The Role of Gender, Risk, and Time Preferences in Farmers' Rice Variety Selection in Eastern India

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ABSTRACT

Using data from 5,601 rice farmers in Eastern India, this study examined the role of gender, risk, and time preferences in farmers' rice variety selection in Eastern India. The determinants of the following were estimated: farmers' rice variety selection according to variety type (i.e., modern [non-hybrid], stress-tolerant, hybrid, and traditional), and farmers' main reasons (i.e., yield potential, taste/cooking quality, marketability/affordability, and stress tolerance) for choosing a rice variety. A multivariate probit model was employed to identify the factors that influence farmers' decision-making, since some farmers choose to mix rice varieties from multiple categories. The results revealed that female farmers, who are more risk-averse, usually choose rice varieties based on cooking quality (e.g., good taste, high cooking quality, and good straw quality) and stress tolerance. They are less likely to select hybrid rice, and also less likely to base their decision on market-oriented reasons, compared to male farmers. Certain rice varieties released many decades ago remain popular among farmers because of multiple preferred attributes. The preference model is useful in understanding why some varieties are more popular than others, among female and male farmers.

Keywords: risk preference, time preference, gender, climate change, rice variety, drought tolerance, submergence tolerance, Eastern India

JEL Classification: D81, J16, Q54, C35, O18, Q12

INTRODUCTION

Socio-economic, demographic, and institutional factors, in addition to technology attributes and economic returns, affect farmers' adoption of agricultural technology (Feder et al. 1985; Feder and Umali 1993; Estudillo and Otsuka 2013). Recent studies found that farmers also seek specific varietal attributes, such as early maturity, yield potential, tolerance to stress (e.g., pests and diseases, drought, and submergence), better processing quality, and plant and grain size (Kalinda et al. 2014; Joshi and Bauer 2006). Previous studies on farmers' adoption of rice varieties examined their choices through biological classification (Estudillo et al. 1999; Estudillo and Otsuka 2006), and focused on the dichotomy between traditional varieties (TVs) and modern varieties (MVs) or across generations of MVs based on years of release. This way of classifying choices corresponds well with yield potential. However, farmers choose rice varieties based on a range of attributes, which also includes cooking quality and stress tolerance. The biological classification fails to capture such preferences and provides minimal explanation as to why certain rice varieties remain popular for many decades.[1]

The biological classification is also ill-suited to understand the rice variety choices of female farmers, who tend to consider other attributes besides yield potential. Many female farmers consider taste as the most important characteristic, while many male farmers prioritize yield and marketability, in choosing an improved variety (Addison, Edusah, and Sarfo-Mensah 2014). In developing improved varieties, less attention has been given to gender preferences in varietal attributes (Gladwin and McMillan 1989). Without addressing gender-specific constraints and preferences, the acceptance and full potential of improved technology may never be reached (Klawitter et al. 2009).

A plausible reason for the slow adoption of improved seed technology is the time lag between the costs associated at adoption time and the realization of benefits at harvest time. Farmers with a high discount rate, which implies that they consider the value of the future returns less than what those with a low discount rate do, may be reluctant to invest. Also, risk-averse farmers may be reluctant to choose new technology that they find unfamiliar, even if the new technology is designed to reduce risks.

This study examined the role of gender, risk, and time preferences in farmers' rice variety selection in Eastern India. The determinants of the following were estimated: farmers' rice variety selection according to variety types[2] (i.e., MVs [non-hybrid], stress-tolerant varieties [STRVs], hybrid, and TVs), and farmers' main reasons (i.e., yield potential, taste/cooking quality, marketability/affordability, and stress tolerance) for choosing a rice variety.

The data used in this study were obtained from a large survey of 5,601 rice farmers, covering rice production during the 2013 Kharif season, in Eastern India. The survey was part of the Rice Monitoring Survey (RMS) project of the International Rice Research Institute (IRRI), which was conducted in early 2014 to understand the diffusion process of new rice varieties in South Asia. The size of the survey provides sufficient data on female farmers, which is an advantage of the current study because many gender studies rely on limited data. It is crucial to have ample data on female

1 A recent study by Tsusaka et al. (2015) found out that farmers in South Asia cultivate mostly early-generation MVs that were released in the 1980s and 1990s or earlier.

2 Although hybrid and stress-tolerant rice varieties are also modern varieties, they were excluded from the modern variety category throughout the paper.

farmers because they also make significant agricultural decisions.

This paper is organized into seven sections. The first section provides the context of the study. The second section discusses the rationale for addressing gender in rice variety selection. The third section describes the data used in this paper. The fourth section explains how rice varieties were categorized. The fifth section supplies the estimation methods used and variables in the study. The sixth section discusses the results. The seventh section is the conclusion.

Rationale for Addressing Gender in Rice Variety Selection

The recognition of gender roles and gender-specific needs makes it possible to design and adopt new farming technologies that will benefit both women and men in rice-producing areas (FAO 2004). This study explored gender-differentiated roles in rice variety selection. Women are often considered as natural custodians of seeds (Mgonja 2011), but their seed access is often limited by cultural and economic barriers. As reported by the Food and Agriculture Organization of the United Nations and the International Crops Research Institute for the Semi-Arid Tropics (2004), women mainly oversee seed selection, while men manage the construction of adequate seed storage structures. Both female and male farmers prefer the high-yield variety, but their end-user purpose (e.g., sale, family consumption or food security, special occasion, and feed or fodder) influence their respective preferences in varietal attributes. Female farmers often use a broader set of selection criteria than their male counterparts because they use plants in more diverse ways (Howard et al. 2003). Few studies, however, have conducted statistical gender analysis to understand gender preferences in rice variety selection. In rural India, Paris et al. (2001) investigated gender-based differences in rice variety preferences. They observed that women gave more importance to attributes such as weed competitiveness, ease of husking and threshing, and suitability for food preparation. In Nepal, Joshi et al. (2002) found that local female farmers prefer to grow low-iron than high-iron rice varieties. The color of low-iron rice varieties tends to be white, while that of high-iron rice varieties is reddish. Cultural norms and pragmatism influence their preferences, such as the prestige associated with white rice and the lower amount of labor required in handling white rice compared to red rice, since red bran has to be removed with a rice pounder (Meinzen-Dick et al. 2011). Nanfumba et al. (2013) reported that a variety's maturity stage is very crucial. The authors revealed male farmers view the variety's susceptibility to lodging at maturity stage as an attribute that causes the spoilage of grains that they would otherwise market. The same study found female farmers consider late-maturing varieties more time- and labor-consuming because such varieties require more weeding, which decreases the amount of time they have to find food for their family. Similar results were documented by Addison, Edusah, and Sarfo-Mensah (2014) in Ghana.

