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Does the seed system determine the crop yield and farmers' income? an economic analysis

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Abstract The use of quality seeds is critical in determining the yield and income of the farmers. We study the major seed sources of rice and wheat in India using National Sample Survey Office (NSSO) 77th round data and examine the yield and income differences across different seed sources using a multivariate regression model. The factors determining the choice of seed source were examined using a multi-nominal logit model. The analysis indicated that economic status, social group, awareness about the variety, the experience of crop loss, etc., determine the farmers' seed choice. Besides, farmers using seeds from sources other than own-farm seeds received higher yield and income, which varied further with the seed source.

Keywords Seed system, multi-nominal logit model, multivariate regression, yield, income

JEL codes Q12, Q16, Q18

Seed is a critical input in crop production, as the response of the crop to other inputs depends on the quality of the seed. Quality seed alone contributes 15-20% to the total production directly, which can be further increased to 45% with the efficient management of other inputs (www.seednet.gov.in; Poonia 2013; Ali 2016). The use of quality seeds improves food and nutritional security, supports farmers' livelihood, contributes to sustainable resource use and makes the crop production system resilient to various abiotic and biotic stresses (Louwaars and Manicad 2022). Availability and use of good quality seeds are important factors that determine the yield and quality of the output. Hence it is crucial to develop a seed production and delivery system that continuously develops new varieties suited to the changing environment and disseminates them faster, replacing old varieties.

Seed sector interventions are important because the seed is the carrier of the technological advances made by the research system, including yield enhancement, improving nutrition including biofortification, and incorporating resilience to strive through changing climate and other biotic and abiotic stresses (McGuire and Sperling 2016). India has a well-organized public seed production and distribution system with national, state, and regional institutions involved in producing, certifying, and distributing seeds of different crops and varieties. India follows a definite seed multiplication system consisting of three generations: breeder, foundation, and certified seeds (www.seednet.gov.in).

The seed industry in India has grown significantly over the years owing to various seed legislations enacted from time to time. These policies facilitated the investments in the seed sector by the private players that shifted the predominantly public sector during the 1960s to one which is more competitive and market-driven (Chauhan et al. 2016) . Despite the progress made by the sector, only 30-35% of the total seeds distributed in the country are through the organized sector, and the rest is through the unorganized sector, comprising mainly of farm-saved seeds (GoI 2016).

The seed system is a network of seed supply channels that provides farmers with seeds from various sources based on variety, price, and availability, which can be

distinguished into formal and informal seed systems. The formal seed systems are market-based and involve the exchange of improved and certified crop varieties through research stations, governmental institutions, and commercial seed stockists. In contrast, seed exchanges between farmers using local varieties and non-certified improved varieties, as a part of cultural norms and social relations, are called informal seed systems (Schöley and Padmanabhan 2016). It is imperative to understand if the seed sector development in the country caters to the needs of all farmers in terms of access and quality irrespective of gender, caste, and socioeconomic status. Understanding the seed system dynamics helps design socially inclusive strategies to ensure quality seed access to farmers across all categories. In this context, we examine the seed system of two major staple crops in the country, rice and wheat. We explore the major seed sources of rice and wheat in India, examine the yield and income differentials across sources, and identify the source providing quality seeds that benefit the farmers in terms of higher yield and income. The study also analyses the factors determining the choice of seed source by the farmers.

Data

The study uses farm-level data from a nationally representative survey by the National Sample Survey Office (NSSO) 77th round data on situation assessment of agricultural households conducted from 1st January 2019 to 31st December 2019. The sample used in our analysis comprised 16398 households cultivating only rice and 7335 households cultivating only wheat. The households cultivating only rice and wheat were extracted separately from visits 1 and 2 of the survey.

