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ENHANCING ON-FARM VARIETAL DIVERSITY THROUGH PARTICIPATORY VARIETAL SELECTION: A CASE STUDY FOR *CHAITE* RICE IN NEPAL

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SUMMARY

To enhance the diversification of rice varieties for the specific needs of farmers through a participatory varietal selection (PVS) approach, four pre-release and one released *chaite* rice varieties were distributed in 20 villages of the Western Hills of Nepal in 1991. A survey conducted during June 1993 found that varietal diversity increased in all locations and in 80% of the study area at least two new rice varieties were reported where only CH 45 was grown before the distribution. On-farm varietal diversity was further enhanced by farmer-to-farmer dissemination of new rice varieties. All the rice varieties tested were adopted, but the adoption level varied between locations. Of the households surveyed 37% were growing the new rice varieties and a further 57% were aware of those varieties within two years of introduction. The PVS approach provided farmers with the benefits of new genetic materials five to six years in advance of the formal system and with minimum effort. Institutionalization of the PVS approach and the use of the farmers' network of information and seed exchange, involving relevant grassroots level institutions, can improve the effectiveness of the variety evaluation system.

INTRODUCTION

Though main season rice (*Oryza sativa* L.) is a traditional crop of Nepal, cultivation of *chaite* rice planted in February–March started after the introduction of the variety CH 45 during the early 1950s. *Chaite* rice has a high yield potential because it receives more solar radiation, utilizes production resources more efficiently and is less damaged by insect pests and diseases than the main-season crop (IRRI, 1995). Rapid rural appraisal conducted during 1990 indicated a lack of varietal diversity, and revealed that almost 90% of the area under *chaite* rice was still planted to a single variety, CH 45 (Sthapit, 1990). This may be potentially dangerous should there be any epidemic outbreaks of disease and insect pests.

Varietal diversity is also advisable in order to address varied physical environments, socio-economic conditions and the needs of farmers (Joshi and Sthapit, 1990). The conventional research approach results in the selection of a few widely adapted varieties which is one of the reasons for the low uptake of varieties

developed through this system. The system is not only time-consuming and costly but also marginalizes farmers' participation in technology development. Farmers possess the ability and knowledge for selecting crops and species to suit their environments and resources, and to meet quality and other consumer requirements (Hardon, 1995). Research costs can be reduced and adoption rates increased if the farmers are allowed to participate in variety testing and selection (Joshi *et al.*, 1995).

Evolution of participatory varietal selection (PVS)

Participatory varietal selection (PVS), as a form of informal research and development, was initiated at the Lumle Agricultural Research Centre in 1989–90 (Joshi and Sthapit, 1990) at a time when the formal system was failing to address the diverse needs and preferences of hill farmers. The objective of the programme was to allow farmers to select crop varieties at their most vigorous stage (F_7–F_8) which were appropriate to their needs, preferences and circumstances, and to disseminate them through the farmer-to-farmer network. The participatory approach has been reported to be successful in increasing adoption rates by farmers across a number of crops and species (Gurung and Amatya, 1992; Sthapit *et al.*, 1996; Witcombe *et al.*, 1996). This case study aimed to increase the diversity of the *chaite* rice varieties cultivated and to improve the adoption of new varieties by farmers using the PVS approach. A secondary aim was to analyse whether adoption rates were influenced by socio-economic factors and to assess farmers' perception of the PVS approach.

METHODOLOGY FOR *CHAITE* RICE VARIETAL SELECTION

Five *chaite* rice varieties were distributed amongst 1803 households across the low hills (<800 m) in six districts of the Western Development Region (WDR) of Nepal during spring 1991 (Table 1). One variety of *chaite* rice was given to an individual farmer for evaluation. The seed packets each contained 250 g seed and were accompanied by printed response cards with relevant information on *chaite* rice. Farmers tested the rice varieties as appropriate to their own circumstances and methods, except that any risk of varietal mixture was avoided either in the field or during and after post-harvest operations. Preliminary monitoring during summer 1992 was followed by a household survey during 1993, which was supplemented by farmers' group discussion to understand their perception of the new varieties and to study the effectiveness of the PVS approach.