A study by Mgonja (2011) in Africa document increasing feminization of agriculture in Africa and suggest empowering them to actively participate in better and efficient farming practice can lead to enormous agricultural production. The World Bank (2005) has documented the increasing participation of women in the formation and management of small seed enterprises. According to Paris et al. (2008), involvement in participatory varietal selection and access to new seeds are positively and significantly related to women's empowerment. Their study, which also synthesized the findings of other studies, further revealed that incorporating gender preferences in varietal attributes (e.g., related to labor, consumption, and post-harvest) increases adoption potential compared to merely evaluating new varieties on yield-related, and often gender-neutral characteristics.

The importance of gender is increasingly being recognized in breeding programs, although research on this area is relatively scant (Manyong et al. 2000; CIMMYT 2015). This was the motivation to conduct a study to understand female and male farmers' preferences in varietal attributes and the inherent trade-offs that farmers make among individual attributes in their decision to grow a new variety. To fill the knowledge gap, the present study assessed gender preferences in varietal attributes among farmers. In the survey used in this study, a household member who was responsible for rice farming was interviewed and asked to participate in time and risk preference games, and the gender of the respondent has been used in the analyses.

SAMPLING METHODS

The survey in India, from IRRI's RMS project, employed a multi-stage sampling method to select the states or regions, districts, and villages (Yamano et al. 2014). Four Eastern Indian states were selected purposively: Bihar, Odisha, Eastern Uttar Pradesh, and West Bengal. These are the major rice-growing states in India and account for 43.6 percent of the total rice area in the country (Ministry of Agriculture 2014: 74). They occupy different agro-ecological zones and thus differ in production practices as well as rice varieties grown.

In each state, approximately half of the total number of districts[3] were randomly selected, from which a total of 150 villages were also randomly chosen. A total of 600 villages were selected across the four states and 10 households from each village were randomly selected for interviews (Figure 1). However, the total number of households included in the analysis declined to 5,601 because of inaccessibility or other technical problems, including corrupted computer-based interview files (Table 1). In each household, the household member who was mainly responsible for rice production was selected for the interview. About 4.5 percent of the respondents were women. In the rest of the paper, we investigated the preference of male and female respondents over rice varieties.

Data from female and male respondents were disaggregated to understand gender preferences in varietal attributes (see Table 2). On the average, the female respondents were 43 years old and the male respondents were 48 years old. Female and male respondents spent an average of 3 years and 6.6 years in school, respectively. As such, women are less likely to assume a leading role in their villages. The female respondents' household characteristics indicate that they live in less-endowed households and are more likely to belong to a Scheduled Caste or a Scheduled Tribe. The female respondents had smaller households and land compared to their male counterparts, and the average values of their agricultural wealth and non-agricultural indices were both negative. However, there was minimal gender difference in the experience of drought and submergence in the past five years. Thus, the female and male respondents were equally exposed to drought and submergence, but the female respondents are less endowed, in terms of productive and households assets, than their male counterparts. For risk preference, the female respondents had an average risk-averse measure of 0.45, which suggests that they are more risk-averse than the male respondents. The male respondents had a higher average time discount rate of 6.5, which indicates that they are less patient than the female respondents.

3 The village-level information of Census 2011 was unavailable at the time of sampling for the survey, so information from Census 2001 was considered.

Figure 1. Map of surveyed villages under abiotic stress

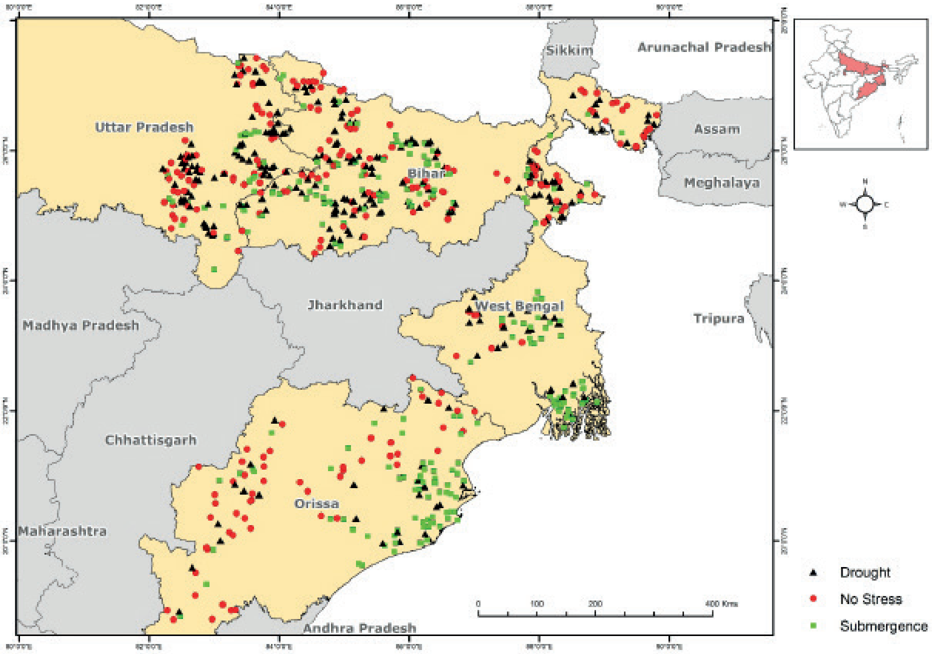


Table 1. Distribution of sample households (2014)

