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Assessing the impact of participatory research in rice breeding on poor rice farming households with emphasis on women farmers: a case study in eastern Uttar Pradesh India[1]

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Introduction

For the past years since the Consultative Group of International Agricultural Research (CGIAR) Systemwide Initiative on Participatory Research and Gender Analysis (PRGA) was initiated, guides for impact assessment of PRGA have been developed (Lilja and Ashby 1999; Johnson et.al., 2000; Lilja and Johnson 2001). However, according to Farnworth and Jiggins (2003) while there is rapidly growing literature on the impacts of PPB on farmers, this is not further differentiated by sex. Despite the immense literature on the impacts of production, post production technologies on women farmers, systematic studies on the impacts of PPB on women in any category, either in terms of the effects of being a participant in a participatory plant breeding process (PPB) process, or in terms of the impact of the new materials generated is few. There is practically no literature that examines the effects of PPB – either as process or in terms of the impacts of the emergent materials – on gender relations at the household, community or any other relevant social or geographic scale along the food chain. Even with women's active involvement in rice production, post harvest and seed management, scientists who are mostly male often talk with the male farmers only. Ignoring women's knowledge and preference for rice varieties may be an obstacle to adoption of improved varieties, particularly in areas with gender-specific tasks, and in farm activities where women have considerable influence. Feldstein (1996) cited three different ways in which gender analysis can be considered in participatory research. These are: the efficiency argument, equity oriented, and empowerment. This study attempts to fill in these research gaps.

The objectives of this paper are to: a) discuss the process used in integrating participatory research and gender analysis in breeding for drought prone and submergence prone environment; b) assess how gender analysis contributed to the design and implementation of the research and development outcomes; c) assess the impacts of PVS on poor women farmers, particularly on women's empowerment; and d) recommend strategies to further enhance women's roles in ensuring household food (rice) food security and improving their social status within the household and the community.

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Background of the project

This study was conducted in Eastern Uttar Pradesh (EUP) which is popularly known as "Purvanchal". Notwithstanding the expansion of irrigation in recent years, rainfed agriculture is still of major importance in this region. The agro ecological conditions are diverse and rice farming is quite risky. EUP currently has 25 districts and accounts for about 27% of geographical area of the state. The share of population of EUP in the state population is high at 40% with a population density of 776 persons per sq km. Thus, EUP is one of the densely populated parts of the state. It also has a high incidence of poverty, with 57% of the population below the poverty line, as against 40% for the state in 1991.The rising population pressure and a high share of rural population have led to a reduction in the average holding size to 0.69 ha in 1990-91. Both caste and agrarian hierarchies are sharply defined.

Rice is the dominant crop in EUP and accounts for 60% of the rice area of the state. Wheat is next important crop grown in areas with supplemental irrigation. In EUP, majority of the improved rice cultivars developed on experiment stations have failed to exhibit their yield potentials on farmers' field. Rice often suffers from drought, submergence, salinity, low temperatures and other biotic stresses during flowering and reproductive phases of crop growth. The poor performance of improved cultivars indicates that new varieties could not compete with native traditional cultivars under adverse conditions met on the farmers' field. To address these various biophysical and socio-economic constraints to productivity, IRRI in collaboration with the Indian Council of Agricultural Research (ICAR), and other institutions dealing with rice research and extension, has been conducting farmer participatory breeding (FPB), along with other research projects under the Consortium for Unfavorable Rice Environments (CURE) and the Global Challenge Program (CP) on Water and Food focusing on saline prone rice environments.

The farmer participatory breeding (FPB) project for rainfed rice was developed at the International Rice Research Institute (IRRI) in collaboration with NARS in eastern India. The project was conducted in response to the low adoption rates of improved released cultivars in rainfed rice environments. This low adoption rates relate mainly to the inability of a highly centralized breeding system to address the enormous diversity of environmental conditions and end-user needs. Varietal preferences often vary significantly from location to location, from season to season, and from farmer to farmer, particularly in subsistence-oriented farming systems (Morris and Bellon, 2004). The goal of this project was to increase food security by providing varieties capable of producing high and stable yields. The aims were to test the hypothesis that farmer participation in rainfed rice breeding can help develop suitable varieties more efficiently, to identify stages along a breeding program where farmer interfacing is optimal, and to enhance the capacities of the NARS in farmer participatory research and gender analysis for rice plant breeding and varietal selection (Courtois et al., 2001). Narendra Deva University of Agricultural Technology (NDUAT) located in eastern Uttar Pradesh was one of the six centers under the Indian Council of Agricultural Research (ICAR) which continued FPB in collaboration with IRRI after 2000 to date. Two districts namely Siddarthnagar and Faizabad were selected for the FPB project. These districts represent contrasting features of rice production systems of EUP. Siddarthnagar is submergence prone while

Faizabad is drought prone. Siddarthnagar is strictly rainfed while Faizabad had supplemental irrigation such as tube wells (hired or owned).

This project had two components. The first is a plant breeding component which aims to develop and evaluate a methodology for participatory improvement of rice for heterogenous environments, and to produce and improve adoption of material suiting farmers' needs. The second is a social science component, which aims to characterize cropping systems, diversity of varieties grown, and crop management practices of rice farmers; and to elicit farmers' selection criteria and their reactions to a range of cultivars and breeding lines. In 1998, a gender specialist and a local sociologist formally joined the team of plant breeders developing participatory methods for including farmers' criteria in breeding rice for the fragile environments. An additional task of the social scientists was to assess what can be done to better involve both men and women farmers in the early stages of the breeding process (Paris et.al. 2001a; Paris et.al.,2001b). Who participates in the different decisions in the innovation process is potentially a determinant of the impact of the participatory process on the research results – in particular the design of technologies, and thus of the outcomes of farmers' using the resultant technology. Here we define gender analysis as a particular case of stakeholder analysis where the chief discriminating variable was defining the stakeholder group of interest is gender. We also considered the social (caste, religion), economic status (size of landholdings), and age as important discriminating variables, which like gender are also determinants of the type and level of impact of participatory approaches and of technical change.