Methodology

Multivariate regression analysis was undertaken to find if there is a significant difference in yield and income across different seed sources. The following model was estimated:

$$Y_i = \beta_0 + \sum_{i=1}^{6} \beta_i X_i + \sum_{j=2}^{5} \beta_j S_j + \sum_{k=1}^{4} \beta_k D_k + u_i \qquad (1)$$

Where, Y_i is the dependent variable. Two models were fitted, taking yield and income as dependent variables. We assume that traditional varieties sometimes may fetch higher prices or require comparatively less cost of production, which may lead to the popularity of traditional varieties. We test if this assumption holds. X_i indicates the size of the farm and expenditure incurred per hectare for crop production such as fertilizer, bio-fertilizers, plant protection chemicals, power consumption (including expenditure for diesel and electricity), and irrigation. S_j indicates a dummy for seed sources from where the sample farmers procure seeds. Ten seed sources were listed in the sample, which we grouped into 5 for analysis. Group 1 comprises farmers purchasing seeds from input dealers and local traders; group 2 comprises farmers procuring seeds from APMC Market, FPOs, Private processors, contract farming, and others; group 3 from cooperatives; group 4 from government agencies and group 5 uses own-farm seeds. Group 5 was used as the base category. D_k indicates the dummy for education, possession of Kisan Credit Card (KCC), crop insurance, and membership in any organization.

In order to evaluate the determinants of seed source choice, we adopt the multinomial logistic regression. We apply the maximum likelihood method to estimate a multinomial logit model along with robust standard errors. For this purpose, we used the four categories of seed sources as the dependent variables, and the own farm seeds group was considered the base category.

The model for seed source choice can be depicted as follows as in Greene (2003)

$$Prob(Y_i = j) = \frac{e^{\beta' j x_i}}{\sum_{k=1}^{4} e^{\beta' k X_i}} \qquad (2)$$

Where j= Groups 1,2,3 and 4 represent different sources of seeds; Group 1 consists of farmers purchasing seed from input dealers and local traders; Group 2 consists of farmers procuring seeds from APMC Market, FPOs, Private processors, contract farming, and others; Group 3 farmers purchase seeds from Co-operatives & Government agencies; and Group 4 farmers use Own-farm seeds which is taken as the base category. The estimated equations provide a set of probabilities for the $J+1$ choices of farmers, and xi_s are the explanatory variables. Only three parameter vectors are required to predict all four probabilities of seed source choices, as one is taken as the base category. The probabilities can be found using the following equation.

$$Prob(Y_i = j \mid X_i) = \frac{e^{\beta' j x_i}}{\sum_{k=1}^{j} e^{\beta' k X_i}}, \quad \text{for } j = 0, 1, \ldots, J,$$

$$\beta_0 = 0 \qquad (2)$$

Table 1 Seed source-wise number of farmers, yield and income for rice and wheat cultivating households in India

Seed sources	Rice			Wheat		
	Number of farmers (%)	Yield (kg/ha)	Income (Rs/ha)	Number of farmers (%)	Yield (kg/ha)	Income (Rs/ha)
Local market (Local traders)	65.48	3376	48372	80.72	3043	50555
Own-farm	24.02	2813	39187	12.98	2334	34945
Input dealers	2.95	3851	56095	2.68	3159	54472
Government agencies	2.4	3056	44152	0.91	1802	31400
Co-operatives	2.27	3292	51942	0.97	3490	58516
Private processors	1.13	3209	52549	0.64	3501	63615
APMC market	0.78	3168	44761	0.33	2886	54191
Farmer producer organisers	0.11	1909	25244	0.31	2012	35122
Contract farming companies	0.04	2926	42666	—	—	—
Others	0.82	3379	52514	0.45	3125	41117

The seed source choice of the farmers is influenced by the various farm and household level characteristics. The predictors included in the model are gender, age, education, social group, monthly expenditure, access to irrigation, access to information, possession of Kisan Credit Card (KCC), history of crop loss, awareness about Minimum Support Price (MSP), and farm size.

Results and discussion

Seed sources and their distribution

Sample farmers procure seeds from ten different seed sources listed in the database. As in Table 1, the major seed source for rice and wheat farmers are local market/ local traders, followed by own-farm saved seeds.

Over 65% of rice and nearly 81% of wheat farmers depend on local traders for seeds, while 24.02% and 12.98% of farmers use own-farm seeds in the case of rice and wheat, respectively. The average yield was found to be comparatively higher for seeds procuring from Input dealers, followed by local traders, cooperatives, private processors etc. At the same time, yield and income are relatively low for seeds procured from FPOs and own-farm seeds. It is clear from Table 1 that there is no advantage in terms of yield and income observed in the case of farmers using farm-saved seeds.

