Managing Rice Biodiversity by Smallholder Farmers: A Case Study in Barak Valley, Assam

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The indigenous rice germplasm of North-East India represents a wealth of valuable genes, which is threatened with the introduction, and popularization of high yielding varieties. As such there is an urgent need to inventorise the indigenous rice varieties and examine the role of traditional farming systems in the on-farm conservation of agrobiodiversity. In this paper, an attempt was made to study the on-farm conservation strategy of rice diversity by smallholder farmers and the traditional farming practices in a village Dorgakona (24°4'N latitude and 92° 41'E longitude) in Barak Valley (South Assam), North-East India. An inventory of rice diversity was made and a total of 12 traditional cultivars were recorded from the study site. Since farmers on the basis of their local knowledge shape the crop diversity, an attempt was made to examine the role of farmers' traditional knowledge in the maintenance of rice diversity. The present study indicates that farmers in Barak Valley still cultivate traditional varieties and modern varieties have not been successful in completely replacing them. The study reveals that the farmers in more fragile ecosystems maintain more crop diversity to adapt to the heterogeneous environment. Also smallholder farmers are the main preservers and managers of agrobiodiversity, and the traditional ecological knowledge and the heterogeneous environment are the main factors determining the diversity and conservation of local paddy land races.

Key words: Rice diversity, Traditional knowledge, Farmers' seed bank, Conservation

India is very rich in its rice germplasm reserve and the existence of 50,000 accessions have been estimated so far and 17,000 rice cultivars have been assembled in Madhya Pradesh State alone (Richharia, 1979). However in recent decades, the green revolution of modern, high yielding varieties of crops has displaced the vast mosaic of traditional crop varieties (Maheswari, 1997). Rice is the principal crop for the people of North-East India. The indigenous germplasm of North-East India represents a wealth of valuable gene systems (Sharma *et al.*, 1971). The heterogeneity in the environmental, conditions and cultivation of crops in three rice growing seasons has resulted in a large diversity of crops in the region (Das and Ahmed, 1995). Traditional farming systems are still widely practiced in North-East India including Barak Valley of South Assam. Traditional farming systems are important *in situ* conservation sites of crop diversity. According to the United Nations Convention on Biological Diversity *in situ* conservation is "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings, and in the case of domesticated or cultivated species, in the surrounding where they have developed their distinctive properties". Traditional farming systems not only serve to preserve the diversity of local varieties but also the human knowledge and behavioral practices that have shaped this diversity (Bellon, 1996). In accordance with the Convention of Biological Diversity Article 7,8 and 10(c) the inventorisation of such areas can help in the identification and conservation of biodiversity while assessing the sustainability of the system. Small scale farmers in such farming systems have been known to retain folk varieties also known as landraces and continue to grow them even as they experiment with and adopt modern high yielding varieties (Bellon, 1996). The need for systematic collection of rice landraces and its wild relatives from the unexplored areas in the North-East India (Hore and Sharma, 1991; NBPGR, 1999; Paroda and Malik, 1990) and the need for on-farm conservation were emphasized by Hore (1999) and Kothari (1997). The inventorisation and collection of rice germplasm in North-East India can serve to preserve the indigenous rice cultivars while assessing the impact green revolution had on the rice diversity of the region. In the present paper, attempt was made to inventorise the rice varieties cultivated with special importance given to local landraces and investigate the role traditional ecological knowledge of the small holder farmers, had in managing and conserving the agrobiodiversity of Barak Valley, Assam.

Meterial and Method

The study was carried out in a village Dorgakona (24°41'N latitude and 92° 41'E longitude) of Cachar

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district of Barak Valley, Assam, North-East India. The rice farmers in this area are basically tea labours and small holders. The valley has an undulating topography characterized by hills, hillocks (locally known as tillah) wide plains and low-lying waterlogged areas (locally called beels). The study area experiences a warm humid climate with a mean annual rainfall of 2660 mm, most of which is received from May to September. The temperature ranges from a minimum of 11°C (January) to a maximum of 32.6°C (August).