In the section below, we discuss the process we used in integrating FPB process and gender/stakeholder analysis[2].

Integrating FPB and gender analysis

Initial site characterization (biophysical, socio-cultural including gender analysis) and assessing farmers' criteria for varietal selection. Farm household surveys and participatory rural appraisal (PRA) were conducted in Siddharthnagar and Faizabad districts to characterize farmers' agro-ecological, socio-economic and cultural environments, farming system, rice diversity, crop management and seed management practices. A structured gender-sensitive questionnaire was used for interviewing fifty households per research site. Information on gender-specific roles and responsibilities in rice production and seed management were included in the questionnaire. Participatory rural appraisal (PRA) tools such as focus group discussions (FGDs) and graphic illustrations of rice varietal traits were used to consult male and female farmers separately on their criteria for selecting rice varieties in their rainfed rice ecosystems (Paris et.al. 2001a;2001b). Here we are most interested in identifying the appropriate collaborators, who have special knowledge in varietal choice or responsibility in doing which tasks related to rice production and post harvest activities.

[2] Gender analysis refers to the analysis of roles and resource use of categories of people differentiated by age and sex, i.e. who does what. It provides a snapshot of who does what in order for researchers to identify the most appropriate collaborators, i.e. who has special knowledge or responsibility or some other state in the particular question, whether it be a commodity or resource management. This is the efficiency argument and is the heart of the issues addressed in the Systemwide Intiative of PRGA (Feldstein, 1999)

Selecting new varieties suitable to the preferences of men and women under their given agro-ecological conditions.From 1997 to 2000, the methodology for FPB was developed by IRRI scientists in collaboration with the NARES under the umbrella of the PRGA. The plant breeding component included participatory plant breeding (PPB) and participatory varietal selection (PVS). The methodology is explained below.

Participatory plant breeding (PPB) Farmers and breeders selected individual plants from segregating populations (F4) from 6 different crosses involving diverse parents. Trials were held on–farm and on-station. Plants selected by breeders and farmers were advanced separately through several generations until fixed. Farmers and breeders evaluated these genotypes at maturity on the basis of panicle and grain characters, and susceptibility to pest and diseases. Breeder-selected and farmer-selected materials were then compared. Promising lines were selected and these genotypes were multiplied and supplied to farmers for evaluation. Observations on yield and other traits were recorded. PPB is still done every year in the Masodha rice research station, Faizabad, eastern Uttar Pradesh.

Participatory varietal selections (PVS). In this trial design, similar sets of fixed varieties (13-25 advance lines and a local check) suited for the specific hydrological conditions in the area were tested on-station and on farmers' fields. The advanced lines were from the IRRI Shuttle Breeding Program and from breeding programs of project partners in eastern India. From 1997 to 2000, two or three farmers per village grew these varieties under their normal management practices. At two to three phenotypic stages of plant growth, farmers and breeders ranked the same set of varieties grown on-station and on-farm. Ranking was ordered from best to worst. Breeders recorded duration, plant height, and yield for each trial. In addition farmers' comments on the characteristics they liked or disliked and reasons for ranking were recorded in diaries. Farmers and breeders visually ranked the rice lines grown in both on-station and on-farm trials. The Kendall coefficient of concordance and the Spearman rank correlation coefficient were used to analyze the agreement of ranking of the genotypes among farmers, among breeders, between farmers and breeders (Courtois et al.,2001) and between male and female farmers (Paris et.al.,2001).

Several lessons were learned from the experiences in developing and testing the methodologies for FPB. These lessons were related to the concerns such as choice of representative sites, number of villages to represent a specific agro-ecology, choice of varieties to be included in the experiments, women's additional work burden in post harvest operations of too many lines, number of varieties to include in sensory evaluation, limited availability of new seeds which limited the participation of more farmers especially women, and institutional constraints (Paris et al., 2002)

In 2001, a new plant breeder who joined IRRI refined the participatory methods of evaluating rice varieties on farmers' fields based on these lessons learned from 1997 to 2000. With the termination of funding from IDRC, FPB was continued in NDUAT with supplementary support from IRRI core budget and supplementary funds from DANIDA for research on gender issues.

"Mother-Baby" PVS trial design. The challenge was to develop methodologies to include farmers' criteria in rice varietal selection and to include them in the early evaluation of

new rice lines under their own management. The same trial designs on-station and on-farm were continued from 2001 to date with new names. The researcher-managed trial consisting of a set of advanced lines and local check was called "Mother" trial. Mother trials were not only conducted in the Masodha research station but also on farmers' fields which represent the stress environment. Farmer-managed trial was called "Baby" trial. Here, varieties that performed well and were selected/preferred by farmers in the mother trial were evaluated by both men and women farmers on their own farms using their level of management.