The farmers' access to seed sources varies across states. Figure 1 depicts the distribution of seed sources across major rice-producing states that contributes around 91% of total rice production in the country. Although

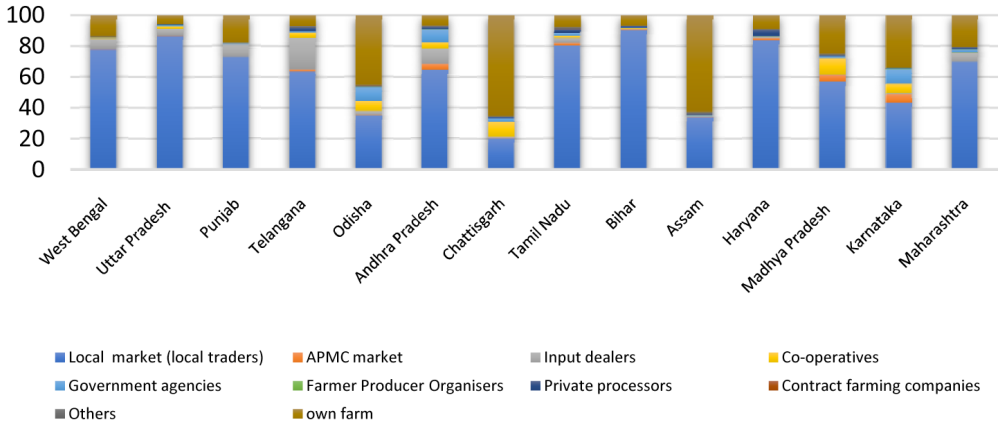

Figure 1 Distribution of seed sources in major rice-producing states

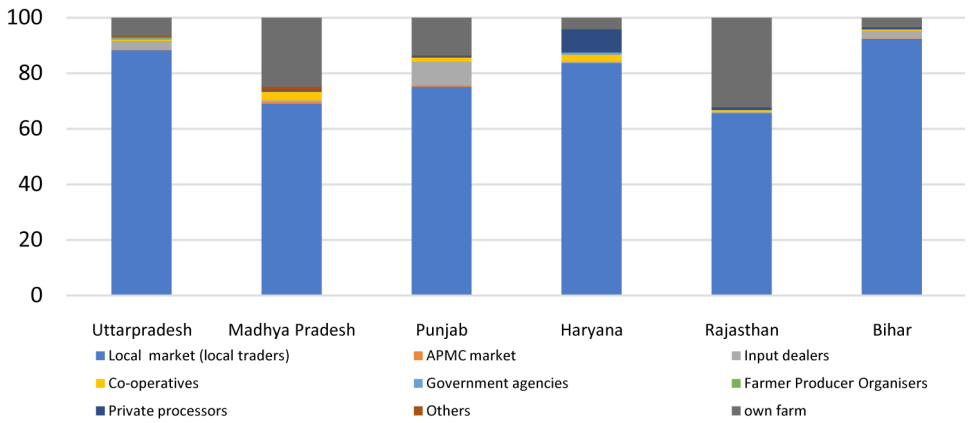

Figure 2 Distribution of seed sources in major wheat-producing states

local traders dominate the system in most of the states, the share of farmers using own-farm seeds was found to be high in states like Chattisgarh (65.5%), Assam (62.57%), and Odisha (45.58%). Inputs dealers are relatively popular in Telangana and Andhra Pradesh, and Cooperatives are highly popular in Chattisgarh, Madhyapradesh, and Odisha. APMC markets are relatively popular in Madhya Pradesh, Karnataka, and Andhrapradesh. Figure 2 depicts the seed source distribution of wheat farmers in India's major wheat-producing states. Although local traders dominate seed distribution across these states, the share of own farm seed users is significant in states like Madhya Pradesh, Rajasthan, and Punjab.

Effect of seed source choice on yield and income of the farmers

This section examines how yields and income differ across farmers using seeds from different sources. We use a multivariate regression model to examine the effect of the choice of seed source on the yield and income of farmers cultivating rice and wheat. The summary statistics of the variables used in the model pertain to rice farming households are given in Table 2, and parameter estimates are provided in Table 3.