The management of agrobiodiversity through cultivation of paddy landraces was studied by primary interaction with 30 farmers through schedule method (Bellon *et al.* 1997; Chambers and Thrupp, 1989) and periodic visit to the farmers' field. Rice germplasm collected from the study area were sent to NBPGR Headquarters to obtain IC Number. Relative importance value of rice varieties was computed on the basis of percent land area occupied by each variety and percent farmers cultivating the variety (Bellon and Brush, 1994).

Results and Discussion

Traditional Farming Practices

Rice is traditionally grown in the study area in three well defined seasons- Sali (winter rice), Aus (autumn rice) and Boro (summer rice). The traditional cultivation methods of rice in the area include sowing, transplanting, harvesting and storage (Fig. 1). First stage in this system involves preparing the seed bed and raising rice seedlings in nurseries. In the second stage preparatory operation of land for transplantation is done, which involves flooding the land and then ploughing (*haal chaash*) with oxen or buffaloes using traditional implements (*haal/langol*) followed by leveling with ladder (*moi*). Ploughing is repeated several times (4-5) in order to incorporate crop residues and bury weeds. Where the soil is deep and soft, and land preparation cannot be done by animals, preparatory operation is done manually by hoe (*kudaal*). In the third stage the seedlings are transplanted (*haali rua*) after 4-5 weeks into puddled field carrying 5-10 cm water. Transplantation involves thrusting the seedling of 3-6 into holes made by the hand and is usually done by female members of the family. Finally after 3-4 months, the harvesting (*dhaan kaata)* is done by sickles, and then the separation of grains or mounding (*maara)* is done by animals. Grains are winnowed by bamboo implements (*daala*) and stored as seed in traditional storage systems (*Ugaar/Dol/ Machan*) or processed for consumption. The straw separated from grain is stored for fodder.

Farmers' Management of Rice Diversity

A total of 25 rice varieties cultivated in the three cropping seasons were recorded in the area. Of these, 20 were farmers' varieties and the rest were modern varieties. Farmers' varieties include crop populations, which farmers have identified and named as units (Lando and Mak, 1994). Farmers mostly grow traditional varieties in the three rice growing seasons. Of the 25 varieties recorded, 12 are traditional varieties covering an area of 15.47 ha, which is more than 50 per cent of the total area. This indicates the local availability of wide indigenous diversity to farmers. The large diversity of rice is managed by the farmers as an adaptive strategy to cope with heterogeneous and uncertain ecological and socioeconomic environments, including different soil types (Das and Das, 2004). Similar reports indicating the dominance of traditional varieties have been made by other workers (Table 1). Of the three cropping seasons,

Table 1. Farmers' management of rice diversity in asia

Country	Rice ecosystem	Sample size	Varieties			Average farm size(ha)
			Traditional	Modern	Average/farmer	
Cambodia						
Lando and Mak, 1994	Rainfed Lowland	17	9	2	1.7	1.1
Malaysia						
Lambert, 1985	Swamp	28	32	0	3.0	0.53
Thailand						
Dennis, 1987	Rainfed Lowland	20	2	1	1.3	0.86
Orissa						
Kshirsagar and Pandey, 1996	Rainfed Lowland	50	33	14	4.7	1.30
Barak Valley, South Assam, N.E. India.						
Paul 2003	Rainfed Lowland	30	31	7	5.07	2.37
Barak Valley, South Assam, N.E. India.						
Das and Das, 2004	Rainfed Lowland	50	25	7	3.4	0.91