Monitoring and evaluation. From 2001 to 2005, "mother and baby" trials were conducted in Siddarthnagar and Faizabad. In 2002, fourteen advance lines from the IRRI led Shuttle Breeding Program, from NDUAT and released variety Mashuri (check) were included in the mother trials conducted in Masodha research station. In Siddarthnagar, mother trials were conducted on famers' fields using the local check, an aromatic variety "Kalamanak" which commands a high price in the market but has low yields. These lines varies by gain type, maturity (135-155 days, plant height (105 to 145 cm) and potential yields (4 – 6 tons/ha). New lines with medium duration were included in Faizabad where more farmers have upland plots while longer duration were include in Siddarthnagar where farmers have more lowland plots. Each year, several lines were replaced by new good lines if the crops did not perform well. Groups of farmers (men and women) were invited to visit the mother trials and rate the varieties using a simple technique called preferential analysis (Atlin et.al. 2002). Baby trials were conducted by farmers in selected villages in Siddarthnagar (submergence prone) and Faizabad (drought prone) districts which represent distinct biophysical and socio-economic characteristics. Due to the drought in 2002, rice crop was damaged and farmers compared the new lines with Sambha Mashuri which covered more than 70 percent of the lowland areas in Siddarthnagar. In 2002,

***Dissemination of new rice lines*.** From 2001 to 2004, seeds of new lines were distributed and evaluated by volunteer farmers according to their land types. In 2004 Kharif season, thirty men and twenty four women evaluated new lines included in the mother trials. In the baby trials, farmers themselves laid out the trials on their own fields and provided their own labor including harvesting and threshing. They rated the new lines in comparison with their local check. They also gave feedback to researchers as to which lines they will keep or continue to grow the following year. Every year, farmer field days were conducted to rate the rice lines included in the Mother trials. The field days and field demonstrations included both male and women farmers. Farmer preferred seeds began to spread through farmer to farmer exchange.

How gender analysis contributed to the design and implementation of the research and development outcomes

We hypothesize that the incorporation of beneficiaries, both men and women, in the innovation process can affect the efficiency of the process itself. The interaction with researchers may affect the beneficiaries as well, both at the individual and community levels, by building social and human capital (Johnson et.al., 2000). Below are the outcomes of including women in the FPB process.

***Inclusion of gender differentiated questions in the questionnaire confirmed that women and not only the men were also end users of the varietal improvement due to gender-specific roles and responsibilities in the livelihood systems*.**

Traditionally, structured questionnaires used in household surveys do not include gender differentiated information particularly on labor inputs from family members and hired laborers. However, by collecting gender disaggregated labor inputs in rice production and post harvest activities, we were able to confirm our hypothesis that female labor participation is determined by socio-economic status (caste, size of landholdings). The majority of the population in the sample villages and districts belong to the lower social status (lower caste with small size landholdings). There is a wide disparity in terms of access to formal education between men and women. Illiteracy rates among adult females are higher than adult females. Tasks in rice production and post harvest operations are gender-specific. Earlier studies in Faizabad showed that women from the lower caste provided 60 to 80% of total labor input in rice production (Paris et al. 1996). Aside from their significant contributions in rice production, women also provide labor in non-rice crops, collect green animal fodder, feed and tend livestock. They are the primary end users of rice byproducts and biomass for livestock and other farm use. Women from the lower caste work do not only work as unpaid labor in their own farms but also work as exchange labor or hired laborers in other farm for additional income. In the villages in Faizabad, women from the lower caste do most of the operations such as applying farm yard manure on the fields, pulling of rice seedlings, transplanting, weeding, harvesting and threshing by hand. In Siddarthnagar villages, more men than women participate in pulling of rice seedlings and harvesting. Women do the transplanting of seedlings and most of the weeding. They possess specific knowledge and skills in crop care and are responsible for maintaining seeds and varieties. Thus, by gender analysis we were able to identify "who" are the actual doers of tasks in rice production and post harvest, "who" has the knowledge on specific traits of rice varieties.

Clearer understanding of the reasons for male and female farmers' varietal choice.

Socio-economic surveys revealed that a major determinant of varietal choice is the conscious attempt of farmers to match varieties with the land type. Each field position in the topo-sequence corresponds to a risk of drought or submergence. In Faizabad (drought prone, more upland than lowland fields, dairy animal raising is more popular), farmers preferred genotypes with drought tolerance, and short to medium maturity (120-125 days) for growing *rab*i crops after rice in the upland fields, and with better yield. In Siddarthnagar (submergence prone, more lowland than upland fields, less livestock,) farmers' prefer slightly late maturing genotypes which have submergence tolerance and long slender grains. A second determining factor is the adaptation to different user needs: food, livestock fodder, thatching roof, and cash. A third determining factor is related to different postharvest operations like ease of threshing, good taste, high milling recovery (above 65%) good storage capacity and premium market price.

Gender-specific roles and responsibilities also determine varietal performance. For example, women preferred medium or semi-tall varieties that are easier to thresh, as well as varieties that have a good quantity and quality of rice straw for livestock feed. Moreover, they preferred varieties for specific rice products that they make such as puffed rice. While it may be difficult to combine all their preferred traits into one unique variety because of genetic correlations, it is important that both men and women have a "basket of choices" of varieties suited to their needs and agroecosystems. Clearly listening to farmers' perceptions and involving both men and women farmers in selecting rice varieties at the early stage of breeding can lead to faster adoption of varieties suited to their specific rice ecosystems and diverse needs (Paris et.al.,2001)

*An**alysis of gender differentiated constraints revealed that there is wide gender disparity in access to education, access to agricultural related information and access to new seeds***. In India, which a patriarchal dominated society, the male heads of households are considered as the only decision-maker in the family. Decisions related to farming including varietal choice are often made by the male heads despite the fact that women do most of the crop operations. However, with the increasing out-migration of male family members in Faizabad and Siddarthnagar, women's roles are beginning to shift from unpaid family labor to farm managers. With the absence of men particularly from among nuclear households, women's participation in decision-making in farm and household matters is increasing (Paris, et.al, 2005)

Alternative approaches to eliciting information were used such as FGDs with separate groups of men and women by social status. An innovative approach was tested to encourage the women to express their perceptions using graphic illustration of traits. Moreover, to avoid the dominance of men in the interviews, this exercise was done with men and women separately. Through graphic illustration of traits, male and female farmers valued the importance of varietal traits according to land types (lowland, midland and upland), by socioeconomic groups and by gender (Paris et.al., 2001).

