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Farmers' Perception and Adoption of Abiotic Stress Tolerant Rice Varieties in Rain-fed Lowlands of North Eastern Uttar Pradesh

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ABSTRACT

The study is based on field level data collected from submergence-prone areas of rain fed lowlands of eastern Uttar Pradesh. Two districts viz. Gorakhpur and Siddharthnagar were selected purposively on basis area and production. The ultimate sample size was 120 farmer households. Qualitative and quantitative information on rice production practices for the *kharif* season of 2015-16 was collected using structured interview schedules.Farmers were asked to compare the relative performance of improved and traditional varieties being grown in the village. The varietal diversity index (VDI) was employed to know rice varietal diversity at farm level in the region.An analysis of farmers' preferences and perceptions showed that majority of sample farmers cultivating Sarjoo-52 (89%) and Kalanamak (100%) preferred these varieties for their good eating quality. However, Swarna Sub-1 and Samba Masuri Sub-1 were preferred by majority of farmers (84 per cent) for higher yield performance during field submergence conditions.

Keywords: Farmer's Perception, Adoption, Abiotic Stress Tolerant Rice Varieties.

INTRODUCTION

Rice is one of the most important staple foods for more than half of the world's population and influences the livelihoods and economies of several billion people. Globally, the spectacular advancement in rice productivity started after the introduction of semi-dwarf high-yielding varieties during the mid-1960s, which enabled many rice-growing economies, including India, to attain self-sufficiency in rice production. Apart from breakthroughs in technology, the rapid expansion in rice area and production was also made possible by enhanced public investment in irrigation and infrastructure, fertilizer, and price policy support (Singh *et. al*, 2017). Subsequently, the thrust of rice breeding programs moved towards improving adaptability to relatively unfavourable production environments and improving quality traits like grain length, texture, aroma, nutritional content, cooking quality etc.Together, these technological, institutional and policy initiatives enabled rice production not only geographically dispersed across different ecosystems (Irrigated, Rain- fed Upland, Rain-fed Lowland, and Flood Prone), but also made the country to attain all time high rice production of 110.15 million tons in 2016-17 (GoI, 2017).

The eastern states of India contribute a substantial share in total rice production in the country, and mainly produce non-aromatic varieties. But agriculture in these region is more dependent on the monsoon rains, and droughts and floods frequently affect agricultural production. These flood-prone ecosystems have enormous potential for more food production to meet the ever increasing demands for rice supply because of the predominance of good soils and freshwater resources (Ismail *et. al*, 2013). Improved stress tolerant rice varieties[1] like Swarna Sub-1 and Samba Masuri Sub-1 were recently introduced flood-tolerant version of the popular mega-variety Swarna (MTU-7029) and Samba Masuri (BPT-5204) popularly grown in Eastern India (Dar *et al.*, 2013). Since rice is one of the major crop in this region, productivity gains in rice is essential to bring the livelihood and food security to the region. With this objective, the Government of India launched a program called "Bringing Green Revolution to Eastern India (BGREI)" in 2009 to harness untapped potential of eastern states, taking into consideration the agro-climatic and socio-economic conditions of the region. Majority of funds under the programme were allocated for improving rice economy in

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the region through incentivizing adoption of improved technologies and enhancing input access to smallholders.

Since, agriculture in this region is dominated by a large number of marginal farmers and smallholders with varying levels of knowledge, skills, capital and resources. Hence, understanding farmers' preferences for crop attributes and incentives to grow improved varieties are critical to the success of another green revolution in the region. Hence, the objective of the study is to analyze farmers' perceptions on varietal attributes of a range of improved and traditional rice varieties that are currently being grown in north eastern plain zone of Uttar Pradesh. The study would help to understand the incentives that farmers need in making the choice of technology adoption, as well as the identification of interventions compatible with the resource endowments and farmers' needs.

METHODOLOGY

The study was based on field level data collected from submergence-prone areas of rainfed lowlands of eastern Uttar Pradesh. Two districts *viz*. Gorakhpur and Siddharthnagar were selected purposively on basis of area and production of rice.Two blocks namely Sardarnagar and Uruwa from Gorakhpur district and Birdpur and Naugarh blocks from Siddharthnagar district were selected purposively based on higher intensity of rice cultivation. Further, three villages from each block were selected randomly making 12 villages in total. Finally, 10 farmers from each village were randomly selected making the ultimate sample size of 120 farmer households. Qualitative and quantitative information on rice production practices for the kharif season of 2015-16 were collected using structured interview schedules. Farmers were asked to compare the relative performance of improved and traditional varieties being grown in the village. The Varietal diversity index (VDI) was employed to know rice varietal diversity at farm level in the region. The varietal diversity index (VDI) was estimated by using the following formula:

$$VDI_i = 1 - \sum_{j=1}^{n} (a_{ij} / A_i)^2$$

Where,

a_{ij} = area planted to the jth variety by the ith farmer

A_i = total area planted under rice by the ith farmer

The index ranges from 0 to 1, zero indicated no rice varietal diversity and 1 indicated very high rice varietal diversity for a farmer. In order to identify the factors determining the level of diversity, linear regression model was employed to know factors influencing rice varietal diversity at farm level. Likert scale was used to measure preferences and perceptions of rice varietal traits and constraints of improved and traditional rice varieties of the study area.

