Euphytica (2009) 166:423–430
DOI 10.1007/s10681-008-9829-8

Landraces and folk varieties: a conceptual reappraisal of terminology

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Received: 11 July 2008 / Accepted: 30 September 2008 / Published online: 1 November 2008

Abstract Farmers' seeds are most often lumped together in one broad category called 'landraces'. But such a category covers variety types that reflect different levels of farmer involvement. Those differences matters when we discuss such issues as genetic erosion, on-farm conservation and seed related policies. The term landrace can be traced to the time when 'modern' varieties of cereals were introduced to European farmers in the late nineteenth century. The farmers' varieties of the time were called 'landraces' and understood as seeds adapted to local growing conditions through natural adaptation usually with no intentional selection. But the term was quickly adopted as generic for all farmers' varieties including those that are bred and maintained by active seed selection on-farm. Such farmer-bred varieties are better termed 'folk varieties'. The article discusses how interaction of crop characteristics and developing technologies resulted in the evolution of crop varieties as either landraces or folk varieties. It is argued that vulnerability to different agents of genetic erosion and feasibility of on-farm conservation are clearly different for the two categories of farmers' varieties. Likewise seed policies, particularly the issue of Farmers' Rights would benefit from clarity of type of farmers' varieties.

Keywords Landrace · Folk variety · Genetic erosion · On-farm conservation · Crop evolution

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Introduction

Most literature on seed supply systems refers to seeds as either 'modern varieties' or 'landraces'. 'Modern variety' is understood as a variety that is improved by a formal breeding programme (Morris et al. 2003). This common understanding of the term modern variety implies that it is released under a registered name and differs from other varieties by distinctive properties for which it is uniform and breeds true. Farmers' seeds are usually lumped together under the name 'landrace'. Such a broad category precludes clear-cut definitions making it difficult to describe farmers' seeds with sufficient accuracy for our needs when we discuss such issues as genetic erosion, on-farm conservation and seed related policies. Landrace can refer to the obscurity of origin (primitive, ancient, traditional, locally selected etc.), diversity and value for breeding: "a landrace is a proxy for genetic resource" (Brush and Meng 1998), an "agroecotype" (Robinson 1996), adaptation and tolerance of diseases (landraces are evolving populations), and what the seeds are not (not formally bred). In addition, Louette (1999), referring to studies of maize in Mexico, found that farmers' varieties "constitute systems that are relatively open" and therefore could not be "well defined for conservation purposes".

The concept of landrace

Zeven (1998) has reviewed the use of the term 'landrace'. Although first used in 1890, it was not in common use until the twentieth century. Early users of the term defined it as a variety that had been grown in a certain locality for a long time and which had become adapted to local growing conditions through natural selection, usually with no intentional selection by farmers. Thus the term 'landrace' reflected seed management in pre-industrial Europe as commonly practiced in wheat and barley. Landraces at this time were often named after a farm or a locality.

These practices of cereal seed management may, at least to some extent, be determined by characteristics of the crop. Sigaut (1996) introduced "affordance", a concept borrowed from psychology where it is defined as "environmental resources for behaviour". He discussed how cereals, founder crops in many cultures, provided different affordances and hence could lead development unto different tracks. Wheat and barley that came to dominate in European agriculture are "afforded" with small seeds and plants that are most conveniently broadcasted requiring thorough seedbed preparation. Hence, the invention of the ox-drawn ard that originated in the old wheat and barley cultures of SW Asia and spread from there with the diffusion of the crops. Also other technical innovations associated with this culture may be seen as a response to characteristics afforded by the crop. This includes the sickle that facilitated the harvesting of sheaves rather than single heads, and later in history, threshing machines and grinding mills. Such changes diverted the attention of cultivators away from individual plants to crop stands and bulk handled grains or flour that came to be seen and dealt with as a commodity.