Both men and women farmers who were involved in the baby trials were able to make better objective evaluations when experiments were done by them. Traditionally, scientists involve only male farmers in conducting on-farm research. Women who belong to poor farming households are rarely involved in on-farm experiments, even in enterprises which are within their domain and sphere of influence—eg. component technologies on rice varietal improvement, weeding, new crop establishment methods, etc..This exclusion of the "actual doers" of tasks leads to ineffective technology transfer. In this project, women farmers were included as farmer cooperators in the baby trials for the first time. Experience from the past years, revealed that both men and women farmers who were involved in the baby trials were able to make better objective evaluations when experiments were done by them, since the project provided a forum for the farmers to compare the performance of their varieties with the new line/genotypes which the breeders offered. Farmers' participation also facilitated the provision of feedback from the farm to the experiment station. Such information was used in setting research priorities and goals to serve the varietal needs of the farmer-clientele. For example, in Siddarthnagar, "Kalanamak" is a traditional variety preferred by farmers, especially the women due to its aroma, good and eating quality and commands a high price in the market. However, yields are low. Thus, breeders in NDUAT improved this variety by combining its quality traits with high yields. On a single plot basis, farmer visual yield ratings were highly correlated with measured yield. Farmers yield rating and farmers preference rating were also highly correlated. Breeder preference ratings were highly correlated with measured yield and farmers' yield rating. On a genotype mean basis, farmers yield rating and measured yields were highly correlated. Farmers had a strong preference for cultivars they rated highly for yield. While PVS trials continued, farmers picked up a few lines which they found promising and grew them on larger plots. In Faizabad and Siddarthnagar, three and six genotypes, respectively were grown by several farmers in several villages (Singh et.al., 2002).

Table 1 shows the frequency of using type of variety used by farmers in both districts where the study was conducted. Of all the varieties grown, 10.4 % and 17.6% in Faizabad and Siddarthnagar districts, respectively were PVS/MB lines. The most

frequent improved varieties used in Faizabad were Sarju, Swarna Mashuri and Sambha Mashuri. Similarly, in Siddarthnagar, Sambha Mashuri was the most popular variety due to its ability to withstand the stresses of drought and submergence. Thus, it was a challenge to introduce a variety which was better than Sambha Mashuri. A higher proportion of the farmers in Siddarthnagar still grow traditional varieties such as Kalamanak and Bengalia which are aromatic varieties and command high price in the market. Hybrid rice is increasingly becoming popular in Faizabad which is nearer the markets where seeds are more accessible.

Table 1. Frequency of using different types of rice varieties by farmers, by district, eastern Uttar Pradesh, Kharif 2004.

Types of rice varieties	prone)		Siddarthnagar (submerge prone)	
	Adopters	Non-adoptors	Adoptors	Non-adoptors
Traditional		2.7	24.9	46.6
Improved	70.1	80.3	53.7	47.4
Hybrid	19.4	16.4	3.9	6.0
PVS /MV lines	10.4	.5	17.6	
Total no of times farmers used variety	67	183	205	116
Total no of sample farming hhlds	37	113	90	60

As shown in Table 2, average yields of PVS/MB lines are slightly lower (2.19 tons/ha) comparable with the improved varieties (2.80 tons/ha) which farmers use in Faizabad. However, average yields of PVS/MB lines are higher (3.39 tons/ha) than traditional varieties (2.37 tons/ha). As expected, average yields of hybrid rice are higher than the other varieties. However, farmers have to buy the seeds every year. As mentioned earlier, farmers will adopt new varieties as long as their yields are superior thatn what they already have.

Table 2 Average yields of rice varieties by district, eastern Uttar Pradesh, 2004 (tons/ha).

	Faizabad		Siddarthnagar	
Varieties	Adoptor	Non-adoptor	Adoptor	Non-adoptor
Traditional		1.53	2.37	2.38
Improved	2.80	2.90	3.68	3.64
Hybrid	3.45	4.12	4.56	4.14
PVS/MB	2.19	1.07	3.39	

Impact of PVS on women

Involving women in the project enabled women to gain confidence in making decisions on varietal choice. According to Ashby (1997), the term "participatory research" is a collection of approaches that enable participants to develop their own understanding of and control over the processes and events being investigated thus leading to "empowerment" of stakeholders. According to Kabeer (1999:p.47) “the concept of empowerment is extremely difficult to measure due to the elusiveness of its meaning and the values which it tends to be loaded with. Measures of ‘empowerment’ particularly for women are used in different context to carry multiple meanings. In general, most of the measures point out to ‘power’ as the root of empowerment. Kabeer (1999) defined power in terms of “ability to make choices”. Sen (1985) refers to the “ability” as one chooses to live and “power to achieve chose results”. Some authors argue that power is the dominant factor of decision-making and its establishment in hierarchy with the sense of responsibility (Sen and Grown, 1985). It is clear that the women’s participation, their decision-making capacity, control over resources and their own welfare practices are the major factors of women empowerment. In other words, empowerment is the ability with full participation of people in the decisions and process for their choice of lives. Women’s empowerment is to exercise their choices with full capability to contribute to social and economic growth for their welfare in overall development and to acknowledge human values of freedom of choice and human rights (Batliwala, 1994; United Nations, 1995; Oxfam, 1995 cited in Hossain et.al., 2004)). In this project, we attempted to assess/measure women’s enabling ability to make decisions on rice varietal choice, acquisition and disposal by following using an empowerment index. This methodology was earlier developed by Hossain et.al., (2004) in Bangladesh and Paris, et.al, (2005) migration study conducted in eastern Uttar Pradesh. Hossain et.al., (2004) measured women’s empowerment in Bangladesh by developing an empowerment index. They found that the important factors influencing women’s empowerment are the size of landholdings and the tenure status of the household and wife’s age. Paris et.al., (2005) in their study on the impact of male out migration on gender roles revealed that wives have greater decision-making authority than husbands on what rice variety to grow for the next season, and how much money to allocate on food. Measuring women’s empowerment is important because women farmers are often the “invisible” stakeholders. Even though they carry out the key tasks in rice production and post harvest, they are not considered as primary decision makers.

