV	8.936	1.759	5.080	0.000	F = 21.645
Number of irrigations	6.142	1.644	3.736	0.000	df = 177
Herbicide use frequency	5.728	1.648	3.477	0.001	
Seed generation used (progeny of seed sown)	–1.095	0.399	–2.743	0.007	
Interaction of the number of irrigation and nitrogenous fertilizers	–0.037	0.017	–2.221	0.028	

Dependent variable: Yield, F value was significant at p = 0.000; df: degrees of freedom; S.E = Standard error of the mean.

area under wheat crop influences farmers' decision to use DAP. However, tube-well irrigation, cultivated area under wheat, and nonfarm employment income influences their decision to use MOP. The use of herbicides, fungicides, and seed replacement is also driven by irrigation. However, the HYVs (HD 2967, PBW 621, Ankur Mangesh, and JK Vijay) are cultivated mainly by those having larger holdings. Furthermore, interaction between age and education also causes variations in the use of HYVs (Table 5).

4.5 Factors influencing wheat yield

A stepwise general linear regression model was used to determine the factors influencing wheat yield. Of the total 12 explanatory variables, the number of irrigations, use of herbicides, seed generation used (progeny of seed sown), and cultivation of HYVs explain approximately 37% of the total variation (R^2=0.369) in wheat yield (Table 6).

In the second model, we included all the 12 variables and the interaction variables, namely progeny of seed × number of irrigations, nitrogenous fertilizers × number of irrigations, phosphate fertilizers × number of irrigations, and MOP × number of irrigations. Only one interaction variable namely nitrogenous fertilizers × number of irrigations causes variation in wheat yield. The variables, the number of irrigations, use of herbicides, seed generation used, cultivation of HYVs, and interaction between nitrogenous fertilizers × number of irrigations explain 38.6% of the variation in wheat yield (Table 6). HYVs and irrigation are the main factors affecting wheat yield. Furthermore, seed replacement and herbicides use also cause variation in yield.

The yield improvement in J&K is considerably lower than the national average; it increased from 696 kg/ha in 1966 (GoJ&K 2011) to 2,093 kg/ha in 2013 (GoJ&K 2014) (slope = 60.38 kg/ha; R^2= 0.48). The slow increase in yield is because of lack of irrigation. Estimated average yield from our data-set in unirrigated areas is 1,863 kg/ha (±1.03) and in irrigated areas was 2,902 kg/ha (±0.77). The difference of 1,039 kg/ha is significant (t = 8.077, p = 0.00). The yield in the unirrigated areas ranges between 440 and 3,520 kg/ha, whereas that in the irrigated areas ranges between 666 and 5,875 kg/ha.

4.6 Output–input relationships

The weighted wheat yield of the NFH and OFH is 2,908 kg/ha. However, for calculating the gross returns of the wheat production per hectare, the average wheat yields of 2,657 kg/ha for NFH and of 2,715 kg/ha for OFH groups has been multiplied by sale price in the year of survey. The wheat yield and gross returns of the NFH and OFH (Table 7) are not significantly different. The average net income of the NFH and OFH

Table 7. Average output–input ratio of wheat production

Parameter	NFH	OFH	Difference	p-value
Output				
Yield (kg/ha)	2657 (±0.92)	2715 (± 1.01)	58	0.674
Gross returns (Rs./ha)	38261	39096	835	0.832
Cost of production (Rs./ha)				
Pre-sowing land preparation	6372 (±1974.14)	5730(±1640.10)	-642**	0.035
Sowing, Plowing and planking	2082(±904.90)	1980(±893.35)	-102	0.505
Inputs				
Seed	2238 (±61.93)	2100 (± 61.96)	-138	0.111
Fertilizer	3510(±85.60)	3738(± 123.91)	228	0.120
Herbicide	480(±26.38)	588 (± 32.17)	108*	0.054
Fungicide	66(±17.27)	102 (±30.38)	36*	0.085
Fertilizer application cost (Rs/ha)	336(±12.86)	294(±18.42)	-42*	0.091
Herbicide application cost (Rs/ha)	354(±13.19)	402(± 20.47)	48*	0.098
Fungicide application cost (Rs/ha)	132 (± 28.44)	144 (± 35.88)	12	0.699
Harvesting	5100 (±2223.39)	5520(±2662.74)	420	0.265
Thrashing	3132 (±1536.07)	3492 (±1525.82)	360	0.152
Total paid out cost (Rs/ha)	23820	24090	270	
Net income (Rs/ha)	14460	15006	546	
Output/Input ratio	1.61	1.62	0.01	