RESULT AND DISCUSSION

Rice varietal diversity and adoption of improved stress tolerant varieties

The region is characterized by predominance of small and marginal farmers and majority of the rural families are directly or indirectly engaged in agricultural activities. The annual rainfall ranges between 1000-1250 mm, but is quite erratic and confined to July-September. The majority of the farm families are illiterate and the average size of land holding is very small. Nearly 82 per cent of the farmers possess holding size less than 1 ha (0.52 ha) and only 12 percent farmers have 1-2 ha (1.39 ha) land. Irrigation status of agricultural land indicates that about 40 per cent of net sown area is wholly dependent on rain and remaining (60 per cent) is irrigated out of which only 18 per cent of the area is fully irrigated. The major area of

Table 1: Distribution of rice varieties grown on sample farms, 2015-16

Variety	Gorakhpur		Siddharthnagar	
	% share to farmers growing the variety	Area(ha)	% share to farmers growing the variety	Area(ha)
Samba Masuri sub1	11.67	7.09	6.67	1.62
Swarna Sub1	3.33	2.02	27.00	8.02
Kalanamak	3.33	1.21	73.33	18.32
Sarjoo-52	45.00	21.26	—	—
Swarna	16.67	9.05	3.56	1.39
Samba Masuri(BPT-5204)	28.33	13.77	31.23	8.62
Local varieties	20	11.34	6.67	1.62

Source: Field survey

[1]Submergence tolerant rice varieties having significant positive impacts on rice yield over current popular varieties when fields are submerged for 7 to 14 days with no yield penalty without flooding.

Table 2: Distribution of farmers according to their rice varietal diversity index

Rice varietal diversity categories	% farmers		
	Gorakhpur	Siddharthnagar	Total
No rice varietal diversity (0)	40.33	45.33	45.83
Low rice varietal diversity (0.01-0.25)	0	0	0
Medium rice varietal diversity (0.26 - 0.50)	43.00	48.66	43.33
High rice varietal diversity (>0.5)	16.67	5.00	10.83
Total	100	100	100

Source: Field survey

the region is occupied by rice-wheat cropping system having the cropping intensity of 150 per cent. Share cropping is the most popular form of land tenure. Altogether 11 improved as well as traditional rice varieties were planted in the study area, and four of these varieties were of local land races. The majority of sample farmers in Gorakhpur district (45 per cent of sample farmers) have grown Sarjoo-52 followed by Samba Masuri and Swarna varieties, while in Siddharthnagar district, 31 percent sample farmers were found cultivating Samba Masuri during the study period. An improved version of Samba Masuri and Swarna was released recently with submergence tolerance trait which is most suited in conditions when fields are submerged for 7 to 14 days with no yield penalty in without flooding conditions. Kalanamak variety of rice which is indigenous to the region and rated as very good in taste was grown by 73 percent of sample farmers in Siddarthnagar. This variety is also rated as premium rice and commands higher market price (Table 1).

On an average, majority of farmers have cultivated more than one rice variety followed by two to three varieties. Farmers were cultivating more than one variety as part of risk minimization and income diversification strategy owing to frequent onset of drought and flash floods, diverse household needs and market demand. The estimated rice varietal diversity index in the region ranged from 0 to 0.70 and results indicated that 46 per cent of the farmers had no rice varietal diversity (grew only one variety) followed by medium rice varietal diversity (43 per cent). Only 11 per cent of sample farmers have reported high rice varietal diversity. A comparison of two selected districts showed that in Gorakhpur district, 17 per cent of farmers had high rice varietal diversity index as against only 5 per cent in Siddharthnagar district. Hence results do not support the hypothesis that varietal diversity increases with an increase in environmental heterogeneity as the average number of varieties grown by farmers is less, reflecting socio-economic constraints in technology adoption. This was made explicitly clear when sample farmers were further examined regarding their seed purchasing behaviour. The frequency of paddy seed purchased as well as sources of seed purchase by the sample farmers' during 2015-16 revealed that only one third of farmers were purchasing paddy seed every year. Maximum number of sample farmers (40 per cent) reported to have purchased seed every alternate year, while another one fifth of farmers purchased rice seed after every two years. It was also reported that majority of the sample farmers' (39 per cent) used seed from own saved sources followed by seed from local market (32 per cent), fellow farmers (18 per cent) and seeds provided by the govt. scheme (11 per cent). Hence, results amply made clear that there still exists informal seed systems in the study area as most selected farmers preferred to use self-retained seeds for low cost of reasons.