These species are self-pollinated but with approximately 1% of cross-pollination. As discussed by Allard (1990) this is sufficient for genetic recombination while it also ensures the retention of favourable gene combinations and thus allows crop evolution in the field. A crop stand that is established by broadcasting is exposed to natural selection for adaptation. When harvested and threshed the grains are mixed but with a strong probability of more adapted and productive individual plants being relatively better represented. In addition it was also a traditional practice to winnow by throwing the grains through the air. Seeds were chosen from the heaviest grains that settle farthest from the worker. Would a random sample of such seeds capture the gains of field evolution and maintain the variety? If such practices were sufficient to maintain the quality of the variety grown, farmers may not have seen any need for further seed selection.

The American plant breeder Harry Harlan travelled in Ethiopia in 1923. Reflecting on the diversity he saw in the barley fields he deduced that there must have been a plant breeding people behind it (Harlan 1957). In contrast, when he surveyed the state of European agriculture after the First World War he came to a totally different conclusion. What he saw in the Danubian region in Europe where people still grew landraces confirmed his expectations from history and collections, that Europe just grew a limited number of types and those had originated elsewhere. Can we deduce from such comments that European farmers had managed their cereals as a bulk for so long that impacts of individual plant selection were not discernible? And why was this different in Ethiopia? Also Ethiopians broadcast the seeds, harvest by sickle, thresh with oxen or horses and manage the harvest as a bulk. The "plant breeding people" assumed by Harlan makes the difference. They do not take seeds as a random sample from the harvest, but select seed heads before harvest. They practice various forms of mass selection and occasionally form new varieties by individual plant selection. This is practiced in parts of Ethiopia and most places by few farmers only. But a variety that is made by such traditional breeding may diffuse into the community, sometimes named after the person who bred it (Aderajew and Berg 2006). This practice may be due to the fact that Ethiopian farmers grow these crops for a variety of end use purposes requiring different varieties that need to be maintained separately (Bayush and Berg 2007b).

Another line of argument is provided by the Barley composite cross population designed by Harlan in 1928. This population differed from landraces by its origin, an extremely diverse hybrid swarm. Otherwise it was grown and managed exactly like landraces. He grew it under current agronomic conditions in California with no intentional selection. Every year he planted a random sample of seeds from the previous harvest. This was continued by Harlan's successors and by the end of the 1980s solid evidence for the steady build up of adaptedness in this population had been accumulated. Allard (1990) studied host-pathogen coevolution in this population and found that evolutionary processes under cultivation increased frequencies of favourable genotypes. Yields were found to be stable and relatively good (Suliman and Allard 1991). Thus natural selection changed the population towards local adaptation resulting in relatively good yields and also enhanced it as a source for breeding (Suneson 1956; Allard 1990 op. cit.). The results obtained with this experimental population shows that natural selection in such crops may be sufficient to maintain the variety and keep it acceptably good in terms of adaptation and yield in a pre-industrial agriculture. This is also how domestication of such cereals has been described by a wheat geneticist:

> Depending on mutation and recombination events, mere harvesting, threshing, winnowing, and sifting might slowly have absorbed types better fit for cultivation and processing (Mac Key 2005, p. 10).

Seeds evolving through such mechanisms would become true landraces,meaning varieties of a seed crop that have been maintained under current agronomic conditions in one locality without individual plant selection over a sufficiently long period to generate a population with stable but flexible local adaptation. Such varieties may well have been adequate to the needs in pre-industrial Europe. But they were certainly not adequate when the industrial revolution and the rapid population growth in Europe during the nineteenth century led to growth of big cities and a huge increase in the demand for agricultural commodities. The need for increased production provided an incentive for representatives of the rural elite who began to experiment with seed selection. Darwin (1868a) writes about a number of such people who tried hundreds of wheat varieties. Although the methods of breeding are poorly described, the practice of single plant selection to create stable varieties seems to have been common. In Central Europe systematic research on methods of breeding eventually resulted in the emergence of seed companies that were able to develop more productive varieties (Wood and Orel 2005; Wieland 2006). Thus, when Mendel's discovery of the mechanism of heredity became known (in the year 1900) and the established trade became a science, commercial seeds already existed as alternatives to the old varieties. The term 'landrace' was used at that time as common name distinguishing farmers' varieties from the new commercial seeds. But with the geographic expansion of plant breeding and the emergence of a global genetic resources movement, the term was brought out of its original context and became generic for all sorts of farmers' varieties.