Figures in the parentheses are standard errors

Notes:

a) The cost of cultivation includes the labor costs, both family and hired labor (Rs. 350 per man-day as reported by the farmers).

b) Cost of pesticides(herbicides and fungicides) at market price 2013–2014

c) Fertilizer at Government approved price prevalent in *rabi*2013–2014

d) The cost of application/spraying of herbicides and fungicides is as reported by the farmers.

e) The expenditure on plowing, planking, and sowing is the mean expenditure/ha incurred by the farmers.

f) Price of purchased or own seed: Rs.1800/q in case of farmers who purchased the seed either from the Department of Agriculture or farmers or used their own seed. In the case of private sector varieties, the cost was calculated as per the actual market price.

g) Thrashing charges worked out only in case of manual harvesting as reported by the farmers which were either 10% of produce or Rs.15/kg

h) The gross returns were calculated by multiplying the average yield by Rs 1440 (mean sale price at which wheat was sold by the farmers in 2013-14)

i) Interest on working capital, fixed costs (rental value of owned land, rent paid for the leased-in land, revenue, taxes, depreciation on implements and farm building, irrigation charges [canal, electricity, and diesel], and interest on fixed capital not included.

groups from wheat were Rs. 14,460 and Rs. 15,006 per hectare, respectively (at 2014 prices), with an almost identical output–input ratio of 1.61. The paid-out costs are not significantly different between the NFH and OFH; however, the cost of land preparation (p=0.035), herbicide and fungicide expenditure, and labor cost of fertilizer and herbicide application (p<0.10) are significantly different.

The net income from wheat cultivation per farm family ranges between Rs.720 and Rs. 578,400 for NFH households and between Rs. 4500 and Rs. 132,060 for OFH households. The average area under wheat cultivation in the NFH group is 1.95 ha, and the average net income estimated per farm household is approximately Rs. 28,200, which is around Rs. 180/day (at 2014 prices). For farmers in the OFH group, the average area under wheat is 1.65 ha, and the average net income is approximately Rs. 24,760/farm household (Ca. Rs.160/day at 2014 prices).

5 Discussion

The most crucial finding of the study is that only 24% of farm households are dependent on farming. For the remaining 76% of the farm families, other economic activities that include (i) employment in the public sector and private sector and (ii) micro- and small-scale retail outlets are more important. This myth that farming is the only livelihood for family farmers is incorrect. Our finding is contrary to the report that 53% of India's population comprises either cultivators or depend on farming for their livelihood. According to the 2011 census, farming is the main occupation of 95.8 million cultivators (less than 8% of the population of India) (Sainath 2013). The farm families with <2 ha of farmland and exclusively engaged in agriculture, are merely able to ensure food for their families and not economic sustainability to their livelihoods. Therefore, this must be the reason that from 1991 to 2011 census, a decrease was observed in the number of full-time farmers from 110 to 95.8 million (slope= –7.1 million/decade, R^2 =0.99), and 75% youth of the farm households want to give up farming (CSDS 2014).

Empirical evidence from the subtropics of J&K show that less than 30% of the farm households are exclusively involved in on-farm economic activities (Peshin et al. 2013; Bano et al. 2016). Worldwide, empirical evidence shows that for most farming families, agriculture is only one of several sources of income (Gardner 2001; Offutt 2002; Boisvert 2002; Rapsomanikis 2014), but this fact has been ignored and its effect on technology adoption has not been analyzed. Therefore, smallholder family farmers require access to nonfarm employment opportunities (FAO 2014) and other employment opportunities to come out of poverty. Even in the developed countries, for example, in the United States, with the large landholding, nonfarm income-generating activities have improved the overall economic performance of the farmers (Fernandez-Cornejo et al. 2007). Our results are contrary to the studies conducted in the developed countries where an inverse relationship between farm size and off-farm work holds (Lass et al. 1989; Lass et al. 1991; Yee et al. 2004). Unlike the findings from the United States, farm size directly impacts farm households' decision for self-employment activities. A high number of years of education and farming experience are hypothesized to increase the probability of adoption of agricultural technologies whereas increasing age is hypothesized to reduce the probability (Fernandez-Cornejo et al. 1994). Contrary to most of the diffusion and technology adoption studies, none of the socio-personal variables are found to play any role in determining the adoption of agricultural innovations. However, biophysical variables, such as farm size, irrigated land, and canal irrigation, and economic endowment, such as minor irrigation (possession of tube-wells) positively affect the adoption decision of wheat growers. Irrigation and non-farm economic activités affect technologies adoption (Fernandez-Cornejo et al. 2005; Fernandez-Cornejo et al. 2007). Nonfarm income is hypothesized to increase uptake of the modern purchased inputs (Diiro 2013). The findings suggest that the farmers who are engaged in nonfarm economic activities apply larger amounts of external inputs, namely fertilizers and pesticides, than do the full-time farmers. Empirical evidence shows that socio-personal variables are the weaker predictors of the use of technologies compared to technology attributes (Rogers 1995; Batz et al. 1999; Rogers 2003; Peshin 2013), biophysical factors, and resource endowments (Pattanayak et al. 2003; Fernandez-Cornejo et al. 2007).