In this study, we interviewed wives of cooperators and non-cooperators on their participation on decisions regarding varietal choice, acquisition and disposal. We interviewed a sub-sample of sixty women from the sample size of cooperators (127) and

non-cooperators (173). The questions we asked were: 1) Who decides what rice variety to grow? 2) Who decides what variety to grow or not to grow for the next season? 3) Who decides to give or not to give new seeds to other farmers? 4) Who decides to sell seeds? 5) Who decides when and where to get the seeds? 6) Who decides whether to participate or not in the PVS trial? We considered the 'female participation' in decision making as the proxy of 'empowerment' and the ability to make choices in relation to rice varietal choice. We selected a few variables to develop a women empowerment index (WEI). We have picked up the impact on the absence of the household male head in the household on women's empowerment, mainly as male out-migration from the household. The reason for emphasizing absence of male head in connection with empowerment should be clear. We hypothesized that absence of male head impinges a larger burden on females in terms of household responsibilities and in the absence of males, females gain relatively more empowerment than in their presence. However, women's empowerment is higher when she can make decisions even if her husband is presence. Thus the wife is "empowered" or "enabled" when she gets a high score.

Since there are many decision-making variables, it is difficult to make sense out of them. We have developed empowerment index with the criteria often used by sociologist. Women empowerment index is coded thru identifying the decision maker and activities where decision is made. The score is the women empowerment index. The rating values of the decision-makers have been assigned according to the weight in favor of wife. For example, higher value (*K*) of an indicator (*X*) goes to indicate higher empowerment level of a woman shown below, where *K* is (1..5):

1=decision is made by other members in the absence of the husband,
2=by husband, when he is present without consultation of the wife,
3=by wife in the absence of the husband
4=jointly by husband and wife, or jointly with others in absence of the husband,
5=by wife, even when husband is present.

The above statement can be measured through rating of each decision indicator (*X*) as below:

X_i = decision making indicators	*K* = any rating value of each indicator				
	Low				High
X_1	1	2	3	4	5
..	1	2	3	4	5
..	1	2	3	4	5
Xn	1	2	3	4	5

Therefore, the average scoring value of X_i (i.e., *i*th indicator) for all households would be the average of the value K_i denoted by the following matrix:

$$X_i = \overline{K_i} \qquad \text{.....(1)}$$

We used the given value of six indicators for each household to construct the women's empowerment index. Six indicators have been used for varietal choice and seed acquisition and disposal ($WEvar_i$), are shown in equation 2:

$$\sum$$ .....(2)

where, $WEvar_i$ representing the following indicators of an ith household

x_1 = what rice variety to grow for the next season
x_2 = whether to give/sell seeds to other farmers
x_3 = whether to exchange seeds with other farmers
x_4 = when and where to get seeds
X_5 = whether to keep the seeds for next season
X_6 = to participate in the PVS trials

Table 3 shows that female cooperators both in the drought prone and submergence prone villages participate jointly with their husbands in making decisions regarding varietal choice. However, in Siddarthnagar (drought prone areas), the wives are highly empowered in making decisions in keeping the seeds for the next season and whether to keep the seeds for consumption or sale. This is especially true in case of marginal and small farmers majority of whom are the sole caretakers of post harvest management and storage for different purposes like consumption, and for seeds. During the hungry months, wives are compelled to use the seeds for consumption rather than to sell them. Farmers are food insecure due to different stresses in climate (early drought, early rains, submergence, and problem soils such as salinity).

Table 3. Empowerment index, by district, Eastern Uttar Pradesh, India, 2004-2005.

DECISION	FAIZABAD				SIDDHARTHNAGAR			
	FC	MC	FNC	MNC	FC	MC	FNC	MNC
1. What variety to grow in the next season	4	3	4	3	4	3	2	2
2. To give/sell new seeds with other farmers	4	4	4	3	4	3	2	2
3. To exchange new seeds with other farmers	5	4	4	3	4	3	2	2
4. When and where to get new seeds	4	2	3	2	4	2	2	2
5. To keep seeds for the next season	5	4	5	4	5	3	4	3
6. To participate or not to participate in PVS trials	3	2	3	2	4	2	3	2
Sample size								

FC = female cooperators; MC = male cooperators; FNC = female non-cooperators; MNC = female non-cooperators
Source: NDUAT-IRRI PVS Assessment, India, 2004-2005.

What factors influence women's decision-making authority or empowerment? We used a multivariate model (OLS) to identify the factors which influence the decision making authority of women in rice varietal choice, seed acquisition and disposal. The following is the specification of model:

Where

Y = empowerment index (score)
a = intercept
X_1 = size of landholding (ha)
X_2 = production systems (1 = submergence 0 – drought prone)
X_3 = participation in the PVS trials
X_4 = age of household head (years)
X_5 = type of household (1-nuclear, 0-joint)
X_6 = direct access to new seeds
X_7 = religion
$b_1 – b_6$ = regression coefficients
e = error term