State	No. of Sampled Households	Female Respondents (%)	By Abiotic Stress (%)		
			No Stress	Submergence	Drought
Eastern Uttar Pradesh	1,384	6.1	34.0	17.3	48.7
Bihar	1,392	2.4	30.0	32.0	38.0
Odisha	1,393	4.5	34.0	48.7	17.3
West Bengal	1,432	5.0	26.0	40.7	33.3
Total	5,601	4.5	31.0	34.6	34.4

Rice Variety Preferences and Grouping

The results of the survey found that most of the farmers cultivated more than one variety in the 2013 Kharif season (Table 3). The most popular rice variety in Eastern India is Swarna (MTU 7029), which occupies 25 percent of the rice area and was cultivated by more than 30 percent of the respondents. This variety was released in 1979. Another popular variety is Mahsuri, which occupies 5.4 percent of the rice area. Other varieties, such as Moti, Arize 6444, Sarju-52, Sambha Mahsuri, Swarna-Sub1, Lalat, Pooja, and MTU1001, occupy more than 1 percent of the rice area individually. Most of the listed varieties were released before 2000. Rice hybrid Arize-6444 was released in 2007, while submergence-tolerant Swarna-Sub1 was released in 2009. Arize-6444 was popular in Bihar, where it is heavily promoted by seed dealers. Swarna-Sub1, which can survive for up to 14 days in full submergence, was developed

Table 2. Basic descriptive statistics (n = 5,601)

Variable	Basic Description	Male		Female	
		Mean (s.d.)		Mean (s.d.)	
Gender	Dummy = 1, if female respondent, 0 otherwise	95.5	(0.19)	4.50	(0.18)
Age	Age of respondent	48.1	(12.80)	42.60	(11.60)
Educational level	Number of years in education	6.64	(4.49)	3.01	(3.86)
Group leader	Dummy variable, whether any household member has a recognized role in the village	0.027	(0.16)	0.004	(0.06)
Caste	Dummy variable, receives a value of 1 if the household belongs to a Scheduled Caste or a Scheduled Tribe and 0 if otherwise	0.28	(0.45)	0.36	(0.48)
Family size	Number of family members in a household	7.82	(4.78)	5.79	(2.82)
Land size	Size of cultivated area in hectares	1.79	(4.85)	1.21	(2.34)
Agriculture wealth index	Composite index for agriculture assets owned	0.013	(1.01)	-0.29	(0.57)
Non-agriculture wealth index	Composite index for non-agriculture assets owned	0.014	(1.01)	-0.27	(0.65)
Tropical livestock unit	Composite index for livestock holdings	3.96	(3.69)	3.00	(3.19)
Drought experience	Number of years with no rainfall in the past 5 years	1.76	(1.49)	1.92	(1.70)
Submerge experience	Number of years with submergence in past 5 years	1.02	(1.28)	1.01	(1.34)
Risk aversion	Constant partial risk aversion coefficient, measured in a separate experimental study	0.33	(0.11)	0.45	(0.09)
Time discount rate	Subjective discount rate, measured in a separate experimental study	6.49	(1.81)	5.64	(1.75)

Note: The respondents were the prime decision-makers in rice farming in their respective families.

by IRRI (Xu and Mackill 1996; Septiningsih et al. 2009). It has been distributed in Eastern India and Bangladesh since 2009 (Yamano et al. 2014).[4]

It is not easy to examine farmers' adoption of individual varieties separately. This study used a conventional method of categorization, where rice varieties are grouped based on their biological classification, such as MVs (i.e., non-hybrid varieties bred by scientists since 1950s), STRVs (i.e., varieties that are resistant to stress like drought and submergence), hybrid, TVs (i.e., indigenous varieties that farmers have used for a long time), and unclassified (see Table 4).

Approximately 56 percent and 3 percent of the respondents cultivated only MVs and STRVs, respectively (see Table 5). Among the respondents who cultivated STRVs, 8 percent cultivated only hybrid rice varieties and 6.6 percent cultivated only TVs. Hybrid varieties

4 Swarna-Sub1 was developed by introgressing a single quantitative trait locus (QTL) responsible for submergence tolerance to Swarna. Swarna was chosen to be a parental variety so that farmers familiar with Swarna would adopt Swarna-Sub1 easily. Yamano et al. (2016) describe the development of Swarna-Sub1 and other rice technologies that have been developed and promoted among farmers in recent years.

Table 3. Distribution of rice varieties reported by farmers (2013 Kharif season)

Variety Name	Cultivated Area[1]		Farmers[1]		Year of Release[2]	Duration (Days)[2]	Major Category[2]
	Ha	%	No.	%			
Swarna	2,926.7	25.0	1,694	30.2	1979	150-155	MV
Mahsuri	641.4	5.4	276	4.9	1972	125-130	MV
Moti	568.7	4.8	431	7.7	1988	140-145	MV
Arize 6444	496.2	4.2	261	4.6	2007	135-140	Hybrid
Sarju 52	363.7	3.1	244	4.3	1980	130-133	MV
Samba Mahsori	324.4	2.7	260	4.6	1989	140-145	MV
Swarna-Sub1	250.8	2.1	217	3.8	2009	145-150	
Lalat	246.0	2.1	250	4.4	1988	125-130	MV
Pooja	203.1	1.7	365	6.5	1999	140-150	MV
MTU 1001	182.7	1.5	158	2.8	1997	130-135	MV
Khandagiri	64.1	0.5	123	2.2	1992	125-130	MV
Kalachampa	55.0	0.4	113	2.0	1999	125-130	TV
Other hybrid	694.8	5.94	373	6.6			
Other modern varieties	1,261.2	10.7	824	14.7			
Other traditional	777.8	6.6	609	10.8			
Unknown/ Do not know	2,605.9	22.3	1,300	23.2			
Total sample	11,702.2	100	5601	100			

Note: Short duration is 90–120 days, medium duration is 120–140 days, and long duration is 140–180 days; MV = modern variety (non-hybrid); TV = traditional variety

Sources: [1] Yamano 2017

[2] Directorate of Rice Development: Details of Rice Varieties. Department of Agriculture, Cooperation & Farmer Welfare. NIC Bihar State Centre. http://drdpat.bih.nic.in/

are grown mostly in Bihar (51%) and Eastern Uttar Pradesh (38.7%). In total, about 86 percent of the respondents cultivated rice varieties that belonged to one group. Farmers that cultivated rice varieties from multiple groups usually combined MVs and TVs.