What is a folk variety?

Applying Sigaut's concept of 'affordance' to millets, rice and maize, a different story of crop-man association emerges. Since those crops do not store well when husked and threshed, they were traditionally stored as unthreshed panicles or cobs. Europeans who grew common millet (*Panicum milliaceum*) stored their grain harvest in that way in spite of availability of the technology of bulk-processing which they used for their wheat. They threshed their millets in small quantities according to daily consumption needs. That made it impractical to apply the equipment and machinery that had been developed for wheat processing and people kept using simple household equipment. In France this practice continued until millets cultivation was finally abandoned in the 1960s (Sigaut op. cit.). That has implications for seed management. A random panicle taken from the storage bin would most likely not represent the variety well and could even involve a risk of getting seeds from a poor mother plant. Taking seeds from a selected panicle would be experienced as a necessity. With dibbling rather than broadcasting, and with panicle picking rather than sheave harvesting, observation of individual plant differences was more obvious than in wheat under traditional European and SW Asian husbandry. The daily processing for food also enabled the detection of variation in post-harvest qualities (storage, processing, cooking, and taste qualities). Such observations coupled with the practice of planting of seeds from selected panicles, provided a basis for farmers to discover whether favoured traits would appear in the offspring or not.

When the selection of panicles was taken to the field this selection practice lead to separation of seeds and food. The seeds were kept unthreshed while the food could be stored as threshed grains in farm granaries.

In many areas with rice, millets or maize as the staple crops, we still find farmers' who have named varieties that are selected and maintained for their distinctive properties. One farm may have more than one variety of the same species, each kept for particular traits. Such varieties do not conform to the original understanding of the term landrace. Cleveland et al. (1994) use the alternative term 'folk variety' as a substitute for landrace. Here I define folk variety as a farmers' variety that is selected and maintained for one or more distinctive properties. It may be fairly uniform for the selected traits, but otherwise diverse and therefore responsive to new selection. It differs from modern varieties by having an unknown (or unclear) origin, more inherent diversity, and less varietal stability. In Tin et al. (2001) study in the Mekong Delta in Vietnam farmers' varieties of rice were shown to change quickly in terms of loss of adaptation to previous conditions and new adaptation to current conditions during a period of intensification of the farming system. While the change was obviously the result of natural selection, intentional selection maintained the distinctive properties of each variety and also brought some change in grain quality as a response to market requirements. Yield capacity and isozyme diversity did not change. This example may be characteristic of the typical folk variety. It also shows that folk varieties are not limited to traditional farming systems but may adapt to and become part of modern intensified forms of agriculture, as pointed out by Brush (1995). Some of the varieties found among the typical folk variety breeders may be derived from modern varieties through selection of off-types or selection among hybrid offspring. Such farmer-selections may be sufficiently distinct and uniform to qualify for formal release like commercially bred varieties (Salazar et al. 2007).

Both rice and the millets species that are mentioned here are self pollinated and selected types are easy to maintain. In the case of the open-pollinated maize, however, the co-existence of different varieties on the same farm requires careful persistent conscious seed selection. Folk variety breeders are apparently able to maintain their varieties regardless of breeding system.