The estimated parameters of the regression model are shown on Table 4. Regression analysis shows that all the hypothesized factors such as production systems, participation in the PVS trials, age of household head, and type of household, direct access to new seeds which influence women's decisions in varietal choice, acquisition and disposal, except for size of landholdings and religion, are statistically significant. Sufficiently large F value indicated that the model is significant. Based on this study, women who come from submergence prone villages (Siddarthnagar) appeared to be more empowered compared to the women in the drought prone villages (Faizabad) and (drought prone villages). This is due to the fact that the drought prone villages are nearer the labor markets eg. Faizabad city. A recent migration study revealed that in Faizabad, more husbands than sons migrate. In contrast, in Siddarthnagar more sons migrate than husbands (Paris, et al, 2005). Due to the absence of husbands, wives are compelled to make farm related decisions. Women's participation in PVS trials and access to seeds positively influence women's empowerment. Thus despite women's low literacy rates compared to men, their decision making authority in varietal choice, acquisition and disposal is enhanced. By participating in the project, women were provided access to information (when to plant the seeds, at what time, with what inputs, etc) which enables them to make sound decisions in better crop management. The role of labor force participation in female empowerment has been studied as cited in Hossain et.al., 2004. The channels may be explained in terms of cash income, external contacts and access to information that affect the fall-back position, self confidence and perception of family members about women's worth (Sen, 1990). Based on these sample households, size of landholdings and religion are not an important variables in influencing women's empowerment. Due to poverty, the Muslim women in Siddarthnagar are actively in most of the rice operations particularly when their husbands migrated to other places. During the initiation of the project, women particularly the Muslims in Siddarthnagar were shy, hesitant to talk to us and did not want to reveal their knowledge and concerns. They preferred to be interviews inside their home rather than in the open areas with the presence of men. During the village meetings, the men dominated thus, the women became disinterested. However, after convincing them to participate in the

rating of the new lines during the farmers' field days, they began to be interested in joining the project and began to speak their minds and share with us their opinions.

Table 4. Factors influencing women's empowerment: estimates of multivariate regression

Factors	COEFFICIENT	t-VALUE	SIGNIFICANCE	MEAN
Intercept	3.626	9.958	0.000*	
Size of landholding (hectare)	-0.048	-1.353	0.179	1.04
Production system				
(1-submergence, 0-drought)	-0.837	-6.179	0.000*	0.50
PVS cooperator (1-cooperator, 0-non cooperator)	0.326	2.955	0.004*	0.50
Family type (1-joint, 0-nuclear)	-0.307	-2.595	0.011**	0.47
Age of household head (years)	-0.013	-1.593	0.119***	47.7
Access to seeds (1-with access, 0-without access)	1.596	12.975	0.000*	0.35
Religion (1-muslim, 0-non-muslim)	0.188	1.477	0.143	0.25
R-Squared	72.69%			
F-Value	42.59*			

Note: Dependent variable: women empowerment index * - significant at 1%
** - significant at 5%

Women who participated in the PVS project either rating the "Mother" trial or participating as cooperator in the "Baby" trial cited increased productivity, managing the rice crop better, making sound decisions, and most importantly, being consulted by scientists for the first time as the benefits they derived from joining the project. By being asked about their opinions on the crop performance as well as the cooking and eating qualities of the varieties made them realize how important their roles are in farming. They also gained respect from their husband and also their mother- in- law. Their self-esteem, their confidence and pride in being a farmer have increased because of acknowledgement and building up of knowledge based on their experience. Women of Minority group as well as other castes who are our respondents in CURE and PVS programs are now more empowered in the sense that they are now actively participating in seed distribution. They are willing to increase the area for these new lines. They said that " For a long time since we lived in this village, we had been growing the traditional varieties because nobody came to us to give new seeds. We never thought that there are many other varieties from which we can select or choose depending on what we need for our conditions"

As expressed by one of the female cooperators (married, member of Minority community with marginal size of land) of the "baby" trials conducted in Siddarthnagar. "*I*

had been growing one of the PVS lines since the last 4 years due to its good yield, slender size of grains, high milling recovery and good taste. Because of its high yields, now I can feed my family (nine children) the whole year round. My fields are on the lower lying areas, thus I need taller plants. This variety (NDR96005) is good for my fields were water stagnates longer. The duration of this line is also good. It matures 10 more days than Sambha Mashuri which is the most popular variety for the lowland lying areas. I will increase the seeds of this variety and give to other farmers. .

Mrs.Hussain is one of the farmer cooperators of "Mother and Baby" trials. She is a farmer with medium size of land holding ((2.25 ha) of Village Padri in Siddharthnagar district (submergence prone). She said " *I selected 2 lines from MB trial (MB-1 and MB-3). We grew MB-3 on a large areas due to it short fine grains, and good performance. Thus, I was able to have more seeds which I was able to sell at a high price of Rs 25-30 per kg. during the 2004 Kharif season. After milling, MB-3 has good quality which makes it popular as a gift during special occasions.*

Recommended strategies to further enhance women's roles in ensuring household food (rice) food security and improving their social status within the household and the community.

1) *Agricultural universities should employ social scientists, female scientists or female extension workers in particular who are interested to work in a team which conducts on-farm experiments with farmers*. Biological scientists and agronomists should listen to women farmers' opinions, assess attitudes towards certain practices and consider their criteria in the design and dissemination of rice technologies. Without a female member in a team, it is difficult to elicit information from women farmers, particularly in situations where men dominate. There are now initiatives to include at least one female member in a team in most problem-solving farmer participatory research projects conducted by IRRI in collaboration with NARES in eastern India. The Women's Leadership Training for Asian Women engaged in Research, Development and Extension offered every year at IRRI, provides professional women with skills as agents of change and leaders in their workplace as well as in the grassroots level.

2) *Farmer/community participatory research projects should include not only men but women farmers as well*. Learning by doing (through participatory on-farm experimentation, hands-on-training and managing their own demonstration plots) is important for disseminating technical know-how to poor women with low levels of formal education and social restrictions on their mobility. Separate trials and field days should be held to test technology options and discuss results. Women demo farmers can change misconceptions that they are not farmers by proving that they learn improved technologies and that they know as much as male farmers about field agriculture. Based on our experience, women farmers cannot voice their opinions because the men dominate and correct their opinions.