As discussed previously, there is limited research on how variety attributes influence farmers' preferences for modern varieties. In this study, the respondents were asked about their main reasons for choosing a rice variety that was cultivated in the 2013 Kharif season (see Table 6). The main reasons were high yield, stress tolerance (i.e., varieties with short duration and tolerance to pests and diseases, drought, and submergence), market-oriented (i.e., marketable grains, affordable seeds, available seeds, easily threshed, and good for storage), and cooking quality (i.e., good taste, high cooking quality, and good straw quality).

Both female and male farmers listed high yield as the main reason behind their chosen variety. This applied to all popular varieties except Sambha Mahsori and Sarju 52, which were chosen primarily because of their grain quality and stress tolerance, respectively. Among the farmers that cultivated Swarna, 74.6 percent said that they liked it because of its high yield. Thus, it can be postulated that farmers take yield into account when deciding

Table 4. Conventional grouping based on agro-economic qualities

Category	Characterization	Varieties Included
MVs (non-hybrid)	High-yielding varieties	Swarna, Sambha Mansori, Moti, Pooja, Lalat, MTU-1001, Khandagiri, Naveen, Pant 11, IR-36, Kalanamak, Satabadi,
STRVs	Varieties resistant to stress like drought and submergence	Flood-resistant varieties: Swarna-Sub1, IR 64 SUb1, Samba Sub1 Drought-resistant Varieties: NDR97, Sosku Samarat, Sahbaghi Dhan, CSR-36
Hybrid	Varieties produced with cross-pollinated crops to improve agronomic qualities such as high yield, resistance to disease, better weed control, more soil nutrient, etc. These seeds need to be purchased every year.	Arize 6444, Phb-71, Loknath, Gorkhnath, Gangakaveri, Pioneer, Dhanraj
TVs	Indigenous varieties farmers have been using for a long time	Kalachampa, US 312, Reshma, Tulsi, Gutkha, Parvati,Jaya
Unclassified	The name and origin of the varieties are unclear, or farmers did not know the name	Badala, Annapurana, Zera etc.,

Note: MVs = Modern variety (non-hybrid; excluding stress-tolerant varieties); STRV = stress-tolerant rice variety; TV = traditional variety

Table 5. Joint and marginal probabilities by conventional grouping

Possible Combinations	Solo	Two Category Combinations				Three
		MVs	STRVs	Hybrid	TVs	
MVs only	55.9					
STRVs only	2.9	1.0				
Hybrid only	8.0	2.8	0.2			
TVs only	6.6	4.2	0.0	0.4		
Unclassified only	12.7	0.9	0.4	0.1	1.4	
Three or more (combined)						2.5
Total	86.1	8.9	0.6	0.5	1.4	2.5

on what variety to cultivate. The following varieties, which were released in the 1980s or earlier, remain popular and irreplaceable by new varieties because of their grain quality: Sambha Mahsori (75.5), Kalachampa (20.9%), Mahsuri (20.6%), and Moti (19.4%). The respondents indicated that they liked Sarju 52 because of its stress tolerance (34.9%) and high yield (29%), along with market-oriented reasons (14%). An assessment of the proportion of farmers who selected rice varieties for different reasons revealed that decisions were based mainly on high yield (55.3%), followed by market-oriented reasons (10.7%), cooking quality (9.9%), and stress tolerance (7.3%) (Table 7). In total, 88.3 percent of the respondents selected rice varieties that belonged to one preference category. The remaining respondents mixed varieties from different preference categories. Popular combinations included high yield and market-oriented reasons as well as high yield and cooking quality. It appears that some farmers diversify their variety portfolio for multiple reasons.

Table 6. Main reasons for rice variety selections

Varieties	Main Reason				
	High Yield	Stress Tolerance	Market-oriented Reasons	Cooking Quality	Others
Swarna	74.6	8.6	7.4	8.0	1.4
Pooja	82.7	1.9	7.4	7.1	0.8
Lalat	61.2	14.0	17.8	5.5	1.6
Moti	57.4	7.1	5.3	19.4	10.9
MTU 1001	65.6	3.1	18.2	11.9	1.4
Mahsuri	54.7	5.4	16.8	20.6	2.4
Swarna-Sub1	90.9	1.0	6.8	1.4	0.0
Sambha Mahsori	12.8	3.6	5.5	75.5	2.7
Sarju 52	29.0	34.9	18.0	4.8	13.2
Arize 644	83.1	10.0	4.6	2.0	0.3
Khandagiri	70.7	13.0	9.8	4.9	1.6
Kalachampa	73.9	2.7	1.7	20.9	0.9
Other hybrid	77.8	2.6	11.6	5.3	2.8
Other modern varieties	58.8	6.1	16.2	14.4	4.7
Other traditional	33.1	17.1	20.2	26.3	3.1
Unknown/Do not know	44.7	20.4	17.1	14.9	3

Note: Stress-tolerant qualities include pest and disease resistant, drought tolerant, submergence tolerant, and short duration. Market-oriented qualities include marketable grains, affordable seeds, available seeds, easily threshed, and good for storage. Quality includes good taste, high cooking quality, and good straw quality.

Based on the gender-disaggregated distribution of rice varieties by conventional grouping, majority of the respondents selected MVs (Figure 2). Hybrid varieties are more commonly used by male farmers (12%) than female farmers (7%). According to Yamano et al. (2015), female farmers have a lower self-perception score toward agricultural technology. As such, it is possible that they contact seed dealers less frequently than male farmers do. Hybrid seeds are also more costly. These reasons may explain why only a small percentage of female farmers use hybrid varieties. However, overall, there was minimal difference between female and male farmers in terms of their selection of rice variety types based on conventional grouping. The gender-disaggregated distribution of varieties by preference-based grouping revealed greater differences (Figure 3). Female farmers appreciated the taste and cooking quality (19%) as well as stress tolerance (17%) of a variety, while male farmers appreciated features like taste and cooking quality (16%), marketability and affordability (16%). Figure 2 better illustrates the preferences of female and male farmers.