Sampling frame and sample size

A total of 242 of the initial 1803 households monitored in 1992 formed the basis for the sampling frame for the 1993 study. The members of 92 households from 20 villages were interviewed taking a 35% ($\pm$5%) sample from the 238 households. A proportionate stratified random sampling was used to identify the respondent households, and the sample was largely in proportion to packets distributed for

Table 1. *Details of* chaite *rice varieties included in the participatory varietal selection programme in the Western Development Region of Nepal, 1991–93*

Variety	Status	Number of households†		
		Distributed 1991	Monitored 1992	Surveyed 1993
NR 10158-2B-2	Pre-release	181	34	12 (7)‡
IR 28128	Pre-release	601	73	26 (4)
IR 13155	Pre-release	434	68	17 (4)
Chaite 4	Released	527	55	23 (4)
Other varieties§	Pre-release	60	8	4 (7)
Unidentified varieties	Pre-release	—	—	10

†Rice varieties were distributed amongst 1803 households is spring 1991. Preliminary monitoring in summer 1992 was followed by a household survey in 1993. ‡Figures in parentheses show the percentage of households surveyed in 1993 relative to 1991. §Other varieties included were Palung 2, IR 32419 and IR 44595. Of these only IR 44595 was adopted by the farmers and could be traced in the subsequent studies.

each variety (Table 1). For stratification purposes, the parameter selected was the variety of *chaite* rice received by the respondent. Randomization was done within the strata to select respondents. Respondents were also categorized into three food sufficiency categories: food surplus; food balance; and sufficient food for 3–8 months.

Field work and analysis

A formal interview schedule was prepared for collecting information in 1993 and two agronomists, one socio-economist and one junior technician, were involved in the survey. At least two team members participated at each site. The field work was performed just before harvest of the crop, between 22 June and 6 July 1993. The raw data were entered onto a computer using the SPSS Data Entry Module, and analysis was performed using SPSS/PC+.

Farmers' preferences for tested *chaite* rice varieties and their willingness to continue to grow the same varieties were studied. Willingness to continue growing the variety was cross-checked by investigating whether farmers saved seed for the next season's planting. The response was coded as 'adopted' for those who saved seed for next season's planting and 'rejected' for those who responded that they had not saved seed and did not wish to continue to grow *chaite* rice. Farmers who failed to give a definite answer were classified as 'undecided'.

RESULTS

Varietal diversification through PVS approach

The varietal diversity of *chaite* rice in the study area was increased substantially through the PVS approach (Fig. 1). Results of household surveys and group

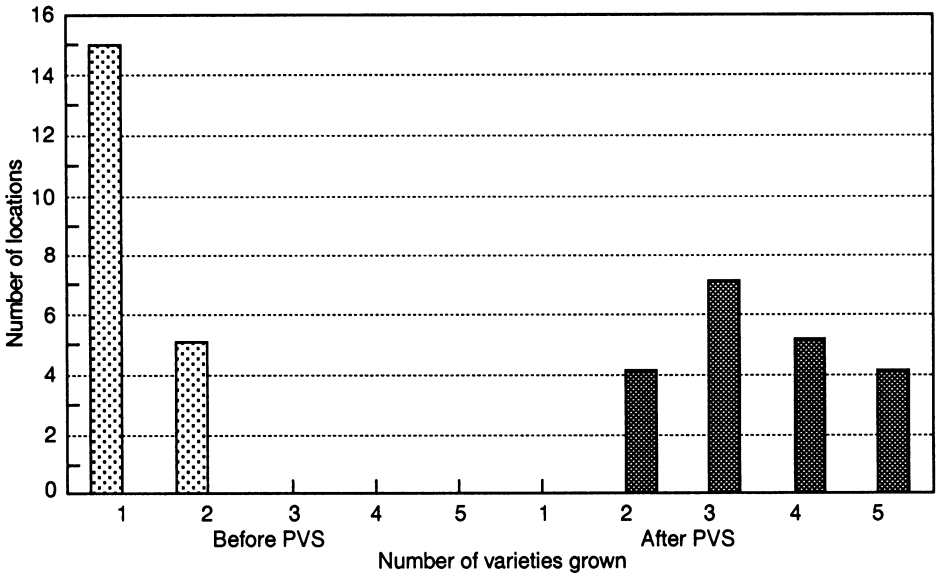

Fig. 1. Varietal diversity of *chaite* rice in the Western Development Region before ⁘ and after ⁙ initiation of the participatory varietal selection (PVS) approach.

discussions with farmers revealed that in the majority of cases farmers adopted more than one variety of *chaite* rice partly replacing the variety CH 45. Farmers also made their own comparisons between the rice varieties they received the first time and other new varieties grown by their neighbours, and sometimes they replaced one for another. Farmers' awareness of the *chaite* rice varieties distributed in a village but not received by them was assessed. About 57% of households were aware of such varieties and had asked for seed from their neighbours to try in the following year.

