Development of Plant Genetic Resources by Farmers: Some Recent Examples

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The outstanding contributions made by the farmers in the domestication and improvement of Plant Genetic Resources (PGR) in the past are well understood and appreciated. But there is a debate on the role of farmers in PGR development in the present era of predominance of professional plant breeding. We present recent examples of PGR development in rice (Sharbati) and American cotton (Bikaneri Narma and Jhurar) and domestication of a weed *bathu* by the farmers of the Punjab state. The farmers developed these valuable genetic resources in spite of sweeping genetic erosion of PGR in the Punjab state during last about 40 years.

Key Words: ***Oryza sativa, Gossypium hirsutum, Chenopodium album*, Farmers' rights, Benefit sharing**

Genetic resources were earlier freely exchanged across political boundaries, and it paid rich dividends. However, with international agreements like Convention on Biological Diversity and World Trade Agreement coming in to force in 1990s, there has been paradigm shift. Genetic resources, earlier considered Heritage of mankind are now sovereign right of the nation and are an intellectual property.

One of the issues that is now a hot topic of discussion and debate is the contribution of farmers in the development, conservation and utilization of Plant Genetic Resources (PGR) and consequent farmers' rights and benefit sharing. Though, there is a general agreement on the stellar role played by the farmers in the domestication and improvement of crop plants, yet, there is no consensus on the farmers' contribution in the present scenario when plant breeding is carried out by professionals and there is a well developed seed industry.

We present recent examples of the development of PGR by the farmers in the Punjab state, the agriculturally most progressive state in the country, where the Green Revolution had started and had the maximum impact. The examples relate to rice (*Oryza sativa* L.) and cotton (*Gossypium hirsutum* L.), the most important food-grain and commercial crops, respectively, in the country. In both crops, Punjab Agricultural University (PAU), Ludhiana, and Indian National Agricultural Research System (NARS) have very strong crop improvement programmes, the competence and contributions of which are well recognized at the national and international levels. In addition, domestication of a weed (C*henopodium album* L.) is discussed.

With the advent of Green Revolution in 1960s, there was a rapid enhancement of average productivity of wheat (*Triticum aestivum* L.) and rice in the Punjab state (Table 1). The economic returns from the cultivation of these crops increased and that gave a boost to the expansion of the area under their cultivation. Consequently, there has been manifold increase in their production. The Punjab state became grain bowl of the country. Since 1970s it has been the major contributor to the national buffer stock of food-grains comprising wheat and rice, which the National Government maintains to ensure the food-grain supply through the public distribution system. The contribution of the Punjab state has generally been 50 to 75% in wheat and 30 to 45% in rice (Fig. 1), though, the Punjab state has only 1.53% of the geographical area of the country.

Table 1. Area, average productivity and production of rice and wheat in the Punjab state

Crop	Year	Area (m ha)	Productivity (kg/ha)	Production (mt)
Rice	1960-61	0.227	1009	0.229
	2004-05[a]	2.647	3943	10.437
	2007-08 [b]	2.610	4019	10.489
	Maximum increase (%)[c]	1066	298	4480
Wheat	1960-61	1.400	1244	1.742
	1999-2000 [d]	3.388	4696	15.910
	2007-08 [e]	3.494	4516	15.780
	Maximum increase (%)[c]	149	277	813

[a] Rice area was the highest during 2004-05
[b] Rice productivity and production were the highest during 2007-08
[c] Increase over 1960-61
[d] Wheat productivity and production were the highest during 1999-2000
[e] Wheat area was the highest during 2007-08