ESTIMATION METHODS AND VARIABLES

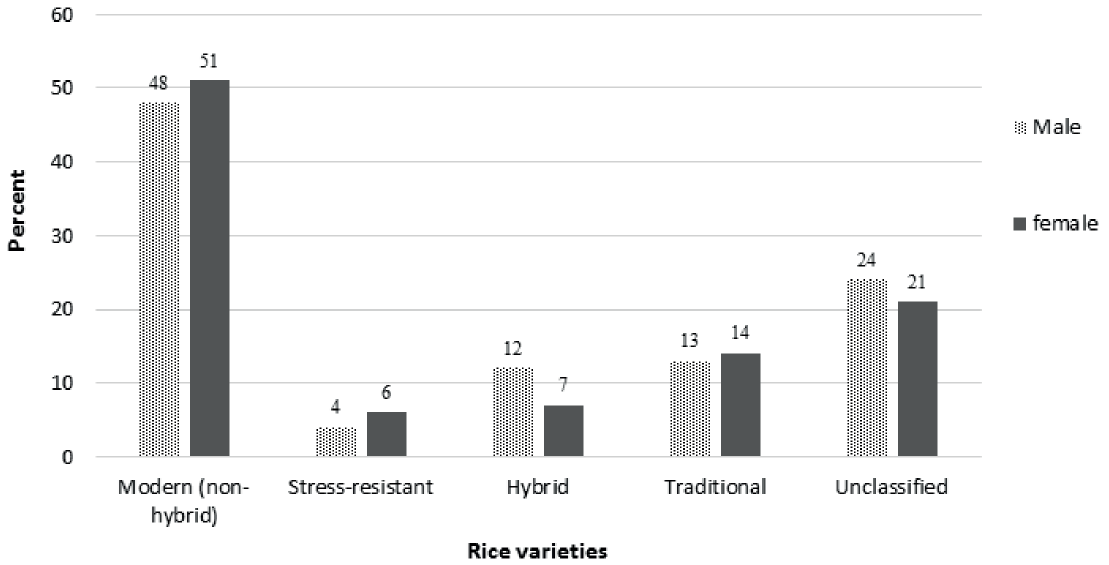
To elicit the relationship between farmers' risk preference and adoption of varieties, especially STRVs, the major categories of varieties were used. These categories were based on the conventional and the preference-based grouping. The focus was on how the farmers arrived at a decision when they selected

Table 7. Joint marginal probabilities by preference-based grouping

Possible Combinations	One Reason	Two Reasons Mixed				Three or More Reasons Mixed
		Yield	Stress Tolerance	Marketability	Cooking Quality	
High yield	55.3		-	-		
Stress tolerance	7.3	2.2		-		
Market-oriented reasons	10.7	4.6	1.5			
Cooking quality	9.9	4.5	0.5	2.1		
Other	0.1	0.0	0.0	0.0	0.0	
Three or more reasons mixed						1.4
All	88.3	11.3	2.0	2.1	0	1.4

Note: Stress-tolerant qualities include pest and disease resistance, drought tolerance, submergence tolerance, and short duration. Market-oriented qualities include marketable grains, affordable seeds, available seeds, easily threshed, and good for storage. Quality includes good taste, high cooking quality, and good straw quality.

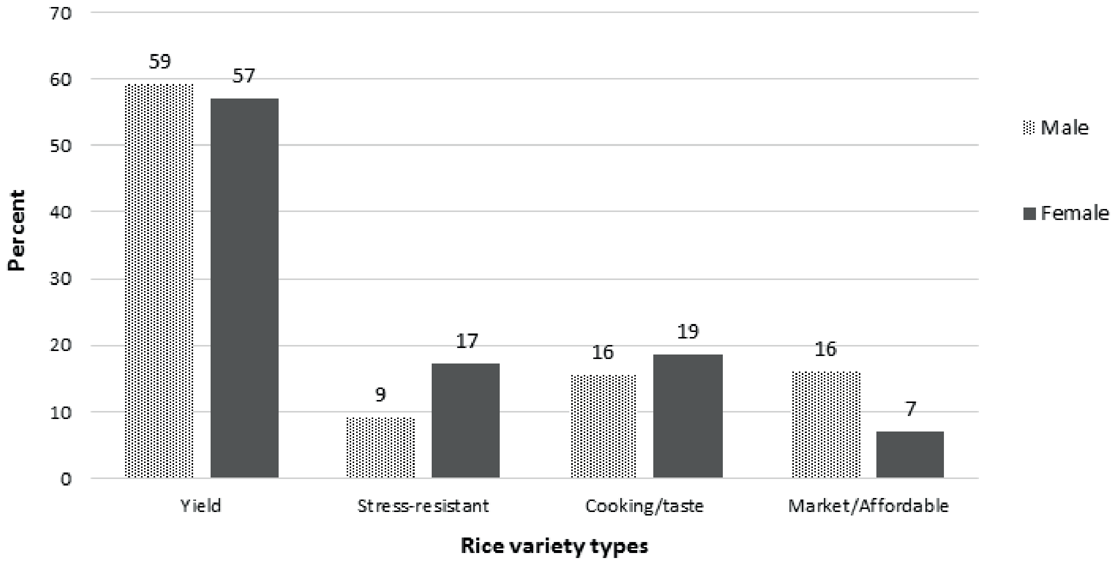
Figure 2. Gender-disaggregated distribution of varieties by conventional grouping



varieties among the major categories. It was assumed that the farmers knew the function and profitability of each variety they cultivated. The possibility that the farmers' risk and time preferences will influence their decision was also considered.