The study revealed a number of examples of farmer-to-farmer exchanges of seed and seedlings, with women farmers playing a significant role in this. Women who visited their parents in the study area received seeds or seedlings of new varieties as a gift and disseminated them to different villages. It is customary to provide a breeding animal or the seed of a popular crop variety as a gift to relatives, particularly to a newly married daughter when she goes to her husband's house (Joshi, 1995).

The spread of new rice varieties was also discussed with farmers. Seeds or seedlings were mostly distributed within a radius of 10 km but in some cases planting materials were carried 50–100 km. In one case a farmer carried seeds a distance over 100 km from the Bhanu Village Development Committee in Tanahun District to the Nawalparasi District. Farmers with a food surplus were the main source of seed distribution, though some seed was also distributed by food-balance and food-deficit groups (Fig. 2).

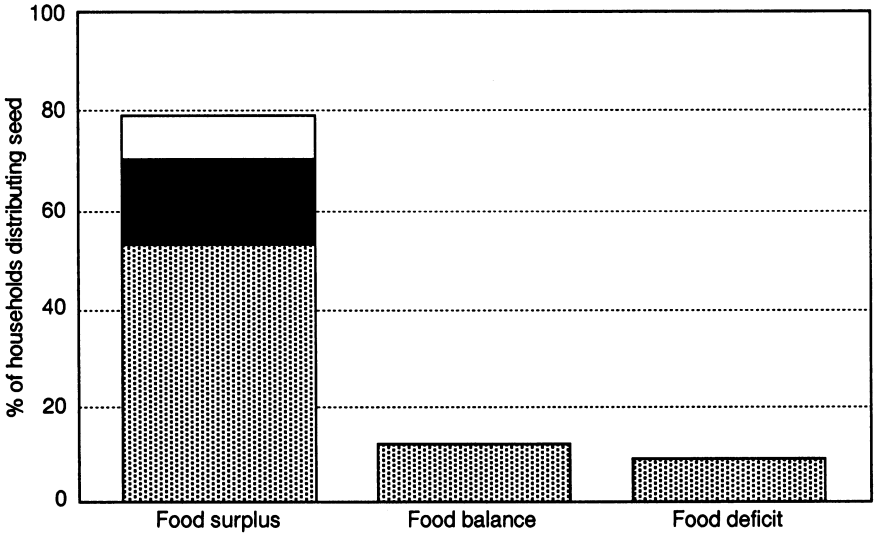

Fig. 2. General pattern of seed distribution to neighbours □, relatives ■, and strangers □ during the participatory varietal selection programme with *chaite* rice varieties in the Western Development Region of Nepal in 1991–93. Bar graphs show food sufficiency level of different groups of farmers.

Adoption of chaite rice varieties

The association between farmers' willingness to continue growing the new *chaite* rice varieties after 1992 and their actual adoption during 1993 was studied. Although 59% of respondents indicated in 1992 that they were willing to continue growing new rice varieties, only 37% adopted them in 1993 (Table 2). Of these 44% planted a larger area than in 1992 whereas 56% did not increase the area.

The difference between the percentage of households 'willing to continue' and the 'adopters' was similar for most varieties except for IR 28128 which was dropped in a number of locations. The adoption level for the officially released variety Chaite 4 was also low whereas IR 13155 and NR 10158 had above 40% adoption (Table 2). Although the adoption level for IR 44595 appeared impressive however, it was based on a very small sample size and should be interpreted with caution.

Discussions with the participating farmers, provided various reasons for adopting certain varieties. A female farmer at Bhanu, and farmers at Huwas, Ganeshpur and Ranigaon adopted IR 13155 partly replacing their existing variety CH 45. A farmer at Bhoteodar dropped IR 28128 to grow IR 13155. Many farmers liked IR 13155 for its high yield potential, a growing period suitable for multiple cropping, good cooking quality, and because it was safe from shattering. In some areas, particularly where labour was a constraint, it was not popular because of difficulty in threshing.

IR 28128, which had short straw, low straw yield and late maturity, was preferred by one farmer at Taranagar and another at Jamune, but two farmers at Ganeshpur said they did not like these characteristics and rejected it.

