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On-farm Conservation of Landraces of Rice (*Oryza Sativa* L.) through Cultivation in the Kumaun Region of Indian Central Himalaya

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Abstract: The Himalayan region is a known hot spot of crop diversity. Traditional varieties (usually called primitive cultivars or landraces), having withstood the rigors of time (including harsh climatic conditions as well as attacks of insects, pests and diseases), can still be found in crop fields in rural parts of Indian Central Himalaya (ICH). These landraces harbor many desired traits from which, for example, varieties that are tolerant/resistant to abiotic/biotic stresses could be developed. In addition to the above benefits, landraces provide a basis for food security and a more varied and interesting diet. Some landraces are also known to be of medicinal value. These, along with some lesser known hill crops, are often referred to by different names such as under exploited crops, crops for marginal lands, poor person crops, and neglected mountain crops. The Himalayan region continues to be a reservoir of a large number of landraces and cultivars whose economic and ecological potential is yet to be fully understood and/or exploited.

Indians have had a history of rice cultivation since ancient times. Farmers, including tribals inhabiting the IHR, still cultivate a plethora of landraces of rice and thus directly contribute towards on-farm conservation of valuable germplasm and help in the preservation of crop diversity. The present paper looks at the on-farm conservation of rice germplasm, which is still practised in the Kumaun region of ICH.

Keywords: Germplasm; Himalaya; landraces; on-farm conservation; rice

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Introduction

Plant genetic resources, being the raw material for any breeding program, are crucial to global food security. Without the continued availability of genetic diversity, the world's future food supply will be put at risk (Maikhuri et al. 1997). Since the birth of agriculture, crop genetic resources have been used to either consciously select or develop new varieties of crops with higher productivity for different agro-climatic regions. They constitute a priceless reservoir of genes conferring adaptation to stress environments and resistance to diseases and pests. For this purpose, as in the past, we will continue to depend on the genetic resources available in the form of traditional varieties/ landraces (Bawa 1993). However, in the wake of the spread of high-yielding varieties, genetic variability including landraces and their wild relatives is getting eroded; we are constantly losing landraces of major crop plants, thus narrowing down the available gene pool (Palni 1993). This has become a prominent global issue, particularly after the 1992 Convention on Biological Diversity (CBD).

The agrobiodiversity of a region encompasses an enormous array of biological resources tied with agriculture such as crops, livestock, soil biota, wild and weedy relatives of crops, and rangelands. It has two contrasting dimensions, viz, the "traditional agroecosystem", which maintains and protects biological diversity, and the "intensive cropping system/modern agroecosystem", such as mono-cropping, agroforestry and plantations (these have evolved recently, basically to enhance production (Paroda 1997)). There has been a steady shift from the traditional to the modern agroecosystem, with considerable loss of biological diversity (Palni and Sharma 1999). However, present agricultural policies have largely ignored this vital resource base for the sustainable conservation of the agro-ecosystem (Shiva and Vanaja 1993). Neglect towards the Himalayan agroecosystem and traditional crops and the massive push towards technologies with ever-increasing dependence on external resources seem to be important factors in this crisis (Swaminathan 1991, Ramakrishnan et al. 1994)

The loss of biodiversity will have serious and irreversible consequences for human welfare. For this, a system will have to be developed and continuously strengthened for the unrestrained flow and exchange of germplasm for plant breeding programs. The importance of plant genetic resources for food security and sustainable agriculture has been recognized internationally. Various factors have promoted the use of high-yielding hybrid varieties in agriculture in modern times, which has gradually resulted in the eradication of native germplasm (landraces). Landraces have largely disappeared from the crop fields in the plains of Kumaun Himalaya, where commercial agriculture is practised. On the other hand, traditional agricultural practices of hill farmers strongly favor the maintenance of high crop diversity in the form of landraces (Palni and Sharma 1999).