Most of the farmers grow different types of varieties in a season. The methodology offers insight on the socio-economic factors that drive farmers to adopt different rice varieties. The empirical specification of choice decision over the four different categories of varieties

Figure 3. Gender-disaggregated distribution of varieties by preference-based grouping



can be modelled in two ways: multinomial or multivariate regression analysis. One of the underlying assumptions of multinomial models is the independence of irrelevant alternatives (i.e., error terms of the choice equations are mutually exclusive) (Greene 2003). However, the choices among the different categories are not mutually exclusive because farmers grow multiple rice varieties simultaneously. As such, the random error components of the four variety categories may be correlated. Therefore, a multivariate probit model (MVP) was used because it allows for the possible contemporaneous correlation in the choice to access the four different variety categories simultaneously. MVP estimation has already been used in a number of studies that evaluate factors that affect adoption of agricultural technologies (see Ghimire et al. 2012; Mittal and Mehar 2015). These studies argue that modelling adoption decisions using an MVP framework allows for increased efficiency in estimation in the case of simultaneity of adoption.

The equation is:

$$Y_{ij} = X'_{ij} \beta_j + \varepsilon_{ij} \tag{1}$$

where:

$Y_{ij\,(j=1,\dots,m)}$ = represents the different variety categories or the farmer's main reasons for selecting a rice variety

$_{i,}X'_{ij}$ = is a 1×k vector of observed variables that affect the farmer's decision

β_j = is a k×1 vector of unknown parameters (to be estimated)

ε_{ij} = is the unobserved error term

Assuming the error terms (across $j = 1,\dots, m$ alternatives) are multivariate and are normally distributed with mean vector equal to zero, the unknown parameters in equation (1) are estimated using simulated maximum likelihood.

Prior to estimating the model parameters, it is crucial to look into the problem of multicollinearity among the explanatory variables. A condition index was used to detect correlation (Belsley et al. 1980). In this study, the value of the condition index was less than 30. Therefore, there was no problem of multicollinearity in the data.The pair-wise correlation of the error terms associated with a farmer's adoption decision was computed and its significance was tested to further justify the use of the MVP. The independent variables that were likely to influence the farmer's behavior in accessing information from different sources were age, education level, farm size, access to assets, and geographical parameters represented by state dummies.

Education Level

The education level was measured in terms of the level of literacy as a continuous variable. Education is one of the important factors that influence a farmer's decision to bear the risks associated with new technologies and modern information sources. Farmers with better education are seen to be earlier adopters of modern technologies and apply modern inputs more efficiently throughout the adoption process (Feder et al. 1985). Jenkins et al. (2011), Thompson (2012), Just et al. (2006), and Ali and Kumar (2010) demonstrated in their studies that age, education, and income are important parameters that influence a farmer's decision to select from different information sources.

Gender

Women and men follow different coping strategies to mitigate risk, given their boundary of knowledge and resources. In previous empirical studies (Byrnes et al. 1999; Eckel and Grossman 2008), it was found that women are more risk averse than men. Failure to include gender-differentiated production and consumption attributes and focusing on the wrong attributes lead to bias and inappropriate varietal promotions. Paris et al. (2008) suggest that ignoring women's indigenous knowledge and rice variety preferences may result in slow adoption of new varieties. Consulting women and involving them in varietal evaluation leads to the inclusion of varietal traits, especially gender-related varietal preferences, leading to better acceptability and faster adoption of varieties (Lilja and Erenstein 2002). A recent study examining gender-differentiated preferences for cassava has suggested that breeders should include trait in cassava that makes it is easy to peel, a trait preferred by women exclusively, as most of the women are processors (Bentley et al. 2017).

Risk Aversion and Time Discount Rate

Considering the time lag between sowing and yield realization of a variety as well as climate uncertainty, the risk and time preferences of farmers could affect their adoption decision. It is measured using experimental game played during survey (see Mehar 2016 for a detailed methodology). Most of the farmers are risk averse, which is one of the major hindrances towards the adoption of new seed technology (Feder, Just, and Zilberman 1985). At the time the current study was conducted, no research had been previously conducted on the role of time preferences in the adoption of new technology.

Farm Size

Farm size is a proxy for a farmer's economic status. It is the total amount of land in acres that a farmer owns or hires for a particular variety. It is hypothesized that the more land a farmer has or hires to grow particular variety, the wealthier she or he is. Farm size is expected to be positively associated with risk-seeking. The sample has a larger share of small and marginal farm holders, and this matches the operational land holding statistics of agricultural census data by the Government of India.

Caste

The caste system strongly influences the lives of people, especially in rural areas. An upper caste farmer is more likely to have access to resources such as labor and credit, and thus more likely to take risks. Using randomized field experiments in 128 villages of Odisha, Dar et al. (2013) examined the impact of the submergence-tolerant rice variety Swarna-Sub1 on rice yields as well as on socially disadvantaged groups of people (i.e., Scheduled Caste and Scheduled Tribe).

Household Characteristics

Family size

Family size is captured as the number of adult members that live in the same household. Since farming is a family affair and most of the members are directly and indirectly involved in farming, more adult member means more labor. This decreases the risk of not having enough labor and can also result in farmers being able to take more risks. Apart from their own risk behavior, farmers' decision to adopt a new technology is also affected by the climatic conditions of their region.

Stress experience

Farmers were asked about their experience of drought and submergence in the past five years. This information was used to understand relationship between farmers' stress experience and their varietal preferences. Several household studies (Pender et al. 2004; Reardon and Taylor 1996; Tanaka 2013; Skees et al. 2001) found that in less favorable agro-climatic zones, farmers experience a lower level and/or a higher variability of crop yields than those in more favorable zones, resulting in different risk-coping strategies across zones. Fearing high variability in farm income due to drought or shorter crop season, farmers in less favorable areas may exhibit stronger impatience or aversion to risks than those in more favorable areas (Cardenas and Carpenter 2008). Alternatively, the relatively low level of welfare due to unfavorable conditions may result in higher risk aversion or higher discounting.

Family status

For variables where a direct relationship was not observable, composite indices[5] were constructed using different indicators. For the analysis, tropical livestock unit as well as agriculture and non-agriculture wealth indices were used. In rural economies, families with a recognized status in society are considered more progressive and influential. This study sought to determine if having a recognized social role influenced household members' decision to select an improved variety. This study tried to capture whether a member of the household has a recognized role (such as progressive farmer, community leader, member or head of Panchayat Raj Institution, member of agriculture department, etc.). This is included as leadership dummy in the empirical analysis.