Evidence from history

If cereals in pre-modern Europe were mainly landrace types, we would expect to find few references to named varieties in old historic sources. White (1970) reviewed the entire Latin literature about Roman agriculture and provides a detailed description of the agricultural system of the time. He found no specific mention of improvement of varieties, but seed selection to prevent deterioration was emphasised in the literature. Experimentation with seeds from various origins occurred. One author mentions six different varieties of wheat and one distinguished four varieties of emmer. Millets is mentioned in the book, but without any reference to varieties and quality of seeds. Zeven (1999) traced later historic (Middle ages) references to wheat seed management in Europe. The literature refers mostly to sources of seeds and the benefits of seed replacement but not to named varieties.

In literature that explicitly deals with seeds and seed quality, the absence of mention of named varieties is peculiar. In that respect the European sources contrast dramatically with Chinese history that abounds with references to seed selection and named varieties (Bray 1984). The main staples, millets and rice, are "afforded" with characteristics that favour the formation of folk varieties. Northern Chinese farmers evolved an enormous number of millet varieties (both foxtail millet, *Setaria italica* and common millet, *Panicum milliaceum*) representing differences in yield, flavour, drought or flood resistance, and growth period. "The Chinese developed careful selection techniques enabling them to isolate and maintain millets varieties with desirable characteristics" (Bray, op cit., p. 441). Bray also quotes a sixth century source that listed nearly a hundred varieties of non-glutinous foxtail millet. Historic sources also refer to specific rice diversity and to farmers who were able to distinguish between varieties according to ripening period, morphology, water requirements, resistance to diseases and weather, and whether the grains are glutinous, fragrant or coloured (Bray, op cit., p. 490). Rice varieties and breeding could even be the subject of high level politics in the old China. The emperor Cheng-tsung (998–1022) ordered the distribution of early-maturing rice types in drought affected areas (Ho 1956). The new seeds were subsequently reselected by farmers and improved by Chinese plant breeders. Ho (op cit.) tells that plant breeders in traditional China were unknown peasants. The only exception he could mention was an emperor who reigned from 1662 to 1722. This emperor is credited for having selected a variety that became known as Imperial Rice.

Unlike the predominant landrace diversity of traditional wheat and barley in Europe, millets and rice in the old China were typical folk varieties, selected and maintained by traditional plant breeders.

Evidence from studies of current seed systems

Maize growers in Latin America commonly maintain three, four, and sometimes even more distinct varieties that are selected for specific food, feed or industrial traits (Morris et al. 2003). Similar findings are reported in numerous studies of sorghum, millets, and rice in Africa and Asia (reviewed by Nuijten 2005, p. 89). The most amazing example of diversity of farmers' varieties may be the case of rice in Laos. Rao et al. (2002a) collected 13,192 samples of cultivated rice that they classified according to farm ecosystem, endosperm type and maturity. The authors recorded 3,169 distinct variety names and identified a three layer naming system consisting of a basic name, a root name, and a descriptor (Rao et al. 2002b).

Diversity of variety names does not always reflect real genetic diversity. In Papua New Guinea with as much as 700 languages the name of one banana variety may change from village to village (Sharrock 1995). Here the issue is whether the naming diversity reflects intentional selection. The basic name in the Laotian rice naming system simply means rice. The root name identifies the variety as lowland or upland, and glutinous or non-glutinous. The third element in the naming system, the descriptor, further identifies particular characteristics such as earliness, growth habits, morphological traits, and sometimes also from where it was introduced. Thus the name indicates cultivation requirements and end use and becomes an integral part of the variety management (Rao et al. 2002b).

In these cases the naming clearly reflects intentional selection. The varieties are selected, maintained and named according to distinctive traits; those are folk varieties.