It can be inferred from Table 3 that education, possession of a KCC, membership in any organization, and most other inputs affect the yield and income of farmers positively. Crop insured under PMFBY positively affects income with no significant effect on yield, which implies that crop insurance helps the farmer to have a stable income in the event of crop failures. Farm size is inversely related to yield, as reported in many studies (Wang et al 2015; Gaurav and Mishra 2015). The seed source choice also has a significant effect on yield and income. Compared to the base category, the farmers using own-farm seeds, all other groups realized higher yield and income. Among all sources, the yield and income of farmers using seeds from cooperatives were comparatively higher, followed by groups 1, 4, and 2. A similar analysis was undertaken for wheat farming households, and the summary statistics of variables used are given in Table 4.

From Table 5, it can be understood that almost all the input variables are positively related to yield and income. The farmers possessing KCCs could also realize better yield and income than their counterparts. Most importantly, the yield and income vary significantly across different seed sources. The farmers purchasing seeds from groups 1 and 3 realized higher yields than farmers using own-farm seeds. Compared to own-farm seeds, the farmers using seeds from all other groups could realize higher income because of the better price of the cultivated variety. So, it can be concluded that in rice and wheat farming households, the seeds from sources other than own-farm performed well by fetching better yield and income. Therefore, the farmers should be encouraged to frequently replace the seeds with good quality seeds to realize better yield and income.

Determinants of seed choice

The farmers' choice of seed source depends on various socio-economic and farming-related variables. The multi-nominal logistic model using four groups of seed

Table 2 Summary statistics of multivariate regression and multi-nominal logit model (Rice farming households)

Variables	Mean	Std. Dev.	Min	Max
Yield (Model 1)	3240.04	1730.76	0	18712
Income per hectare (Model 2)	46271	31462	-224770	589095
Education (1=literate,0-non-literate)	0.67	0.47	0	1
Kissan credit card (Yes=1, No=0)	0.17	0.37	0	1
Membership in any organisation (Yes=1, No=0)	0.04	0.19	0	1
Crop insured under PMFBY (Yes=1, No=0)	0.04	0.20	0	1
Farm Size (ha)	0.79	0.86	0	28
Fertilizer expenditure (Rs/ha)	4680.10	4518.80	0	224770
Bio-fertiliser expenditure (Rs/ha)	1627.28	3060.30	0	86450
Plant protection chemicals expenditure (Rs/ha)	1573.63	2828.09	0	80275
Power expenditure (Rs/ha)	920.69	2597.19	0	103740
Irrigation expenditure (Rs/ha)	1957.35	4182.18	0	205833
Seed source categories for multi-variate regression (Base category- Group 5)				
Group 1	0.68	0.46	0	1
Group 2	0.03	0.17	0	1
Group 3	0.02	0.15	0	1
Group 4	0.02	0.15	0	1
Group 5	0.24	0.43	0	1
Additional variables for multi-nominal regression*				
Gender (Male=1, Female=0)	0.92	0.28	0	1
Age (Years)	50.60	13.22	12	105
Access of information about improved variety (1=Yes, 0=No)	0.28	0.45	0	1
Monthly expenditure (Rs)	8507.94	4767.55	500	81700
Access to irrigation (1=Yes, 0=No)	0.67	0.47	0	1
Crop loss experienced(1=Yes, 0=No)	0.40	0.49	0	1
Awareness about MSP(1=Yes, 0=No)	0.36	0.48	0	1
Social groupsST	0.19	0.39	0	1
SC	0.16	0.36	0	1
OBC	0.40	0.49	0	1
Others	0.26	0.44	0	1
Seed source categories (Categorical Dependent Variables)				
Group 1	0.68	0.46	0	1
Group 2	0.03	0.17	0	1
Group 3	0.05	0.21	0	1
Group 4 (Base Category)	0.24	0.43	0	1
No of observations	16398			

*Some of the variables used for the multivariate regression model and multi-nominal regression model are same, hence summary statistics of both models are accommodated in the same table.