A multivariate linear regression analysis is presented using diversity index as dependent variable to aid in understanding the determinant of farm crop diversity in rice. The results of the regression of the diversity index on the farmers' socio-economic characteristics, credit and market access etc., are presented in Table 3. The coefficient associated with the size of the operational holding was estimated positive and statistically significant. The coefficient associated with access to credit, number of visits made by extension personnel on farm also turned out to be positive and significant. The family size and caste did not have statistically significant effect on the varietal diversity. Thus, farm size, access to credit, education and age of the head of household were found to be the main factors determining the degree of varietal diversification in the study area.

Table 3: Determinants of rice varietal diversity on sample farms

Variables	Coefficients	Standard Error
Intercept	-0.44	0.14
Farm size	0.29	0.05
Non-farm income	2.02E-07	5.02E-07
Livestock units owned	-0.01	0.01
Age of head of household	0.006*	0.002
Distance from market	0.00067	0.005
Extension visits	0.07*	0.02
Level of education	0.03**	0.01
Access to institutional credit	0.11*	0.04
Family size	-0.003	0.004
Caste	0.07	0.04
R Square	0.60	-
Observations	120	-

Note: * and ** indicates significant at 1 and 5 per cent level, respectively.

Farmers' preference & perception on rice varietal traits

An analysis of farmers' preferences and perceptions showed (Table 4) that majority of sample farmers cultivating

Table 4: Farmers' perception of rice varietal traits in the study area

Traits	% farmers			
	Sarjoo-52	Swarna Sub 1/Samba Masuri Sub1	Samba/Samba Masuri (BPT-5204)	Kalanamak
Good eating quality	88.8	72.72	74.07	100
High yield performance	74.07	83.63	66.66	21.73
Higher price in the market	44.44	45.45	93.02	95.65
Early maturing	55.55	40.25	74.74	—
Resistance drought	—	—	—	47.82
Tolerance to lodging	81.48	81.81	92.52	91.30
Resistance to submergence	—	100	—	86.95
Resistance to pests/disease	40.74	54.54	81.48	—

Source: Field survey

Table 5: Farmers' perception on preferred varietal traits in improved rice cultivars

Attributes of varieties	Average Score	% farmers		Total
		Gorakhpur	Siddharthnagar	
High yield	7.86	90	100	95
Tolerance to submergence as well as drought resistance	7.81	100	83	92
Better taste	7.24	80	95	88
Stem borer resistance	7.20	93	86	90
Tolerance to lodging	7.19	100	90	95
Brown leaf spot resistance	7.07	96	100	98
Early maturity	7.04	83	93	88
Medium and slender grain	5.27	86	95	91

Source: Field survey

Sarjoo-52 (89%) and Kalanamak (100%) preferred these varieties for their good eating quality. However, Swarna Sub-1 and Samba Masuri Sub-1 were preferred by majority of farmers (84 per cent) for higher yield performance during field submergence conditions. Out of all the major rice varieties grown, farmers' opined that no variety is resistant to drought. Kalanamak, a traditional variety of the area was perceived by the respondents somewhat resistant to the drought. It is important to note that all the farmers were fully aware of the fact that Swarna Sub-1 and Samba Masuri Sub-1 are performing better in submergence conditions as compared to other existing rice varieties. Similarly, 81 per cent sample farmers preferred these two varieties because of resistance to major diseases and pests. More than 90 per cent farmers' also opined that both the Sub-1 varieties and Kalanamak are also having resistance to the lodging.

Data in Table 5 clearly revealed that among the varietal attributes which farmers from the region demand in new rice variety, higher yield and tolerance to drought and submergence together scored the highest in terms of preference scale in both the districts of the region due to frequent occurrences of drought and flash floods. Next to this, better taste and cooking quality received high on preference scale (7.24) and preferred by 80 per cent and 95 per cent farmers of Gorakhpur and Siddharthnagar districts. Tolerance to lodging was also a trait which was preferred by 100 per cent and 90 per cent farmers of Gorakhpur and Siddharthnagar respectively because most of the varieties lodge at the time of harvest that makes mechanical harvesting more difficult. Resistant to stem borer and brown leaf spot were also preferred by sizeable number of farmers in the study area.

CONCLUSION

The farmers' practice of growing old but long tested improved and traditional rice varieties due to their experience and perception about varietal traits suitability to the local environment seem to be major determinants of technology choices in the region. Though, the adoption rate of improved rice varieties like Swarna-Sub1 and Samba Masuri 1 was 50% among the sample households in the region, although all sample households in the region suffered from flash floods almost on recurrent basis. This indicates a range of socio-economic and institutional constraints limiting technology adoption. Thus, scope does exist for encouraging the adoption of improved varieties through appropriate policy and institutional interventions. The findings also suggest that there is great scope for improving the production and productivity of rainfed lowland rice one key constraints such as drought as well as submergence tolerance may be addressed aggressively by rice breeding programmes. Besides this, timely availability of quality seeds, improved crop management, and remunerative prices with effective procurement also need to be addressed adequately.In terms of preference for new cultivars, farmers preferred cultivars having high grain yield with drought as well as submergence tolerance and insect resistant without compromising other preferred attributes. The study also revealed that a considerable proportion of the farmers had limited knowledge of improved varieties and access to seeds. This further calls for more research and adequate extension services for better farm management.

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