3) *Women farmers particularly the de facto heads of households should also be included in "hands on training programs related to agriculture.* However, topics should not only include the post- harvest but also production technologies. Their knowledge and skills are vital in making sound decisions on growing rice and post harvest, particularly when wives become de facto heads of households after households after husbands migrate to jobs in the cities or abroad. With the increasing out-migration of men women should also

be equipped with technical know- how on crop management as they left to manage the farms.

4) Conduct interviews or exercises separately for men's and women's groups. Village meetings and interviews may start with mixed groups followed by single sex groups to keep men from dominating the floor. In the early stages, women can express themselves better if they are with a group of women only. Moreover, the place, time and duration of meetings for women should consider women's time for reproductive activities. More women will participate in training activities if it is held in the village after they have done their household chores in the morning. Thus, it should no be an excuse that women do not want participate in farmer meetings.

5) *Explore, test innovative communication methods to disseminate knowledge intensive technologies particularly to women who do not have formal education*. These communication media include radio dramas, village theater/plays, video for disseminating information on knowledge-intensive crop management technologies as well as micro- finance management, proper health, sanitation and child nutrition, women's rights, etc. Despite social barriers and low levels of formal schooling, can be effective change agents if given equal opportunities as men in getting training and access to support services (Paris et.al, 2005).These will create awareness and reduce gender inequality in access to resource and to promote the social status of women in the household and in the community.

6) Researchers should collaborate with pre-existing women's groups such as self-help groups and also with NGO partners who already have access to women's groups in the village. In Bangladesh, women-to women and family approaches reach poor women effectively (Paris, et.al. 2005). In a policy dialogue held in Dhaka, Bangladesh, several gender- responsive policies were suggested, one of which was to channel agricultural credit through women rather than men (Paris, et.al., 2004, Hossain et.al, 2004) .

Conclusions

This research demonstrated that integrating farmer participatory breeding and gender/stakeholder analysis and by paying greater attention to women in relation to men, enabled women to gain confidence in making decisions related to varietal choice, acquisition and disposal. Participation of both men and women in the early evaluation of the performance of the rice lines/genotypes on their own farms led to the further development of varieties which are suited to their fragile environments. However, involving women in PVS is only the first step towards reducing gender disparity in access to new seeds and knowledge on crop management technologies. Efforts are now going on to provide women farmers with new knowledge and skills in conserving and managing the seeds as well in crop resource management. Based on this experience, the best methods for accelerating the adoption of technologies are on farmer/community participatory approach which involves "learning by doing" and "farmer to farmer" training or exchange of information. With the increasing out-migration of men to the cities, the roles of women will shift from unpaid labor to *de facto* farm managers. Thus, women who are actively engaged in rice-based farming should also be involved in any farmer participatory research project.

References

Ashby J (1997) What do you mean by participatory research in agriculture? In: New frontiers in participatory research and gender analysis for technology development: proceedings, International Seminar on Participatory Research and Gender Analysis for Technology Development 1996. Cali (Columbia) Centro International de Agricultura Tropical, p. 15-22.

Atlin, G., TR Paris, B Linquist, S Phengchang, K Chongyikangutor, A Singh, VN Singh, JL Diwedi, S Pandey, P Cenas, M Laza, PK Sinha, NP Mandal and Suwarno. 2002. In Whitcombe, JR, Parr LB, Atlin GN (eds). *Breeding rainfed rice for drought –prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia*: proceedings of a DFID Plant Sciences Research Programs/IRRI Conference, 12-15 March 2002, IIR, Los Banos, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Program (PSP) Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila, 104 pp.

Courtois, B, Singh Bartolome B, Chaudhury D, McLaren G, Misra CG, Mandal NP, Pandey S, Paris TP, Piggin, C, Prasad K, Roy AT, Sahu RK, Sahu VN, Sarkarung S, Sharma SK, Singh, A, Singh, HN, Singh, ON, Singh, NK, Singh, RK, Singh, R.K, Singh S, Sinha PK, Sisodia BVS, and Takur R. 2001, "Comparing farmers and breeders ranking in varietal selection for low-input environments: a case of rainfed rice in eastern India. *Euphytica* 122: 537-501, 2001. Kluwer Academic Publishers, Netherlands.

Farnworth C..R and Jiggins J (2003). Participatory plant breeding and gender analysis. CGIAR Systemwide Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation: Centro Internacional de Agricultura Tropical (CIAT), 2003. PPB Monograph No.4

Feldstein Hilary Sims (1999). Methodology issues in differentiating users of new technologies: participatory research and gender analysis for technology development. In

Frontiers in Participatory Research and Gender Analysis (PRGA), CIAT Columbia. Proceedings of the International Seminar on PRGA, Sept 11-14, 1996, pp 75-85..

Hossain M, Bose ML and Ahmad A (2004) Nature and impact of women's participation in economic activities in rural Bangladesh: insights from household surveys. CPD-IRRI Policy Brief 7. IRRI Dhaka, Bangladesh.

Johnson N, Lilja N and Ashby J (2000). Using participatory research and gender analysis in natural resource management. Working Document No.10. Consultative Group of Internatinoal Agricultural Research (CGIAR). Participatory Research and Gender Analysis. Centro Internacional de Agricultura Cali, Columbia: Centro Internacional de Agricultura

Kabeer, N (1999) The conditions and consequences of choices: reflections on the measurement of women's empowerment, UNRISD Discussion Paper DP108, United Nations Research Institute for Social Development, Geneva

Lilja N and Ashby J. (1999). Types of gender analysis in natural resource management and plant breeding. Working Document No. 8. Consultative Group on International Agricultural Research (CGIAR). Participatory Research and Gender Analysis (PRGA), Centro Internacional de Agricultura Cali, Columbia.