Table 3 Parameter estimates of multivariate regression model (Rice farming households)

Variables	Yield (kg/ha)		Income (Rs/ha)	
	Coefficients	Robust Std. Err.	Coefficients	Robust Std. Err.
Education (1=literate,0-non-literate)	91.31***	24.75	2590.36***	454.73
Kissan credit card (Yes=1, No=0)	114.11***	36.38	4558.67***	698.00
Membership in any organisation (Yes=1, No=0)	182.76***	55.60	4300.36***	1181.40
Crop insured under PMFBY (Yes=1, No=0)	73.03	61.58	4574.39***	1232.32
Seed sources (Base –Group 5)				
Group 1	327.86***	33.98	8639.86***	642.49
Group 2	127.80*	71.69	4816.14***	1542.70
Group 3	532.59***	78.77	14095.39***	1470.09
Group 4	245.38***	79.67	6082.20***	1470.15
Farm Size (ha)	-39.47**	17.17	588.30	360.77
Fertilizer expenditure (Rs/ha)	0.08***	0.02	0.92**	0.40
Bio-fertiliser expenditure (Rs/ha)	0.08***	0.01	0.63**	0.31
Plant protection chemicals expenditure (Rs/ha)	0.07***	0.02	1.42***	0.41
Power expenditure	0.04**	0.02	0.63	0.41
Irrigation expenditure (Rs/ha)	0.04***	0.01	0.41	0.25
State fixed effects	Yes	—	Yes	—
Constant	1224.62***	315.25	33478.74***	6229.341

*, ** and *** indicate statistical significance at the 10 %, 5% and 1% level, respectively

Table 4 Summary statistics of multivariate regression and multi-nominal logit model (Wheat farming households)

Variables	Mean	Std. Dev.	Min	Max
Yield (Model 1)	2945.14	1383.64	4.94	15808
Income per hectare (Model 2)	48503	33875	-114649.2	1851951
Education (1=literate,0-non-literate)	0.63	0.48	0	1
Kissan credit card (Yes=1, No=0)	0.23	0.42	0	1
Membership in any organisation (Yes=1, No=0)	0.02	0.15	0	1
Crop insured under PMFBY (Yes=1, No=0)	0.03	0.18	0	1
Farm Size (ha)	0.70	0.82	0	13.36
Fertilizer expenditure (Rs/ha)	4606.77	3575.45	82.33	68611
Bio-fertiliser expenditure (Rs/ha)	1614.25	3170.76	0.00	61750
Plant protection chemicals expenditure (Rs/ha)	1080.45	2360.82	0.00	135850
Power expenditure (Rs/ha)	1702.92	3169.04	0.00	45078
Irrigation expenditure (Rs/ha)	2884.40	4096.56	0.00	98800
Seed source categories for multi-variate regression (Base category- Group 5)				
Group 1	0.83	0.37	0	1
Group 2	0.02	0.13	0	1
Group 3	0.01	0.10	0	1

Contd...

Variables	Mean	Std. Dev.	Min	Max
Group 4	0.01	0.10	0	1
Group 5	0.13	0.34	0	1
Additional variables for multi-nominal regression				
Gender (Male=1, Female=0)	0.92	0.28	0	1
Age (Years)	49.30	13.57	12	104
Access of information about improved variety (1=Yes, 0=No)	0.30	0.46	0	1
Monthly expenditure (Rs)	9082.45	5294.73	800	90083
Access to irrigation (1=Yes, 0=No)	0.91	0.28	0	1
Crop loss experienced(1=Yes, 0=No)	0.33	0.47	0	1
Awareness about MSP(1=Yes, 0=No)	0.27	0.44	0	1
Social groupsST	0.09	0.29	0	1
SC	0.19	0.39	0	1
OBC	0.48	0.50	0	1
Others	0.24	0.43	0	1
Seed source categories (Categorical Dependent Variables)				
Group 1	0.83	0.37	0	1
Group 2	0.02	0.13	0	1
Group 3	0.02	0.14	0	1
Group 4 (Base category)	0.13	0.34	0	1
No of observations	7335			

Table 5 Parameter estimates of the multivariate regression model (Wheat farming households)