Table 2. *Preference and adoption levels for different* chaite *rice varieties included in a participatory varietal selection programme in the Western Development Region of Nepal, 1991–1993*

	1992		1993	
	Number of households		Number of households	
Variety	Surveyed	Willing to continue†	Surveyed	Adopted‡
NR 10158-2B-2	34	20 (59)§	12	5 (42)
IR 28128	73	51 (70)	26	6 (23)
IR 13155	68	41 (60)	17	8 (47)
Chaite 4	55	20 (36)	23	6 (26)
IR 44595	8	8 (100)	4	4 (100)
Unidentified varieties	0	0	10	5 (50)
Total	238	140 (59)	92	34 (37)

†Farmers willing to continue growing new *chaite* rice varieties after 1992. ‡Farmers adopting *chaite* varieties in 1993. §Figures in parentheses represent percentage value.

One farmer at Ganeshpur and two farmers at Arba dropped Chaite 4 because of threshing difficulties due to the short straw, poor heading and high sterility, while it was adopted by the farmers of Bhanu and Rakhi. The same farmers who dropped Chaite 4 picked up IR 13155 from their neighbours.

Influence of socio-economic factors on varietal adoption

The adoption level of *chaite* rice varieties was analysed further on the basis of food sufficiency level and size of holding. Of the 29 'adopters', 48%, 37% and 15% of households were from food-balance, food surplus and food-deficit groups respectively. The adoption level for IR 13155 (47%) and NR 10158 (42%) was higher than for IR 28128 (23%) and Chaite 4 (26%). Irrespective of variety, farmers with a food surplus had higher adoption rates than those with a food balance.

Ethnicity influenced the role of gender in varietal selection and adoption decisions. In the Tamang (Tibeto–Burman) community of Jholunge Phant, women contributed more to the process, whereas the opposite was true for the Brahmin (Indo-Aryan) community in the neighbouring village.

The opinions of farmers as to the number of *chaite* rice entries to be tested at a time was also determined. Irrespective of the gender of respondents, 44% wished to have two varieties, 25% preferred to have three, while 21% farmers wanted only a single variety at a time. The majority of female respondents (78.6%) were willing to test two or three varieties at a time. Discussions revealed that access to two or more varieties made the process of comparison easier.

When farmers' familiarity with the names of the distributed *chaite* rice varieties was assessed only 23% of the respondents were able to name new varieties. The Chi-square test revealed that this had a significant effect on the final adoption of the same varieties ($p < 0.05$). Of those who could name new varieties, 78% were

food-surplus farmers, 22% were food-balance farmers, and none were from the food-deficit group.

Farmers perception of varietal performance

Group discussions at different locations revealed that the new *chaite* rice varieties distributed under PVS were superior in germination, early establishment, early seedling growth and tillering, but seedling height at transplanting was no different from that of local varieties. Farmers believed that the new improved varieties failed to perform well when planted on poor soil and so they would require higher fertility levels, better irrigation and more intensive management. Farmers evaluating new varieties said that in addition to grain yield (unhusked paddy), they also considered parameters such as growing period, plant height, ease of threshing, milling recovery (weight of milled rice/weight of unhusked rice), taste and other characteristics of the cooked rice (Joshi *et al*., 1995).

Results of the household survey indicated that farmers used a combination of biological and socio-economic criteria for variety selection. For example, early and uniform maturity, plant height, yield and yield components are the most important traits influencing the varietal preferences of farmers. The majority of respondents (65–100%) identified that new semi-dwarf rice entries were higher yielding than the local one; some farmers harvested 4.8 t ha^{-1} of unhusked paddy where a local variety could have produced only 1.9 t ha^{-1}. The valuable findings of the study were that grain type, milling recovery, cooking quality, increase in volume of *bhat* (cooked rice), and quality of *bhat* are important criteria if a new rice variety is to be widely adopted and these criteria are often ignored in formal variety evaluation systems.

The majority of respondents (95%) liked the idea of testing a small quantity of seed of new *chaite* rice varieties and 87% of respondents were willing to test new genotypes, even if they encountered failures. They believed that this type of programme was a means of disseminating new varieties. However, 9% of the respondents were not willing to participate in this programme. Food-surplus and food-balance farmers who could take more risk showed more interest in testing new varieties than farmers with food deficits.

DISCUSSION

Over three years, diversification of *chaite* rice varieties increased substantially with three pre-release varieties in particular being adopted by a considerable percentage (37%) of farming households. Witcombe *et al*. (1996) reported that the number of cultivars adopted will increase where a large number of farmers are exposed to many cultivars. The present study also supports this. Diversity in the physical environment and socio-economic conditions also favours adoption of more than one cultivar thereby increasing the diversity on-farm. The results indicate that the use of PVS can lead rapidly to diversity of varieties

and that the participatory approach works well within complex farming communities.