Biological diversity plays a significant role in maintaining the long-term stability of traditional agro-ecosystems in a variety of ways (Palni et al., 1998b). For example, it helps to minimize crop losses due to insects, pests, diseases and nematodes, inhibits weeds, helps to maintain productivity per unit area, conserves soil from erosion on steep slopes, and provides insurance against crop failure (Tokey and Ramakrishnan 1983). In addition to the above benefits, traditional varieties/landraces provide greater food security (Agnihotri et al. 2003). Once a local crop race is displaced, its unique germplasm gets lost forever (Alteri and Merric 1987). This paper reports on the on-farm conservation of rice landraces through cultivation, with reference to the Kumaun region of Indian Central Himalaya (ICH).

1 Study Area

The study area (Kumaun) falls in the ICH and has a unique geographic location between the plateau of Tibet on the north and the Gangetic plains to the south. With the entire northern and eastern boundaries being international, ICH assumes strategic significance and thus the area is politically sensitive. The exploration work for the present study was carried out in the Kumaun region of ICH (excluding Greater and Trans Himalaya). A brief description of this region illustrates its uniqueness and landform diversity. The Kumaun region extends from 28°44' ~ 30°49' N latitudes to 78°45' ~ 81°5' E longitudes with a total area of 21,033 km^2. The extent in the east-west direction is about 155 km while along the north-south it stretches for about 235 km (Joshi et al. 1983). On the basis of geological and geo-graphical differences this is further classified into different regions viz., (i) *Tarai,* (ii) *Bhabar,* (iii) Siwalik, (iv) Lesser Himalaya, (v) Greater Himalaya, and (vi) Trans Himalaya (Figure 1).

2 Material and Methods

Surveys were carried out in the different landforms *(tarai*, *bhabar*, Siwalik and Lesser

Himalaya, except Greater and Trans Himalaya) to identify different agricultural practices and the landraces of different crops being cultivated in the farmers' fields with particular reference to the diversity within rice landraces. In the mountains, like elsewhere, roads in particular represent connectivity and exposure to new technologies; thus in the Siwaliks and Lesser Himalaya, areas were further categorized on the basis of distance from the motor road to examine the impact of remoteness vis-à-vis connectivity on the occurrence of the number of landraces of rice. Frequent surveys were made for the collection and characterization of various landraces cultivated on the farmers' fields. In the present investigation, only the survey (collection) part has been covered and described for richness of the gene pool in the various landforms and their respective villages.