Variety types and genetic erosion

The merits of landraces are, from the farmers' point of view, adaptation and yield stability. But that alone is not sufficient justification for continued cultivation once higher yielding varieties are available. That was the historic experience in early twentieth century Europe. Zeven (1996) reviewed European efforts to conserve landraces on farm during the pre-World War II period. They all failed. Zeven concluded that on-farm maintenance of landraces is not possible and would result in complete loss of the genetic resources. At the same time as landraces were disappearing in Europe pioneers of worldwide germplasm exploration started to worry about a potentially similar development in gene-rich "far-away" areas such as Ethiopia and Tibet (Harlan and Martini 1936). They assumed that modern plant breeding would lead to displacement of farmers' varieties also in those areas as had happened in North America and Europe. Almost 40 years later this was discussed at length in an influential article (Harlan 1975). The loss of farmers' varieties that had taken place in industrial countries was seen as imminent in the world centres of crop diversity. All farmers' seeds were described as landraces and all declared to be threatened by genetic erosion. The view that plant breeding and introduction of modern varieties would inevitably lead to genetic erosion remained unchallenged until Brush (1995) reported on communities that accepted new varieties but did not discard their old ones. The ensuing debate would have been less contentious if a clear distinction between folk varieties and landrace-diversity had been made. Farmers who have folk varieties exchange seeds as a routine. They adopt or reject new seeds. And they normally chose to grow more than one variety. Adding a modern variety to such a system will not necessarily result in a net loss of diversity which is the common definition of genetic erosion.

This is not to say that genetic erosion of folk varieties does not occur. If the culture of seed selection falls into decline and farmers stop practicing maintenance selection, the local seeds would soon be as vulnerable to genetic erosion as landraces. If the conditions for which the folk varieties are selected change, the varieties may become irrelevant. When agronomic practices and climate change, folk varieties may become obsolete. And if food habits change, parts of the diversity may no longer be demanded. Genetic resources may also be lost during times of war, natural disasters and famine. When farms become smaller and farmers poorer, number of varieties per farm tends to go down (Sperling and Loevinsohn 1993; Bayush and Berg 2007a).

But if such factors of genetic erosion are not present, new varieties may enrich rather than erode the diversity in areas with folk varieties. Louette (1999) found that introductions were source of diversity rather than a genetic erosion inducing factor in Mexican maize cultures. Likewise Morris et al. (2003) described a process of *rustification* or *creolisation* during which maize growers deliberately facilitated introgression from modern to traditional maize varieties. The same could happen also in self-pollinated crops (Jusu (1999) on rice in Sierra Leone, Salazar et al. (2007) on rice in SE Asia). It has also been noted that farmer breeders tend to receive modern varieties with enthusiasm (Berg 1996; Jusu 1999) because they bring more diversity for their local experimentation.

Since folk varieties are selected and maintained for particular desired properties, on-farm cultivation can be encouraged by stimulation of critical factors. Experiences from Ethiopia indicate that vanishing seed selection practices can be revived (Berg 1992). Furthermore, declining seed supply can be restored and markets for particular varieties can be strengthened (Bayush and Berg 2007a).

In areas and in farming systems where modern varieties out-yield the landraces conditions for such interventions may be difficult to establish. Being result of natural selection the landraces remain important as genetic resources, but would normally be without any selected traits to justify continued use. An exception may be the growing culinary niche-market that has revived the interest in some landraces, such as the hulled wheats (einkorn, emmer and spelt).

Variety types, farmers' rights and IPR laws

FAO (Resolution 5/89) defines Farmers' Rights as "rights arising from past, present, and future contribution of farmers in conserving, improving and making available plant genetic resources, particularly those in centres of origin/diversity". The International Treaty on Plant Genetic Resources for Food and Agriculture (adopted by FAO in 2001 and entered into force in 2004) also recognises these rights and suggests ways through which national governments can promote such rights. Protection of farmers' traditional knowledge and sharing of benefits related to their varieties are mentioned. But that reflects a culture of seed management strong among folk variety growers and less so among landrace growers. The primary argument for Farmers' Rights is therefore provided by folk variety growers.

National seed laws in India (Sahai 2003) and Ethiopia (FDRE 2006) refer to Farmers' Rights. In both of those laws the articles about Farmers' Rights explicitly mention farmers who breed plant varieties. Those articles would have little real content if farmers only managed seeds as typical landraces.