Particulars	Yield (kg/ha)		Income (Rs/ha)	
	Coefficients	Robust Std. Err.	Coefficients	Robust Std. Err.
Education (1=literate,0-non-literate)	40.05	30.97	1481.45*	684.46
Kissan credit card (yes=1, No=0)	163.59***	39.47	5873.29***	1859.31
Membership in any organisation (Yes=1, No=0)	-53.31	79.82	-964.75	1827.34
Crop insured under PMFBY (Yes=1, No=0)	-38.98	80.92	-1748.73	1879.65
Seed Sources (Base –Group 5)				
Group 1	260.26***	51.34	8751.41***	1017.62
Group 2	182.63	117.76	7231.54***	2467.15
Group 3	1051.23***	164.61	21715.29***	2753.93
Group 4	66.48	184.61	6502.24*	3586.18
Farm Size(ha)	-11.91	20.58	341.57	611.85
Fertilizer expenditure (Rs/ha)	0.08***	0.01	1.50***	0.22
Biofertilizer expenditure (Rs/ha)	0.02**	0.01	-0.49**	0.20
Plant protection chemicals expenditure (Rs/ha)	0.00	0.04	-0.48	0.83
Power expenditure (Rs/ha)	0.08***	0.01	1.37***	0.18
Irrigation expenditure (Rs/ha)	0.05***	0.01	0.76***	0.19
State fixed effects	Yes	—	Yes	—
Constant	1127.77***	92.46	16897***	1933

*, ** and *** indicate statistical significance at the 10 %, 5% and 1% level, respectively

Table 6 Determinants of farmers' seed choice using multi-nominal logistic regression (Rice farming households)

Particulars	Group 1		Group 2		Group 3	
	Coefficients	Std.Err.	Coefficients	Std.Err.	Coefficients	Std. Err.
Gender (Male=1, Female=0)	-0.129	0.086	0.080	0.229	-0.061	0.168
Age (years)	-0.007***	0.002	-0.001	0.005	0.001	0.003
Education (1=literate, 0=non-literate)	-0.105*	0.057	0.237*	0.135	0.123	0.105
Farm size (ha)	0.082**	0.036	0.178***	0.049	0.177***	0.044
Access of information about improved variety (Yes=1, No=0)	0.210***	0.057	0.062	0.132	0.415***	0.096
Social Group						
ST	-0.722***	0.075	-0.478***	0.189	-0.530***	0.151
SC	-0.082	0.085	0.255	0.201	0.073	0.167
OBC	-0.079	0.067	0.107	0.157	0.236*	0.124
Monthly expenditure (Rs)	0.000***	0.000	0.000***	0.000	0.000**	0.000
Kisan credit card (Yes=1, No=0)	0.304***	0.072	0.201	0.160	0.549***	0.112
Membership in any organisation (Yes=1, No=0)	-0.282**	0.123	-0.032	0.263	0.215	0.177
Access to irrigation (Yes=1, No=0)	0.283***	0.061	1.064***	0.148	0.579***	0.111
Crop loss experienced (Yes=1, No=0)	-0.170***	0.054	-0.215*	0.126	0.221**	0.095
Awareness about MSP (Yes=1, No=0)	0.319***	0.059	0.149	0.133	0.606***	0.106
State fixed effects	Yes		Yes		Yes	
Constant	0.689***	0.177	-3.781***	0.450	-2.769***	0.334

*, ** and *** indicate statistical significance at the 10 %, 5% and 1% level, respectively

sources as dependent variables was applied to determine the determinants of choice. The summary statistics for the variables used can be found in Tables 2 and 4 for rice and wheat farming households.

From Table 6, it is clear that younger farmers prefer own-farm seeds comparatively. Age is a proxy for farming experience. Hence, with experience, farmers become aware of various seed sources and use seeds from other sources than farm-saved ones. Farmers tend to prefer seeds from sources other than farm-saved seeds as farm size increases. The literate farmers use seeds from group 2 (APMC Market, FPOs, private processors, contract farming, and others) and tend not to prefer group 1 (local traders). If the farmers have access to information about improved varieties, they prefer either group 1 or group 3 (Co-operatives and Government agencies) compared to the base category. Caste-related networks in a village are crucial in determining the seed source choice (Gupta et al 2020). We found that farmers from the Scheduled Tribe group prefer farm-saved seeds to other sources. The farm households with higher spending and access to irrigation are likely to go for seeds from sources other than own-farm seeds. Farmers who have experienced crop loss tend to prefer seeds from group 3. Access to credit encourages the farmers to use seeds from groups 1 or 3.