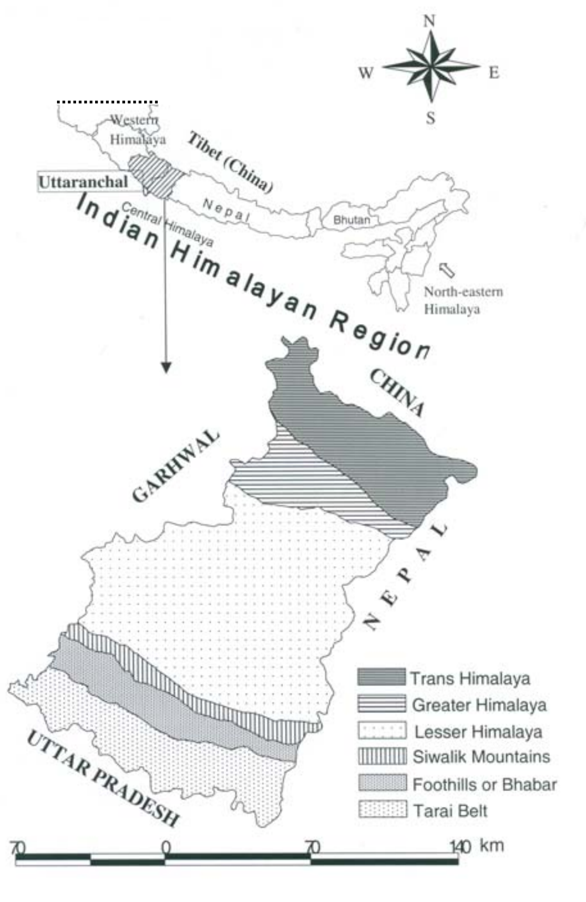

Figure 1 Different landforms in the Kumaun region of Indian Central Himalaya

3 Results and Discussion

The various crops grown in the *tarai* region today are all introduced varieties (improved and high yielding, Figure 2). The same is true for the *bhabar* belt. However, the villages located in the Siwalik region (next to *bhabar*) show a transitional situation (both for introduced and traditional varieties, Figure 2). Exposure to modern agricultural practices and other markers of development seems to have played a significant role in this eradication process, either by way of minimizing the use of local landraces of crops or zero use of traditional varieties in the plains or the adjoining Siwalik region, which largely practices commercial agriculture. This is illustrated using rice as an example. Among all crops, rice is particularly rich in landraces throughout the world. Likewise, this region is also endowed with many varieties/landraces of this crop. Out of a total of 8 improved varieties listed during the survey, 7 find places in the modern agriculture of *tarai* and 3 in the *bhabar* region. However, no improved variety finds a place in the traditional agricultural practices still being followed in the mountains (Figure 2).

The mountain villages situated along or near the motor road (0 ~ 4 km from road head) were found to have, on an average, about 3 landraces per village. As the distance of a village from the road head increased (4 ~ 8 km from the motor road), a concomitant increment in the number of landraces of rice was observed (Table 1). The values ranged from 2 to 21, and on an average 11 landraces were found under cultivation per village. Here altitudinal variations were not found to have any relationship with the number of landraces found in a particular region (Table 1).

Hill agriculture continues to provide an effective niche for the maintenance of the rich diversity of landraces of a number of crop plants including rice. As much as 33 landraces of rice were collected from the Lesser Himalayan region during the survey of the present study. The above results clearly indicate that the agricultural advancement in the *tarai* (and in the *bhabar*) regions, as well as improved technical know-how have played a crucial role in the development of commercial agriculture, compared to other regions. The promotion and use of newer varieties and hybrid seeds have slowly resulted in the replacement of native germplasm and local landraces from the crop fields.

The hill farmers (in the Lesser Himalayan region) maintain high crop diversity (in the form of landraces), and this feature correlates well with the distance of a village from the road head (Agnihotri 2002, Table 1). In general, the effect of remoteness is clearly indicated by the continued cultivation of a number of landraces of different crops. Thus, it may be observed that as the distance of a village from the motor road increases, a concomitant increase in the abundance of landraces of a given crop is seen. Villages located at some distance (more than 4 km) from the motor road are found to hold greater landrace diversity than the villages closer to the road head (Table 1).

Landraces are known to be associated with the cradle areas of crop domestication that are generally characterized by highly heterogeneous environments. These are also associated with traditional farming systems characterized by small-scale marginal farm lands and subsistence production (Zhu et al. 2000). Regions where landraces persist also happen to be economically weak and thus have become the target of developmental programmes in recent years, resulting in the genetic erosion of traditional landraces. Diffusion of improved varieties into areas of traditional agriculture is thought to introduce new and often detrimental elements into the evolutionary system (Wolfe 2000). The result is genetic erosion and accelerated loss of germplasm from the extant crop gene pool. By this, more germplasm is lost than can be replaced by natural processes or by the introduction of new ones.