Ploughing of paddy field

Transportation of rice seedlings for transplantation

Transplantation of rice seedlings

Harvesting of rice

Mounding of rice by bullocks

Manual separation of grain from straw after mounding

Winnowing of mounded grains

Drying of grains in field

***Fig. 1:** Traditional rice farming practice*

Sali is the most important cropping season in the area and it coincides with the Harvest festival (*makar sankranthi*). It is sown in July-August and harvested in November- December. Larger number of rice varieties is cultivated in this season (20), of which 10 are traditional varieties. The relative importance value for rice varieties in the Sali cropping season (Fig. 2) shows that the *Chhatoki* variety dominate the rice area. This variety occupies larger land area (17.05%) and is cultivated by larger number of farmers (50%). Of the other traditional varieties *Chhoeamara* occupies the second position. These two varieties are highly preferred because of their stress tolerant and eating quality. Farmers cultivating modern varieties were also found to cultivate a traditional variety to spread the risk of crop failure, which was reported by farmers to be often associated with the high yielding varieties.

The diversity of traditional varieties is still maintained by the farmers because of their agromorphological characteristics and traditional ecological knowledge base (Table 2). Traditional cultivars are still popular for their palatability and reliable yield performance even under low input conditions (Shiva et al., 1995). Traditional varieties such as *Chhatoki, Chhoeamara* and *Khoibaruah* have red kernel and are highly preferred because of their rich taste and high nutrition content. Varieties such as *Birain* and *Pakhi Birain* are used in the preparation of rice flakes, while *Chhoeamara* is used for preparation of puffed rice. Certain varieties such as *Bashphool* and *Kaalijira* are also preferred for their scented aromatic character. Many traditional varieties find use as indigenous medicine. Varieties such as *Baigon Bichi* are used to

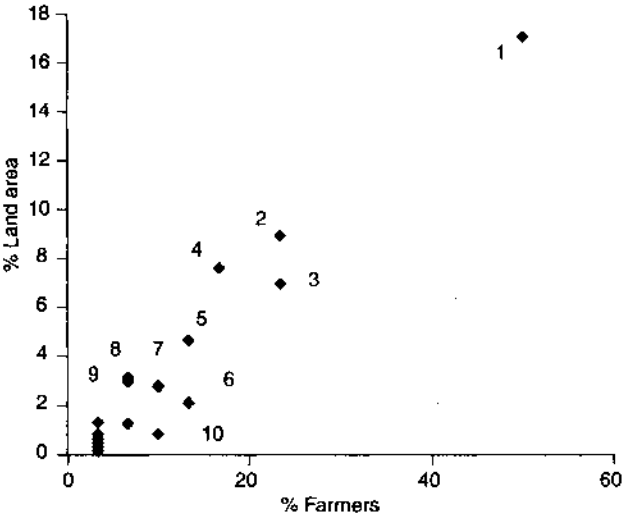

Fig. 2: *Relative importance of rice varieties (1)Chhatoki, (2) Nagrasail, (3) Chhoeamara, (4) Badaal, (5) Ranjit, (6) Latoi, (7) Terabali, (8) Ikorjali, (9) Irri, (10) Birain Others: Kartika, Pankaj, Moinahaal, Krishna, Baigon Bichi, Kaalijira, Balam, Ranjit, Aizong, Pakhi Biroen*