Discussion

Varieties reflecting different modes of seed management and different levels of farmer involvement do exist. When we assess the varieties for vulnerability to genetic erosion, for conservation on farm, and when we discuss policy issues related to Farmers' Rights, these differences matter.

The typical landraces can normally not compete with higher yielding modern varieties in commercial agriculture. The historic experience is that they quickly disappear from farmers' fields during periods of economic transition. On-farm conservation of landraces requires special subsidies and may be difficult to sustain. Folk varieties, however, survive alongside modern varieties if they are characterised by distinctive traits that make them relevant in the farming system or demanded in the market. On-farm conservation of folk varieties can be encouraged by means of interventions in the farming and seed supply systems.

The FAO resolution on Farmers' Rights referred to farmers' contribution of genetic resources for breeding, both historic and current, and that is equally relevant regardless of type of farmers' seeds. However, the FAO-resolution also mentions farmers' improvement of genetic resources, which can only mean the efforts made by those who have and breed folk varieties. Thus the discussions on how to operationalise the concept of Farmers' Rights would benefit from clarity of types of farmers' varieties.

Farmers have invented seed management practices leading to the formation of either landraces or folk varieties through experiences that are determined by the biological characteristics of the crops and the developing farm technology. This explains why both landraces and folk varieties may exist in the same community depending on crop type and applicable technology. The pre-industrial Europe with predominantly landrace diversity of cereals had a plethora of vegetable and fruit varieties that were characterised by clear morphological and quality traits. Since the utility and demand for such crops depend on conspicuous qualitative traits, and those traits cannot be captured by natural selection, the active breeding by gardeners was obvious. The garden strawberry can represent this type of crops. It originated through interspecific crosses in Europe during the eighteenth century. The variation among selected types attracted such an interest in strawberry breeding that many new varieties soon came into being and were also introduced to America. The USA had around 1,300 strawberry varieties between 1836 and 1925 (von Staudt 1961). Charles Darwin referred to such forms of diversity in his introductory argument in "The Origin of Species" and he returned to it in more details in later writings. His observation was that domestic forms display visible variability only in those attributes that are considered useful. He summed up such observations in this way (Darwin 1868b: p. 220):

> On the whole we may conclude that whatever part or character is most valued—whether the leaves, stems, tubers, bulbs, flowers, fruit, or seed of plants, …—that character will almost invariably be found to present the greatest amount of difference both in kind and degree. And this result may be safely attributed to man having preserved during a long course of generations the variations which were useful to him, and neglected the others.

Although Darwin reviewed available information from all over the world this statement reflects primarily what he saw around him in Europe at the time. Thus Europeans bred conspicuous varieties of many species while their cereals were maintained mainly in the form of landraces.

Now the market has wiped out most of the crop diversity that Darwin could observe, not necessarily because the old varieties are useless, but rather because seed supply is commercialised and concentrated and because the market chains require uniform and standardised products. In countries where such commercialisation of seed supply and marketing has not taken place, many folk varieties survive. They are not easily beaten when they are selected for specific desired traits. Growers may add modern varieties to what they have and the seed selectors among them may see the modern varieties as a resource for renewal and breeding. The strings of intellectual property rights that sometimes come with the modern seeds are more difficult to reconcile with the culture of farmer breeding. It may make sense to have laws that protect both the business interests of commercial breeders and the rights of farmer breeders to manage seeds in customary ways. But preventing the intellectual property rights of the industry from encroaching into the sphere of collective rights where farmer breeders operate remain a challenge. The principle of Farmers' Rights may be used to secure the space for farmer breeders. This is not just to honour a traditional practice, but also to stimulate an ongoing and dynamic practice that contributes significantly to world agriculture and that also may evolve with knowledge and science and can be further developed through participatory plant breeding.

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