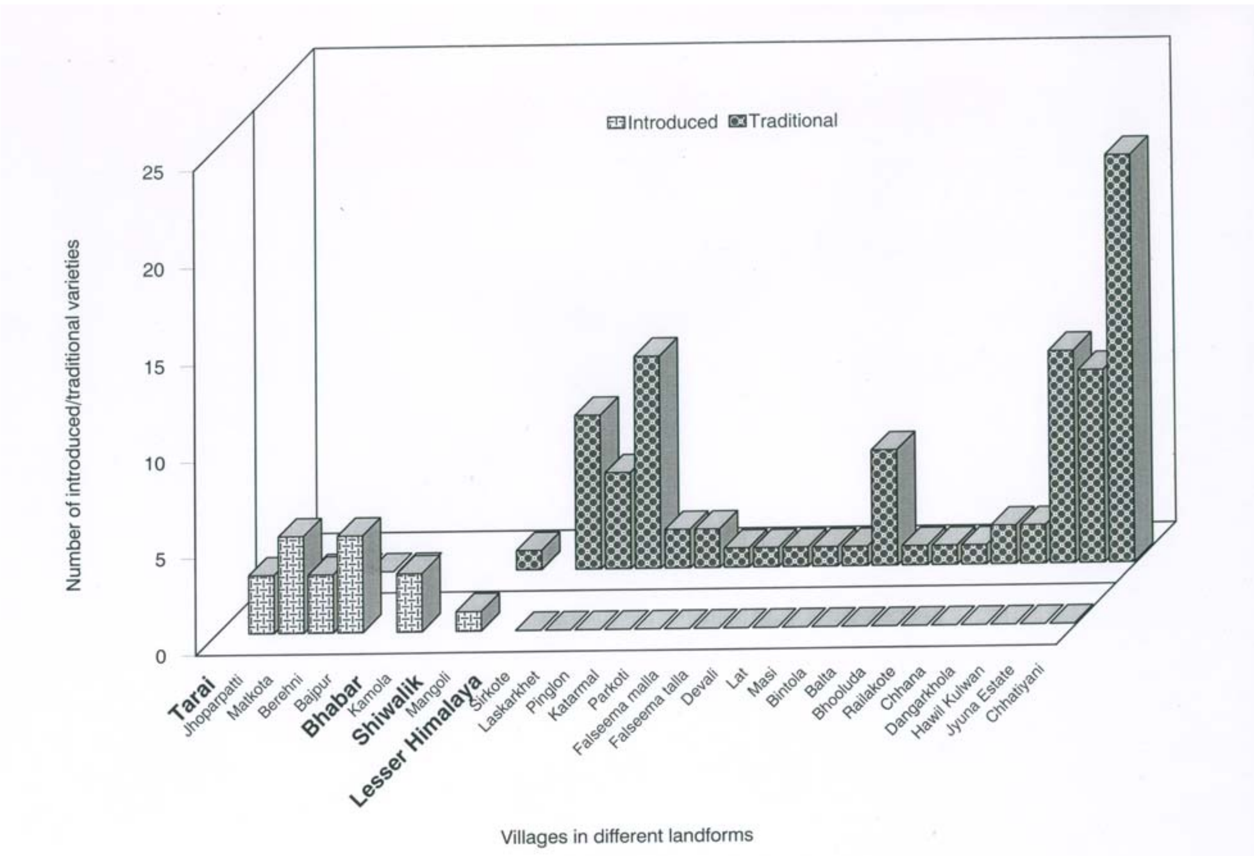

Figure 2 Introduced high yielding varieties and traditional landraces of rice under cultivation in selected villages of different landforms of Kumaun region of Indian Central Himalaya

Table 1 Number of rice landraces under cultivation in different villages in Lesser Himalayan region, Kumaun (based on distance from road head)

Village	Altitude (m)	Distance from road head and number of landraces*	
		0 ~ 4 km	4 ~ 8 km
Sirkote	(1600 ~ 1700)	8 (1,2,3,4,5,6,7,8)	
Laskarkhet	(1300 ~ 1700)	5 (1,3,4,5,6)	
Pinglon	(1150 ~ 1300)	11 (1,2,3,4,5,6,7,8,9,10,11)	
Katarmal	(1200 ~ 1300)	2 (3,12)	
Parkoti	(1250 ~ 1600)	2 (5,6)	
Falseema Malla	(1200 ~ 1250)	1 (11)	
Falseema Talla	(1000 ~ 1175)	1 (11)	
Devali	(1175 ~ 1250)	1 (11)	
Lat	(1200 ~ 1400)	1 (12)	
Masi	(750 ~ 1000)	6 (3,12,13,14,15,16)	
Bintola	(1250 ~ 1350)	1 (11)	
Balta	(1300 ~ 1375)	1 (11)	
Bhooluda	(1350 ~ 1400)	1 (11)	
Railakote	(1400 ~ 1500)	1 (11)	
Chhana	(1300 ~ 1475)	2 (11,13)	
Dangarkhola	(1700 ~ 1950)		2 (11,13)
Hawil kulwan	(1600~ 2200)		11 (1,3,5,6,7,13,17,18,19,20,21)
Jyuna Estate	(1300 ~ 2100)		10 (1,5,6,7,13,17,18,19,20,21)
Chhatiyani	(1400 ~ 1600)		21 (1,3,5,6,7,13,15,17,21,22,23,24,25,26,27,28,29,30,31,32,33)
Average		**2.97**	**11.00**

Note: *Actual landraces under cultivation are given in parenthesis.