RESULTS AND DISCUSSION

Conventional Grouping

The estimation results on the factors affecting farmers' rice variety selection are presented in Table 8. The MVP coefficient estimates show that the estimated coefficients differ substantially across the equations. The likelihood ratio test statistics rejects the

5 The composite index is formed measuring multi-dimensional concepts that cannot be captured by a single indicator (Nardo et al.2005).

null hypothesis of equal-slope coefficients, indicating the heterogeneity in selection from different categories and relevance of the MVP model compared to the probit model. The results suggest that other things the same, farmers are more likely to select modern varieties and less likely to select STRVs. However, it is important to note here that STRVs as reported by surveyed farmers were released in India only in the past few years. Thus, there is a possibility that surveyed farmers are not aware, or able to receive such seeds.

The gender dummy coefficients show that female farmers are more likely to select modern varieties and less likely to select hybrid varieties. This finding is of particular interest in developing countries, where female involvement in agriculture is increasing mainly due to male migration (Datta and Mishra 2011; Kalmakar 2011; Krishnaraj et al. 2008: 45; Rao 2006; Vepa 2004). Moreover, hybrid rice seeds may not be affordable to female farmers, who are mostly resource poor (Erenstein et al. 2007; OECD 2012: 86).

Agriculture and non-agriculture wealth indices were positively correlated with selection from modern varieties. The tropical livestock unit was positively associated with the selection of hybrid variety. The non-agriculture wealth index was positively associated with modern varieties and negatively with STRVs. When the size of farm land increases, the likelihood that farmers will adopt STRVs also increases. This suggests that farmers with large farms could be cultivating STRVs on a portion of their land. Progressive farmers are more likely to select modern varieties than STRVs. Family size negatively influences the likelihood that farmers will select STRVs. Farmers might prefer options with higher yield and with more cooking-related attributes to meet the needs of a large family. The number of years of experiencing stress influences the selection decision significantly. As farmers' years of experiencing drought increases, the more likely they are to select hybrid category and less likely to select TVs and STRVs. However, as farmers' years of experiencing submergence increase, the more likely they are to select TVs and less likely to select STRVs and modern varieties.

The state dummy results show that among the four variety categories, farmers in Eastern Uttar Pradesh are more likely to choose STRVs and modern varieties compared to farmers in West Bengal. This may be due to better wealth parameters and farm holdings among farmers in Eastern Uttar Pradesh. Farmers from Bihar are more likely to select variety from hybrid and less from modern varieties as compared to West Bengal farmers. This is also due to private companies' initiatives to promote hybrid varieties in Bihar. Farmers in Odisha are more likely to select hybrid and modern varieties than STRVs. The focus group discussion with farmers and discussion with agriculture experts revealed that most of the farmers have the misconception that any new variety introduced to them are hybrids and can be cultivated for a year.

Preferences-based Grouping

The estimation results on the factors affecting farmers' rice variety selection based on preferences are presented in Table 9. The descriptive statistics show that yield is the primary consideration in selecting a rice variety. However, the MVP regression results show that keeping all things constant, farmers are less likely to prefer high-yield varieties and more likely to select varieties with positive market-oriented attributes. Stress experience plays a crucial role in explaining farmers' rice variety selection. As farmers' years of experiencing drought or submergence increase, the less likely they are to prefer varieties with positive market-oriented and cooking attributes, and the more likely they are to choose varieties that have higher stress tolerance and yield.

Table 8. Estimated parameters of farmer attributes on rice variety selection by conventional grouping (MVP)

Variables	STRVs	Hybrid	MVs	Traditional
Gender (Dummy, Female=1)	-0.113 (0.16)	-0.470** (0.175)	0.423*** (0.106)	-0.223 (0.126)
Risk aversion	2.17 (1.217)	0.853 (1.151	-3.399*** (0.778)	0.545 (0.914)
Time discount rate	0.508* (0.204)	-0.176 (0.181)	-0.383** (0.127)	-0.194 (0.154)
Caste	-0.045 (0.069)	-0.255*** (0.071)	-0.085* (0.043)	-0.115* (0.051)
Family size	-0.020* (0.008)	0.009 (0.006)	0.004 (0.005)	0 (0.007)
Agriculture wealth index	0.04 (0.046)	-0.002 (0.035)	0.057* (0.028)	-0.013 (0.035)
Non-agriculture wealth index	-0.566* (0.224)	0.178 (0.198)	0.342* (0.139)	0.194 (0.169)
Tropical livestock unit	-0.013 (0.012)	0.048*** (0.01)	0.01 (0.007)	0.005 (0.009)
Years of drought experience	-0.074*** (0.021)	0.038* (0.017)	0.005 (0.013)	-0.077*** (0.016
Years of submergence experience	-0.065** (0.024)	0.023 (0.019)	-0.059*** (0.014)	0.101*** (0.017)
Farm size	0.029* (0.013)	-0.011 (0.012)	-0.003 (0.01)	-0.002 (0.01)
Education level	-0.019* (0.01)	0.009 (0.009)	0.006 (0.006)	0.005 (0.008)
Group leader	-0.843* (0.34)	-0.019 (0.283)	0.711*** (0.208)	0.259 (0.252)
State-fixed Effects (Reference: West Bengal)				
Bihar	0.165 (0.271)	2.219*** (0.235)	-0.867*** (0.169)	-0.183 (0.209)
Odisha	-1.403* (0.911)	1.512* (0.816)	1.624*** (0.570)	0.615 (0.689)
Eastern Uttar Pradesh	0.814** (0.248)	1.655*** (0.258)	-0.636*** (0.157)	-0.500** (0.188)
Constant	-5.017*** (1.232)	-2.29 (1.103)	3.992*** (0.769)	-0.077 (0.924)
Number of observations	5,563			
Log-Likelihood	-7,850.692			
Wald chi^2 (64)	989.44*			

Notes: Figures in parentheses are robust standard errors; *, **, and *** represent statistical significance at 1%, 5%, and 10% levels, respectively.