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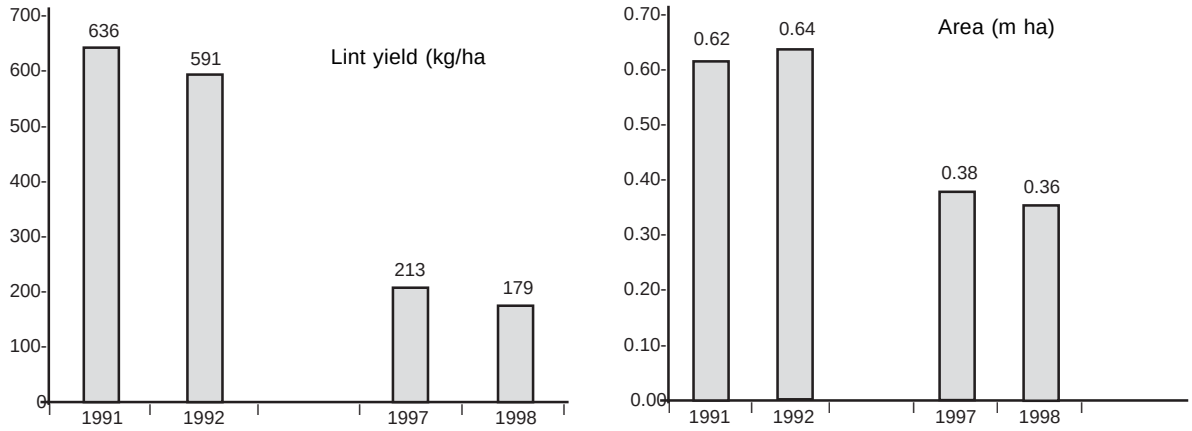

Fig. 1: Lint yield and area under American cotton in Punjab

Total wheat acreage and almost all rice acreage have come under the cultivation of officially released high yielding varieties. In cotton (*Gossypium* spp.), the third most important crop in the state, officially released high yielding varieties occupied more than 90% of the acreage during 2006-07. The spread of high yielding varieties led to sweeping genetic erosion of PGR of these crops, there also being no wild relatives of these crops in the Punjab state and adjoining regions. In spite of that the farmers made significant contributions in the development of PGR in rice and cotton.

Rice

In rice some farmer-bred varieties, such as Sharbati, Govida, Deve Gowda, Gaurav and Tericot were cultivated on a very small area during recent past. Of these, Sharbati has gained importance since 2006. It has long slender grain because of which it got premium price in the market. This accompanied by other desirable traits (early maturity, and tolerance to stresses due to salinity, low moisture and low nitrogen), gave a boost to its cultivation, and the area under it increased without support from any research institution and development agency in the region. During monsoon season of 2007, it was cultivated on about 2% area of 2.6 m ha under rice cultivation in the Punjab state (the cultivation of Sharbati started in mid-1990s). To exploit its desirable traits, Sharbati is being used by the rice breeders of PAU in their hybridization programme.

Cotton

In American cotton (*G. hirsutum*), farmers developed Bikaneri Narma, which was an early maturing germplasm that rapidly spread during 1970s in the cotton belt in North-West India comprising the contiguous area of the states of Punjab, Haryana and Rajasthan. The superiority of Bikaneri Narma was hesitantly accepted by the plant breeders working in the agricultural universities and research institutes in the region and it was used in various breeding programmes that resulted in the development of improved varieties like F414, H777 and Ganganagar Ageti.

During 1980s, another germplasm Jhurar of American cotton came into prominence. Jhurar was late maturing but had large bolls and high lint yield. In addition, its fibre quality was good due to which it got premium in the market. In spite of an efficient extension education system and excellent rapport of the PAU with the farmers of the Punjab state, the farmers did not respond to the advisories by the scientists to not to cultivate Jhurar. The scientists' apprehension was that the cultivation of Jhurar (because of its long duration) will promote the build up of the population of American bollworm (*Helicoverpa armigera* Huebner), a serious pest of cotton, besides the fact that its cultivation delayed wheat sowing that lowered wheat yield. Unfortunately, the apprehensions came true. There was epidemical incidence of *Helicoverpa* leading to a reduction in yield during late 1990s, the decrease being drastic during the monsoon seasons of 1997 and 1998 (Fig. 2). The lint yields that were as high as about 636 kg/ha during 1991 fell down to about 179 kg/ha during 1998. This drastic reduction in yield led to fall in area under cotton cultivation, the fall being the maximum during 1999 and 2000. During 2000, cotton was cultivated on 0.36 m ha, respectively, as compared to 0.64 m ha during 1992. The cotton cultivation in the North-West India was practically threatened. It picked up thereafter with the intensification of integrated pest management by PAU, and later on by the release of transgenic *Helicoverpa* resistant cultivars. Whatever may be the