Key to landraces of rice:
1. Chhotiya 2. Danbasmati 3. Nandhan 4. Sailani 5. Thapchini 6. Kantolia 7. Dalbadal 8. Laldhan 9. Danbasmati 10. Saunji 11. Bauran 12. Dudhdhan 13. Ratna 14. Nauli 15. Basanti 16. Prasad 17. Tilansi 18. Lubri 19. Banpasu 20. Jhumri 21. Kururidhan 22. Dudhikapkot 23. Chhatuli 24. Katmau 25. Chhutumuti 26. Syaudhan 27. Sabhawati 28. Patoli 29. Taichin 30. Anjani 31. Bindudhan 32. Dehradoonibasmati 33. Dutiyau

Diversification also provides buffer in times of drought, pest attack and elusive rains, when one or the other landrace might fail (Kothari 1997, Palni et al. 1998a). There is ample evidence that many farmers would benefit from access to a wide choice of rice (Zhu et al. 2000). This is particularly important for farmers in marginal areas who do not always have access to suitable improved varieties; such varieties are not bred because of failure in the seed supply system. Moreover, major efforts have focused on irrigated agriculture at the expense of neglected traditional rain-fed agriculture, as practised in the hills (Maikhuri et al. 1998, Palni et al. 1998b). Many such farmers may require access to a wider range of existing traditional germplasm of rice containing novel variation than what is currently available to them in the form of landraces in their locality (Wolfe 2000, Wood and Lenne 1997).

The farmers' management of landrace diversity is now being formally recognized as a system that has been conferring vitality and viability to traditional agricultural systems since time immemorial, and with some technical assistance it can lead to wider crop improvement, particularly for marginal areas with great environmental diversity. Riley (1996) illustrates, using the examples of barley and finger millet, how farmers' management has played an important role in shaping the diversity of landraces in those two self-pollinating crops.

It is clear that farmers select their crop plants as they decide which individuals will be allowed to produce the next generation. In simple mass selection, farmers take the second step in breeding, that is, in deciding how individuals that they have selected will be mated to each other. Thus, landraces may be a product of farmers' selection, as well as farmer-based breeding (Zhu et al. 2000). Diversity of landrace populations can be readily observed at three levels: 1) diversity of landraces among regions, 2) among landraces in a village or farm, 3) diversity of components within a landrace. A further level could be the study of the genetic diversity within the components.

How much of genetic bases have already been eroded is hard to say, but since the spread of the green revolution, high-yielding varieties have rapidly squeezed native landraces. Modern varieties were adopted by 40 % of Asian rice farmers within 15 years of release (Myers 1986). In India 30000 indigenous varieties of rice grew prior to the green revolution. Today these are not more than 50 (Shiva and Vanaja 1993). Although this may be a depressingly low figure, the real number may be little higher or so in the hills. This has also led to a change in the food habits of traditional societies living in the Himalaya. Thus, the loss of biological diversity and its impact on the sustainability of the Himalayan agroecosystem is emerging as a major cause for concern.

In view of the above facts, the ecological and biogeographical research on wild populations is necessary to establish and monitor on-farm biological preserves for conservation of wild relatives and landraces of rice. This type of research on on-farm conservation and management will provide the impetus to search for new genetic variability and to look beyond the conventional gene bank of rice (Kulkarni et al. 1998). Thus germplasm collection and conservation using on-farm cultivation is especially important in the current situation. While programmes, of the nature mentioned above, primarily focus on improved and stable production, the maintenance of genetic resources *in situ* (on-farm) will be an important output that must be considered and conducted as an integrated part of all decentralized and farmer-oriented efforts.

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