Table 2. Characteristics of Important Rice Varieties

IC No.	Vernacular name	Important characteristics
IC-311452	Latoi	Fat rice, tasty, moderate yield, high fodder value, can grow in any type of soil.
IC-311453	Mayamati	Scented sweet rice, red kernel, medium fine rice, good yield. Less pest, can grow in any soil.
IC-311454	Chhatoki (lal)	Red kernel, fat rice, good yield, less Pest, tasty, high fodder value, can grow in any type of soil.
IC-311456	Chhoeamara	Red kernel, fat rice, sweet and tasty rice, less pest, yield moderate, shattering quality high, fodder value very high, can grow in any type of soil.
IC-311458	Lal Kartika	Medium fine rice, good yield, can grow in sandy soil.
IC-311459	Moinahaal	Medium fine rice, scented, tasty, less pest, good yield, can grow in moist fertile soil.
IC-311461	Terabali	Very fine rice, yield good, less pest, commercial value high, can grow in athali + balu soil.
IC-311462	Balam	Round fat rice, yield high, can grow in athali soil.
IC-311464	Kaalajira	Very small and fine scented rice, medicinal, yield good, very high commercial value, can grow in athali type soil that is less fertile.
IC-311466	Baigon Bichi	Very small fine rice, yield good, medicinal value, can grow in clayey soil
IC-311467	Berapua	Scented fine rice, cultivated for religious purpose, medicinal, high commercial value, pest resistant, can grow in moist blackish soil.
IC-311468	Kaala Birain	Red kernel, fat rice, used in festivities for pancakes and rice flakes, can grow in athali soil.
IC-311469	Lal Birain	Red kernel, tasty and fat rice, yield good, used in festivities for pancakes and rice flakes, can grow in athali soil.
IC-311470	Puthi Birain	Tasty fat rice, used for making traditional chunga pitha, pancakes and rice flakes, can grow in moist athali soil.
IC-311471	Pakhi Birain	Red kernel used in fe stivities, can grow in kaala type soil.
IC-408350	Khoibaruah	Presence of long awn in grain, difficult to mound because of awn, long grain, fine rice, red kernel, tasty, yield good, grown in poli/athali soil, old and popular boro variety.
IC-408354	Bashphool	Small blackish grain, fine rice, increases on cooking, yield good, cultivated in poli type soil.

revive sick people. The potent medicinal value of the variety and the resultant high commercial value is an important factor in farmers' decision to cultivate the variety. Also mentionable is the variety '*Berapua*' which is rare in the village and has high commercial and medicinal value besides being of religious importance. Another such instance of cultivation of medicinal rice with commercial value (*Navara*) has also been reported from Malabar, Kerala (John and Nizar, 1998). Traditional varieties such as *Kartika* have religious significance and are used as offerings during sacred ceremonies. Certain traditional varieties (*Terabali, Kaalajira*) are still retained by the farmers because of their high commercial value. Farming is predominantly subsistence based and farmers rarely sell rice but prefer to retain certain costly varieties to provide a source of cash in times of emergency.

Farmers reported that traditional varieties show superior performance in terms of pest resistance, flood resistance and show better adaptation to the variable production environment. Farmers' selection of traditional varieties is based on its performance in the field, its yield and its tolerance to stress. Farmers in the study area have a deep knowledge about the characteristics of the traditional varieties and its performance under different environmental stresses. Based on their knowledge and preferences they continue to match cultivars to different environmental conditions in the field while discarding varieties with inferior value for a particular set of qualities such as yield, adaptation to soil quality etc. In this context farmers reported two varieties *Chhatoki* and *Chhoeamara* to be the most stress tolerant. The fact that traditional farmers have a well documented knowledge of their crops and crop varieties has also been well documented by human ecologists, anthropologists and ethnobiologists (Bellon, 1991). Farmers informed that they often have fragmented land holdings with differing soil types and the soil in the village is predominantly of poor quality which favours the selection of traditional varieties in relation to their indigenous soil knowledge. Brush (1995) also observed that farmers keep local landraces in fields that are relatively marginal and characterized by poorer soils. The yield from traditional varieties are low but farmers still continue to cultivate them, even as they adopt newer varieties, because compared to modern varieties the yield from traditional varieties are reliable and prevents the risk of yield failure (Harwood, 1979). The traditional varieties can serve as important source of genes for developing improved varieties. In this context it is mentioned that IR-72 a modern variety of rice was developed by cross breeding 22 landraces (Maheshwari, 1996). Certain traditional varieties (*Terabali, Kaalajira, Baigon Bichi*) were found to be on the verge of extinction due to the displacement and replacement of varieties by farmers.