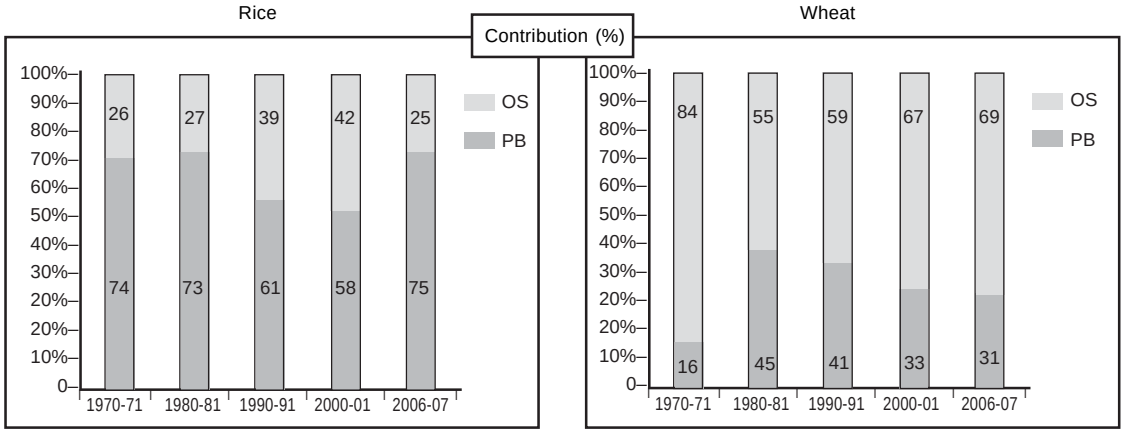

Fig. 2: Contribution of wheat and rice by the Punjab (PB) and other states (OS) to the central pool of food-grains

desirable or undesirable traits of Jhurar, the fact is that Jhurar was an important cultivar during 1985-2000 and the farmer(s) of the Punjab had developed this outstanding germplasm, which possessed some undesirable (late maturity and susceptibility to *Helicoverpa)* traits besides the most desirable ones (high lint yield and good fibre quality).

Bathu

There is a weed, locally known as *bathu* or *bathua Chenopodium album* L., in wheat and other winter season crops. *Bathu* is added to the stems and leaves of *Brassica juncea* (L.) Czern. & Coss., *B. rapa* L. and *B. napus* L. while preparing a vegetable, a local delicacy in Punjab known as *saag*. The traditional belief is that *bathu* adds value to taste of *saag*. In fact *bathu* has high percentage of protein (an excellent example of indigenous technical knowledge). With the development of agriculture during and after Green Revolution, all wheat acreage in Punjab came under the treatment of weedicides, and the availability of *bathu* became scarce. On the other hand, the demand went up due to increased population, improved standard of living and popularity of *saag*. To take advantage of the market, some farmers, without any support from any institution, have started cultivation of *bathu* and, thereby, started the process of its domestication.

Source of Germplasm

A valid question arises that from where the farmers obtained the raw material of rice and cotton in the absence of diverse PGR. There can only be guess. In both rice and cotton, farmers do obtain new strains under evaluation in the research programmes of agricultural universities and research institutes in the region, farmers' varieties from the adjoining states, and cotton germplasm from neighboring country; and some farmer(s) may have worked on the resultant release of genetic variability to develop these farmer's varieties. In cotton, new recombinants do arise as a result of often cross pollination, and there are examples in the official list of cultivars developed by exploiting such variability. But in rice there is a little cross pollination. The most common guess is that the strains developed by some public rice breeding programmes in the region, have been adopted by the farmers. Whatever may be source of germplasm and the protocol of the development, whosoever may be the farmer-breeder(s), and whatsoever may be the merits and demerits of these farmer's varieties, the fact is that outstanding PGR were developed by the farmers and that these farmer's varieties occupied or are occupying appreciable area even in the absence of any support from the agricultural research institutions and development agencies in the region.

Prologue

We have made an attempt to focus on the farmers' role in the development of PGR in the Punjab state, the agriculturally most progressive state, which has no diversity in PGR. It is neither a statement on the contributions of the Indian NARS including PAU nor on the competence of their scientists. It is also not a statement in the context of farmer participatory plant breeding which has its own merits and demerits. The Indian NARS has undoubtedly made outstanding contributions in the development of Indian agriculture and PAU is the cradle of Green Revolution and a front runner among Indian agricultural research institutions in contributing towards the achievement of self-sufficiency in food-grain production and sustenance of national food security.