The existing literature confirms that fertilizers, HYVs, and irrigation are the main drivers of agricultural productivity. The use of N and/or $P_2 O_5$ fertilizers is almost 100% in wheat crop; therefore, the efforts should be directed toward proper use of these fertilizers. In the subtropics of J&K, irrigation coverage should be increased for increasing productivity. The other reasons for lower productivity in the irrigated areas are :(i) farmers' use of old progenies of seed and (ii) closure of the irrigation canal for 3–4 months in the wheat season.

6 Conclusion

Despite the importance of nonfarm income, its role has been largely neglected in the diffusion and adoption research. The traditional unit of analysis (farm and farm business) should be replaced by the farm household and economic activities of farm household members. Furthermore, all the family members of farming households should not be included as cultivators. For augmenting the income of smallholder farm households, nonfarm economic job opportunities should be created. Nonfarm economic activities and farmers' socio-economic factors are not the main drivers of technology adoption. Farm size and year-round irrigation facilities are crucial variables affecting technology adoption and yield of wheat. In the subtropics of J&K, one of the primary reasons for low productivity is that the percentage of net cultivable area under irrigation has not grown over many decades.

Acknowledgements

This study was commissioned and financed by the Directorate of Agriculture, Agriculture Production Department, Jammu and Kashmir State, India.

References

Bano, F., Peshin, R., Wali V.K., & Sharma, L.K. (2016). How policy intervention impacted adoption of mango (*Mangifera indica*) cultivation in subtropics of Jammu, India? Indian Journal of Ecology, 43 (Special issue), 552-556.

Batz, F., Peters, K.,& Janssen, W. (1999). The influence of technology characteristics on the rate and speed of adoption. Agricultural Economics, 21(2), 121-130.

Birthal, P.S., Negi, D. S., Jha,A.K., & Singh, D. (2014). Income sources of farm households in India: Determinants, distributional consequences and policy implications. Agricultural Economics Research Review, 27 (1), 37-48.

Boisvert, R. (2002). Analysis of a re-focused agricultural policy within a farm-household framework: Some data requirements. In: Proceedings of the workshop on farm household-firm unit: Its importance in agriculture and implications for statistics. Wye Campus, Imperial College, University of London. http://household.aers.psu.edu/PapPre/Boisvert-ProblemDefinition.pdf.

CSDS(Centre for the Study of Developing Studies). (2014). State of Indian farmers: A report. Centre for the Study of Developing Studies and Lokniti. www.lokniti.org/pdf/Farmers_Report_Final.pdf .

de Janvry, A., Sadoulet, E., & Zhu, N. (2005). The role of non-farm incomes in reducing rural poverty and inequality in China. Working paper 1001, Department of Agricultural & Resource Economics, University of California, Berkley.https://ageconsearch.umn.edu/bitstream/25043/1/wp051001.pdf. Accessed on May 21, 2015.

Diiro, G.M. (2013). Impact of off-farm income on agricultural technology adoption intensity and productivity: Evidence from rural maize farmers in Uganda. Working paper 11, International Food Policy Research Institute. http://www.ifpri.org/sites/default/files/publications/usspwp11.pdf . Accessed on May 21, 2015.

FAO (Food and Agricultural Organization).(2014). The state of food and agriculture innovation in family farming. Food and Agriculture Organization, of the United Nations, Rome. http://www.fao.org/3/a-i4040e.pdf . Accessed on May 21,2015.