Lilja N and Johnson, Nancy (2001). Guide to impact assessment of participatory research and gender analysis. Working Document No.7. Consultative Group on International Agricultural Research (CGIAR). Participatory Research and Gender Analysis (PRGA), Centro Internacional de Agricultura, Cali, Columbia.

Morris M and Bellon M (2004). Participatory plant breeding research: Opportunities and challenges for the international crop improvement system. Euphytica 136:21-25, 2004. Kluwer Academic Publishers. Printed in Netherlands

Paris T., Singh A. and J.Luis (2005). Impact of male out-migration on rice household economy and gender roles: a case in eastern Uttar Pradesh, India. *Economic and Political Weekly*, Vol XL, No.25, June 18-24,2005, New Delhi, India, pp2522-2529.

Paris, T., Shaila Arifa Nabi, Ahmad Salahuddin and Noel P. Magor 2005 The Right to Learn Women Want More Agricultural Advice. In *Innovations in rural extension: case studies from Bangladesh*. Edited by Paul Van Mele, Ahmad Salahuddin and Noel P, Magor. IRRI and CABI. pp 15-27

Paris, T. Abha Singh, H.N. Singh Joyce Luis and Mahabub Hossain, 2005. Using Participatory Tools in Setting Gender-Sensitive Criteria for Acceptable Rice Varieties in Eastern India. In Gonsalves, J., T. Becker, A. Barun, D. Campilan, H. De Chavez, E. Fajber, M. Kapiri, j. Rivcao-Caminadae and R. Vernoy (eds) *Participatory Research and Development for Sustainable Agriculture and Natural Resource Management. A Sourcebook*. Volume 3: Doing Participatory Research and Development. International Potato Center Users' Perspectives With Agricultural Research and Development, Laguna, Philippines and International Development Research Centre Ottawa, Canada. (pp. 11-17).

Paris, T. Chowhury A. and Bose M.L (2004). Changing women's roles in homestead management: mainstreaming women in rural development. Presented at the Policy Dialogue on Women's Contribution in Rural Economic Activities: Making the Invisible Visible. April 22, 2004. BRAC Centre Inn, Dhaka, Bangladesh.

Paris, T.R., R.K. Singh, G. Atlin and NARS from India.(2002). Farmer participatory breeding and participatory varietal selection in eastern India: Lessons learned. In Whitcombe, JR, Parr LB, Atlin GN (eds). *Breeding rainfed rice for drought –prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia*: proceedings of a DFID Plant Sciences Research Programs/IRRI Conference, 12-15 March 2002, IIR, Los Banos, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Program (PSP) Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Maniila, 104 pp.

Paris, T. R. A.Singh and J. Luis (2001a). Listening to male and female farmers in rice varietal selection: a case in eastern India. In CIAT 2000. An Exchange of Experiences from South and Southeast Asia. Proceedings of the International Symposium on Participatory Plant Breeding and Participatory Plant Genetic Resource Enhancement, Pokhara, Nepal, 1-5 May 2000. Cali, Columbia: Centro Internacional de Agricultura.

Paris T.R., Singh A., Luis, J., Hossain, M., Singh HN., Singh, S., and Singh, ON. (2001b). "Incorporating gender concerns in participatory rice breeding and varietal selection: preliminary results from eastern India. In Lilja N, Ashby A and Sperling L., (eds) Sept. 2001. Assessing the impact of participatory research and gender analysis. Cali Columbia: Participatory research and gender analysis program, Coordination office; International Center for Tropical Agriculture.

Paris, T. R., A. Singh, M. Hossain and J. Luis, 2000. 'Using gender analysis in characterizing and understanding rainfed lowland rice environments". In Tuong TP, Kam SP, Wade L, Pandey S, Bouman BAM, Hardy B, (eds). 2000. Characterizing and understanding rainfed environments. Proceedings of the International Workshop on Characterizing and Understanding Rainfed Environments., 5-9 Dec. 1999, Bali, Indonesia. Los Banos (Philippines): International Rice Research Institute (pp. 339-370).

Paris, T.,A. Singh and M. Hossain, 1995. Social consequences of stressed environments. In Physiology of stress tolerance in rice: Proceedings of the International Conference on Stress Physiology of Rice held in Lucknow, India on 28 February - 5 March 1995. Edited by Singh, V.P. et. al. 1996.

Sahu, R.K., V.N.Sahu, M.L. Sharma. T.R. Paris, K. McAllister, R.K. Singh and S. Sarkarung, 2001. Understanding farmers' selection criteria for rice varieties: a case in Madhya Pradesh, eastern India. In CIAT 2001. An Exchange of Experiences form South and Southeast Asia. Proceedings of the International Symposium on Participatory Plant Breeding and Participatory Plant Genetic Resource Enhancement, Pokhara, Nepal, 1-5 May 2000. Cali, Columbia: Centro Internacional de Agricultural.

Sen G. and Grown, C. (1985) DAWN, Development, crisi, and alternative visions: third world women's perspectives. Development Alternatives with Women for New Era (DWAN), New Delhi.

Sen, A.K. (1990) “Gender and Cooperative Conflicts” in Tinker, Irene (ed) Persistent Inequalities: Women and World Development, Oxford University Press, Oxford.

Singh ON, S. Singh, V.N.Singh, J.L. Dwivedi, A.Singh, H.N. Singh, R.K.Singh, T. Paris, G. Atlin and V.P.Singh 2002. Addressing genetic improvement and on-farm diversity through farmer participatory breeding: a case study of rainfed rice in the Faizabad and Siddarthnagar districts, Eastern Uttar Pradesh, India. In Whitcombe, JR, Parr LB, Atlin GN (eds*). Breeding rainfed rice for drought –prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia*: proceedings of a DFID Plant Sciences Research Programs/IRRI Conference, 12-15 March 2002, IIR, Los Banos, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Program (PSP) Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila, 104 pp.