Traditional Seed Flow and Farmers' Seed Bank

Farmers' selection and management of crop diversity shape the crop genetic diversity. An important aspect in the management of crop diversity is the seed flow and traditional seed storage systems (Fig. 3). Several studies have documented the flow of seed of different varieties among small farmers (Sperling and Loevinshon, 1993). According to Pratap and Sthapit (1998) traditional seed supply systems are vital to the sustainability of subsistence farming and to the conservation of seeds of a variety of native crops and landraces. Seed flow in the area especially for land races happens as farmers exchange seeds among themselves within the same village, purchase seed from market or collect it from other farmers or relatives while travelling. The farmers in the area have their own seed storage systems or traditional seed bank (Fig. 4). Farmers on the basis of performance and preference select the varieties to be stored for seed. Selection of seed is done after harvesting. The grains from the upper portion of the healthy plant are usually separated by hand, foot or by beating with a stick and then sun dried for a day and stored. Storage for each variety is done separately in order to facilitate their identification and allocation to specific field conditions. Storage is done in bamboo

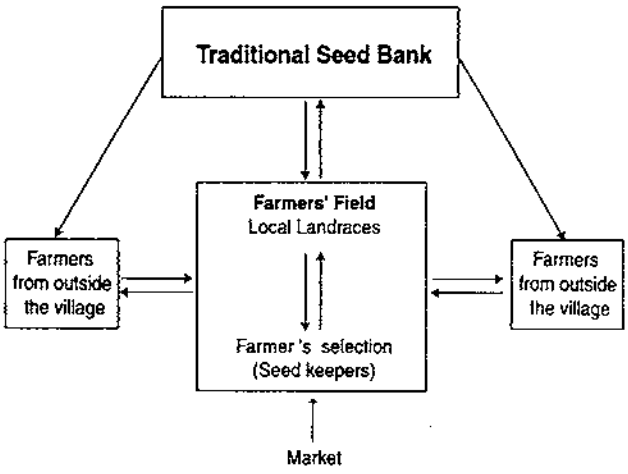

Fig. 3: Traditional seed flow

Fig 4: Farmers' seed bank and seed storage system

baskets (*dol/tukre*) or in godown (*Machan/Ugaar*). The storage devices are made airtight by covering the mouth with straw and a mixture of cowdung and mud. The whole structure is also plastered with the mixture of cowdung and mud. Such storage systems remain pest free in majority of the cases and the viability of the seeds remain intact. These storage systems are the farmers' *own seed bank*. Swaminathan (1998) emphasized the urgent need to encourage and strengthen such *Field Gene Bank* already occurring at the village level for *in situ* on-farm conservation. In this context it is worth mentioning the setting up of a community seed bank in Tamil Nadu to revive the rapidly declining biodiversity of local varieties of paddy (Vijayalakshmi and Nambi, 1996), and an effort made by Virhi Beej Binimoy Kendra in Bankura district of West Bengal supported by Navdanya, New Delhi, to promote *in situ* conservation (Deb, 1999).

Conclusion

The study confirms that smallholder farmers of traditional farming systems are the main managers and preservers of agrobiodiversity. Such farmers continue to cultivate rice landraces even as they adopt newer varieties. Certain agromorphological characteristics, their adaptation to stressful environmental conditions and farmers' knowledge of the varieties favour the selection of traditional varieties. Such areas with stressful environmental conditions are hotspots of rice diversity and special importance to such areas and proper encouragement should be given to the smallholder farmers for on-farm conservation (e.g. developing market for landraces). Such on-farm conservation of traditional varieties is important as it may form a gene pool for future crop improvement programmes. In this context it is pertinent to mention the initiative of preparing a "People's Biodiversity Register" (Gadgil and Rao, 1998) with the aim of i) helping people to access information on availability of seeds of various traditional crop cultivars in different regions, and special properties of these cultivars and ii) help in the continuation of traditional practices of conservation and sustainable use of biodiversity. The declaration of the International Year of Rice 2004 by United Nations General Assembly (UNGA) and to raise awareness of the importance of preserving benchmark traditional rice-based systems was a step towards conserving rice biodiversity (FAO, 2003).

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