Fernandez-Cornejo, J., Hendricks, C., & Mishra, A. (2005). Technology adoption and off-farm household income: The case of herbicide-tolerant Soybeans. Journal of Agricultural and Applied Economics, 37(3), 549-563.

Fernandez-Cornejo, J., Beach, E.D., & Wen-Yuan, H.(1994). The adoption of IPM techniques by vegetable growers in Florida, Michigan, and Texas. Journal of Agricultural and Applied Economics, 26 (1), 158-72.

Fernandez-Cornejo, J., Mishra, A., Nehring, R., Hendricks, C., Southern, M., & Gregory, A. (2007). Off-farm income, technology adoption, and farm economic performance/ERR-36. Economic Research Service/United States Department of Agriculture. http://www.ers.usda.gov/media/200316/err36_1_.pdf . Accessed on May 21,2015.

GoJ&K (Government of Jammu & Kashmir). (2011). Digest of statistics, 2010-11.Directorate of Economics and Statistics, Government of Jammu & Kashmir, India.

GoJ&K (Government of Jammu & Kashmir).(2014). Economic survey, J&K 2013-14. Directorate of Economics &Statistics, Government of Jammu & Kashmir, India.http://www.indiaenvironmentportal.org.in/files/file/J&K%20EconomicSurvey. Accessed on May 25,2014.

GoJ&K (Government of Jammu & Kashmir). (2017). Digest of statistics, 2016-17. Directorate of Economics &Statistics, Government of Jammu & Kashmir, India.http://www.ecostatjk.nic.in/publications/publications.htm. Accessed on August 30, 2018.

Gardner, B.L. (2001). How U.S. agriculture learned to grow: causes and consequences? Australian Agricultural and Resource Economics Society 2001 Conference (45th), Adelaide, Australia , January 23-25, 2001.

Lanjouw, P., & Shariff, A. (2004). Rural non-farm employment in India: access, incomes and poverty impact. Economic and Political Weekly, 39(40), 4429-4446.

Lass, D.A., Findeis, J.L., & Hallberg, M.C.(1989). Off-farm labor employment decisions by Massachusetts farm households. Northeastern Journal of Agricultural Research Economics, 18(2), 149-159.

Lass, D.A., Findeis, J.L., & Hallberg, M.C. (1991). Factors affecting the supply of off-farm labor: a review of the empirical evidence. In: Multiple job holding among farm families(M.C. Hallberg, J.L Findeis, & D.A. Lass, eds.). Iowa State University Press, Ames, USA.

MoA (Ministry of Agriculture).(2014). Agriculture census 2010-2011, all India report on number and area of operational holdings. Agriculture Census Division, Department of Agriculture & Co-Operation, Ministry Of Agriculture Government Of India. http://agcensus.nic.in/document/agcensus2010/completereport.pdf. . Accessed on March 20,2015.

Offutt, S.(2002). The future of farm policy analysis: A household perspective. American Journal of Agricultural Economics, 84(5),1189-1200.

Pattanayak, S.K., Mercer, D.E., Sills, E.,& Yang, J.C. (2003).Taking stock of agroforestry adoption studies. Agroforestry Systems, 57(3), 173-186.

Peshin, R. Sharma, R., Gupta, V. and Ajrawat, B. (2013).Impact evaluation of the government intervention in procurement of rice: Project report. Division of Agricultural Extension Education, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, India.

Peshin, R.(2013). Farmers' adoptability of integrated pest management of cotton revealed by a new methodology. Agronomy for Sustainable Development, 33(3), 563-572.

Rapsomanikis, G**. (**2014). The economic lives of smallholder farmers: An analysis based on household data from nine countries. Food and Agriculture Organization of the United Nations Rome. http://www.fao.org/3/a-i5251e.pdf. Accessed on September 20, 2015.

Rogers, E. M. (1995, 2003). Diffusion of innovations. The Free Press, New York, USA.

Sainath, P. 2013. Over 2,000 fewer farmers every day, The Hindu, May 2nd, 2013.

Yee, J., Ahearn, M.C.,& Huffman, W. (2004). Links among farm productivity, off-farm work, and farm size in the Southwest. Journal of Agriculture and Applied Economics, 36(3), 591-603.

Received: 23 April 2018; Accepted: 23 December 2018