In the case of wheat farming households, farmers at a comparatively young age prefer own-farm seeds because of the lack of experience. With a larger farm size and higher monthly expenditure, farmers prefer seeds from sources other than own-farm seeds. It implies that if the economic status of the farmers is better, they can purchase seeds beyond their own-farm seeds. If the farmer gets any information about the improved variety, they will likely go for seeds from groups 1 and 2. Also, if the farmer has awareness about policy support such as MSP, they will prefer seeds from group 3. In the case of wheat, we can see that the farmers in the ST category are likely to use own-farm seeds that seeds from other sources. It may be because of poor financial status and lack of access to information and seed sources.

Table 7 Determinants of farmers' seed choice using multi-nominal logistic regression (Wheat farming households)

Particulars	Group 1		Group 2		Group 3	
	Coefficients	Std.Err.	Coefficients	Std.Err.	Coefficients	Std. Err.
Gender (Male=1, Female=0)	-0.014	0.142	-0.203	0.368	-0.019	0.350
Age (years)	-0.008***	0.003	-0.012	0.008	-0.004	0.007
Education (1=literate, 0=non-literate)	0.003	0.016	0.027	0.038	-0.035	0.042
Farm size (ha)	0.241***	0.067	0.344***	0.114	0.289**	0.120
Access of information about improved variety (Yes=1, No=0)	0.360***	0.092	0.565***	0.211	0.253	0.209
Social Group						
ST	-0.413***	0.138	-0.275	0.391	-0.749**	0.361
SC	-0.004	0.131	0.877***	0.306	0.091	0.294
OBC	0.096	0.110	0.322	0.269	0.240	0.254
Monthly expenditure (Rs)	0.000**	0.000	0.000***	0.000	0.000**	0.000
Kisan credit card (Yes=1, No=0)	-0.057	0.096	-0.123	0.249	0.129	0.233
Membership in any organisation (Yes=1, No=0)	-0.303	0.257	-0.447	0.758	0.097	0.528
Access to irrigation (Yes=1, No=0)	0.190	0.135	-0.165	0.346	-0.169	0.307
Crop loss experienced (Yes=1, No=0)	-0.210**	0.083	0.304	0.206	-0.010	0.214
Awareness about MSP (Yes=1, No=0)	-0.246***	0.094	-0.347	0.240	1.195***	0.249
State fixed effects	Yes		Yes		Yes	
Constant	0.620**	0.318	-1.798***	0.692	-0.264	0.610

** and *** indicate statistical significance at 5% and 1% level, respectively

Conclusion

Seed is one of the critical inputs in crop production that determines the yield and income of farmers. Therefore, replacing seeds with good quality is imperative to realize the potential yield. Even after implementing various seed legislations and policies, a significant proportion of farmers still use own-farm seeds for cultivation. Using NSSO data on rice and wheat farming households, we study the reasons for farmers' preference for particular seed sources. Out of the major seed sources listed in the database, most farmers prefer seeds from local traders followed by own-farm seeds. Among all groups, the yield and income of farmers sourcing seeds from cooperatives were comparatively higher, followed by local traders in the case of both rice and wheat farmers. Both rice and wheat farmers purchasing seeds from all other sources could realize better yield and income than own-farm seeds. Hence, to improve yield and income, farmers should replace the seeds with good quality ones of improved varieties, especially in those states where the use of own-farm seeds is still widespread.

The seed source of choice of farmers is affected by various factors, which were analyzed using multi-nominal logistic regression. It was found that the farmers with better economic status tend to use seeds from sources other than own-farm seeds. If the farmer has access to information about the variety, the chance of replacing seeds using other sources is high. It indicates that creating awareness among farmers significantly affects seed replacement using quality seeds. Besides, the farmers belonging to the ST category tend to use own-farm seeds in both cases. Hence it is essential to organize awareness programs among ST category farmers and to provide necessary support in adopting improved agricultural practices to improve their income. As most farmers depend on local dealers for seeds, frequent monitoring at the seed dealers' level should be done to ensure the seeds' physical and cultivar purity.

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