Likelihood Ratio Test H0: $\rho21 = \rho31 = \rho41 = \rho32 = \rho42 = \rho43 = 0$, $\chi^2(6)$ = 648.96, p-value = 0.0000

Table 9. Estimated parameters of farmer attributes on rice variety selection by preference-based grouping (MVP)

Variables	Stress Tolerance	Yield	Marketability	Cooking Quality
Gender (Dummy, Female=1)	0.188 (0.116)	-0.213* (0.100)	-0.149 (0.120)	-0.068 (0.110)
Risk aversion	1.047 (0.955)	0.355 (0.781	-2.347** (0.852)	0.902 (0.865)
Time discount rate	0.354* (0.156)	0.123 (0.128)	-0.418** (0.140)	-0.06 (0.144)
Caste	0.08 (0.053)	0.013 (0.044)	-0.173*** (0.049)	-0.187*** (0.05)
Family size	0.009 (0.006)	-0.003 (0.005)	0.003 (0.005)	-0.005 (0.006)
Agriculture wealth index	-0.091** (0.035)	0.099*** (0.028)	0.022 (0.029)	-0.041 (0.030)
Non-agriculture wealth index	0.387* (0.171)	-0.196 (0.14)	0.488** (0.154)	0.121 (0.158)
Tropical livestock unit	0.002 (0.009)	0.019* (0.007)	0.005 (0.008)	-0.019* (0.008)
Years of drought experience	0.034* (0.015)	0.053*** (0.013)	-0.130*** (0.014)	-0.084*** (0.014)
Years of submergence experience	0.116*** (0.017)	0.022 (0.014)	-0.046** (0.016)	-0.046** (0.016)
Farm size	-0.019 (0.011)	0.008 (0.009)	-0.013 (0.009)	0.01 (0.009)
Education level	-0.009 (0.008)	0.015* (0.006)	-0.003 (0.007)	0.002 (0.007)
Group leader	0.408 (0.257)	0.096 (0.211)	0.41 (0.226)	0.255 (0.226)
State-fixed Effects (Reference: West Bengal)				
Bihar	-0.038 (0.192)	-0.084 (0.155)	0.03 (0.17)	0.144 (0.172)
Odisha	1.273* (0.534)	-0.066 (0.438)	1.254** (0.482)	0.123 (0.492)
Eastern Uttar Pradesh	-0.024 (0.192)	-0.394* (0.157)	-0.267 (0.17)	0.628*** (0.175)
Constant	0.988 (1.12)	-0.566 (0.918)	2.643** (1.002)	-0.722 (1.031)
Number of observations	5,563			
Log-Likelihood	-9,748.09			
Wald chi^2 (64)	876.22*			

Notes: Figures in parentheses are robust standard errors; *, **, and *** represent statistical significance at 1%, 5%, and 10% levels, respectively.

Likelihood Ratio Test H0: $\rho21 = \rho31 = \rho41 = \rho32 = \rho42 = \rho43 = 0$, $\chi^2(6)$ = 648.96, p-value = 0.0000

The level of education was positively correlated with the selection of high-yield varieties. Farmers who belong to a Scheduled Caste or a Scheduled Tribe are less likely to choose varieties with positive market-oriented and cooking attributes, since farmers in these categories are poor and would prefer varieties with good returns. A farmer's wealth parameters were also found to be important determinants in selection of the varieties from different categories. However, each wealth parameter had a different outcome. As agriculture wealth index increases, farmers are more likely to prefer high-yield varieties and less likely to select STRVs. The non-agriculture wealth index was positively associated with the selection of varieties that are stress-resistant and more marketable. The tropical livestock unit was positively correlated with the selection of varieties with yield attributes and negatively correlated with the selection of varieties with cooking attributes.

The results further show that female respondents are less likely to select varieties with high yield. They are more likely to select a variety with stress resistance traits though the latter is not significant. The farmers' risk behavior revealed a different selection pattern, as farmers with more risk-taking nature are more likely to select a variety from stress resistant and less from market-oriented attributes. Farmers in Odisha were more likely to select varieties based on stress tolerance and market-oriented reasons, compared to farmers in West Bengal. Farmers in Eastern Uttar Pradesh were more likely to select varieties based on cooking quality instead of yield.

CONCLUSION

The results clearly demonstrate the importance of crop diversity among the surveyed farmers who mostly cultivate MVs for various reasons, primarily yield. The respondents also reported using multiple varieties in the 2013 Kharif season. Given the differences in their knowledge and available resources, female and male farmers had different rice variety preferences. The most popular varieties were Swarna-Sub1, Arize 6444, Sambha Mahsori, Sarju 52, Swarna, Pooja, Lalat, and Moti. Among these varieties, Swarna, Sambha Mahsori, and Sarju 52 were more popular among females because of the following attributes: easy to cook, good taste, high yield, and seed accessibility and availability.

The following insights were derived from the MVP analysis: (1) almost half of the respondents preferred modern varieties (conventional grouping) and prioritized yield among the attributes (preference-based grouping); (2) female and male respondents had different preferences in varietal attributes; (3) most of the farmers cultivated more than one variety to meet their diverse needs; (4) as farmers' willingness to take risks increases and discount rate decreases, the likelihood that they will cultivate STRVs increases; (5) farmers are more likely to select a rice variety for market-oriented reasons than yield potential; and (6) as the number of years of drought and submergence experience increase, the likelihood that farmers will prefer STRVs increases. Female farmers were found to be less likely to take hybrid rice (conventional grouping) and more likely to choose rice varieties because of their stress tolerance (preference-based grouping). However, it should be noted that their choice may not be solely based on their preference but constrained by their limited access to seeds of certain varieties, such as hybrid rice, although this study was unable to differentiate the two possible reasons. Further studies are needed on this issue.

A considerable number of respondents reported that they were unaware of certain rice variety names. During the survey, they listed variety names that were not included in any agricultural records and were unfamiliar to agriculture experts. This suggests that there is a need to educate farmers about the relevance of rice varieties. Furthermore, the results have implication for breeder and institutes involved in dissemination. Rice varieties should be developed to match not only the climate and land ecology of the region but also to address the multiple concerns of female and male farmers. The results also suggest that patient, risk-taking farmers are more likely to adopt STRVs easily. As such, efforts should be made to increase risk-averse farmers' knowledge and understanding of the benefits of using such rice varieties.

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