Diversification was enhanced further by a dynamic form of the variety replacement process whereby one variety replaced either CH 45 or another pre-released variety distributed in the area. In total the number of *chaite* rice varieties grown in all the locations increased after the introduction of the PVS approach, and this offered greater choice as well as a means for risk aversion. Popular wisdom 'betting on more than one horse reduces the risk' (Noordwijk and Andel, 1988) is also meaningful in this context.

Varietal choice between the locations varied greatly depending upon the biological and post-harvest qualities and utilization of *chaite* rice varieties, as well as a number of socio-economic factors. At a single location, varieties had varying levels of adoption across different food sufficiency categories. This finding implied that any one variety is highly unlikely to fulfil the diverse needs and preferences of all farmers, and raises a question mark over the suitability of the conventional approach which attempts to identify and promote a few widely adapted varieties for farmers' diverse situations.

Chemjong *et al.* (1995) and LARC (1995) reported that the adoption rate of modern rice varieties in the hills was 10–11% which shows that the adoption level of pre-released varieties (23–47%) was encouraging. Adoption levels of some varieties were better than those of the officially released variety Chaite 4 (26%) that had been selected through the conventional selection process. In addition to this, about 57% of farmers were aware of new varieties and willing to test them. This means that the total adoption rate is likely to increase. The PVS process allows farmers complete freedom to decide on the suitability of rice varieties for their own conditions and, consequently, adoption rates were increased when this approach was used. It is also suggested that adoption rates increase using the PVS approach because farmers gain confidence in their ability to grow their selected varieties. The study also indicated that different types of varieties might be required for different cropping patterns and socio-economic conditions. For example, NR 10158 was preferred by vegetable growers as it was an early maturing variety and allowed more time for growing commercial vegetables whereas IR 13155 had good cooking quality in addition to tall plant height and high yield.

The problem of slow and hierarchical processes of variety testing in formal systems can be overcome by this approach because promising varieties can be distributed from the F_7 stage onwards when they have more genetic potential. This reduces the time requirement by almost half, which is a big saving of scarce resources. Comparison of the formal and the PVS system in terms of financial and staff costs revealed that on average the PVS system was 43% more cost effective compared to the formal system (Joshi *et al.*, 1996).

Generally, yield and length of growing period are the major deciding criteria for variety selection in a formal system. In this study Chaite 4 was not preferred at Ganeshpur in spite of its very high yield because of difficulty in threshing.

Similarly another high-yielding variety IR 44595 was also rejected by the farmers of Jholunge Phant because of its poor cooking quality and poor milling recovery. IR 28128 was rejected in a number of locations due to its poor cooking quality, poor taste, low milling recovery and short stature which makes it difficult for carrying and threshing. It is very unlikely that this type of information can be achieved from a researcher-designed trial. This suggests that science-based knowledge and local knowledge systems must be optimized in the agricultural research and development process (Haverkort, 1991) in order to make the programme successful. The contribution of indigenous knowledge in this programme has been quite obvious.

The value of the approach is well documented (Gurung and Amatya, 1992; Upadhyay and Sthapit, 1995; Sthapit *et al*., 1996; and Witcombe *et al*., 1996). It has contributed to a reorientation of on-farm research approaches on farmer participatory lines. Interestingly some of the livestock species such as rabbit breeds are disseminated through this approach. We suggest that institutionalization of this approach could make the conventional system more efficient. Utilization of farmers' networks of information and seed exchange and other grassroots level institutions for this purpose can be cost-effective and sustainable.

CONCLUSION

Findings of PVS on *chaite* rice have shown the possibility of enhancing on-farm varietal diversity and increasing adoption rates. The approach allows evaluation of new crop varieties under a range of biological and socio-economic conditions, it increases chances of success and offers the benefit of new genetic resources five to six years in advance of the formal research system. The PVS is cost effective and can be applied in a range of crops and other species. Incremental benefits from this approach may accrue through farmer-to-farmer variety dissemination. As women have an important role in post-harvest quality assessment and in spreading new genetic materials, their participation in the process needs to be strengthened. Post-harvest quality characteristics, biological yield and indigenous knowledge systems are important considerations while developing new crop varieties to enhance varietal adoption and diversification.

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