International Institute for Environment and Development

GATEKEEPER SERIES

127

STATE-FARMER PARTNERSHIPS FOR SEED DIVERSITY IN MALI

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2006

EXECUTIVE SUMMARY

As in many developing countries, the Mali government's approach to seed management is becoming increasingly centralised, revolving around: (1) research programmes to create high-yielding varieties; and (2) collecting and storing germplasm in centralised genebanks for multiplication and distribution to farmers. However, it seems that not only do governments in developing countries lack the budget either to properly conserve these collections or take stock of what they have, but that national seed departments are unable to disseminate information about new varieties to rural areas. As a consequence, less than 5% of the sorghum and millet currently grown in Mali is improved varieties.

This paper explores the potential for grassroots level seed management to fill a gap in the seed distribution system in a way which maintains and promotes genetic diversity. The author draws on long-term and in-depth research into farmers' seed management strategies on more than 600 farms in eastern Mali. Using a global positioning system, mapping and statistical techniques, the author pieced together the 'demography' of individual varieties to understand their life cycle, follow seed supply routes and trace farmers' networks for exchanging varieties. The traditional system of seed management allows farmers to choose from a diversity of seeds to meet their individual production strategies without the constraint of having to manage a large number of varieties.

A growing seed multiplication movement amongst farmers' organisations is fast becoming a bridge between farmers and the state via the use of informal networks to promote and distribute improved varieties. However, the danger of this approach is that increased uptake of improved varieties, which require high inputs of fertilisers and better water management, will expose farmers to greater risk and erode the diversity of better-adapted local genotypes. Thus the author calls for stronger partnerships between research bodies, the state services, village communities, farmers and farmers' organisations to:

- Develop new varieties which combine good yields with the hardiness of local varieties
- Improve awareness and capacity for promoting greater diversity in farming systems
- Develop tools to support dialogue between actors on the development of a new, more effective seed system
- Involve the state in the conservation of local varieties

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STATE-FARMER PARTNERSHIPS FOR SEED DIVERSITY IN MALI [1]

Didier Bazile

A SHRINKING RESOURCE BASE

Global food security depends on diversity in phytogenetic[2] resources (FAO, 1999; Wood and Lenne, 1999). As the most important raw materials for the selector and most vital input for the farmer, these resources are the key to sustainable farming systems. Many phytogenetic resources in agriculture are the result of human selection, which has been going on since farming began. In recent times selectors have exploited this diversity and achieved remarkable results in improving varieties, but if they are to remain viable and continue to evolve, these resources require active and continuous management in farmers' fields and on their farms. Furthermore, the *in situ* diversity of plants grown for food is concentrated in developing countries, where traditional farming helps preserve a diversity of settings.

But modern farming and the agronomic research which supports it threaten agrobiodiversity[3] in two main ways. First, modern agricultural production depends on a small number of varieties designed to be grown intensively, thus significantly reducing the diversity of plant varieties available for future research. In the past,

1. I would like to thank everyone who contributed to the ideas developed in this paper, particularly the national coordinator of the Sorghum Agro-biodiveristy Project in Mali (which was financed by the Fonds Français pour l' Environnement Mondial), Dr Aboubacar Touré, and the principal researchers behind the onsite project, M. Kouressy (IER) and M. Vaksmann (CIRAD). I would also like to thank everyone from the SIG/Télédétection unit in IER-Bamako for the time they spent in the field with me: M. Diakité, M. Soumaré, S. Dembele and K. Sangare. However, my greatest debt of gratitude is to all the farmers, farmers' organisations and national NGOs with whom we constructed a common language that enabled us to talk about agro-biodiversity together.

2. Phytogenetic resources include the varied genetic plant materials contained in traditional varieties and modern cultivars, as well as wild plants related to cultivated species and other species of wild plants that can be used now or in the future for food or farming.

3. Agrobiodiversity refers to all breeds of vegetable and animal in farming, their wild forbears, their original species and the species with which they interact, such as pollinators, symbionts, parasites, predators, decomposers and competitors, as well as the whole range of environments in which agriculture is practised, not just arable lands or cultivated fields (Jackson *et al.*, 2005).

researchers relied on farmers to provide them with new genetic material, but today they increasingly tend to work on a limited number of varieties that they circulate amongst themselves. The homogeneity of modern agriculture is now threatening the genetic diversity from which it originated.

Second, traditional small-scale family farming holds the key to greater biological and cultural diversity, yet it is under threat from globalised agricultural exchange. Farmers are constantly selecting new types of plants as they use their limited resources to adapt to marginal environments. In doing so they have become the guardians of diversity by preserving the genetic variability required for plant genotypes to continuously evolve and adapt in response to global change.

In this paper I consider a possible way forward for conserving phytogenetic resources in farming. I draw on a case study of local management of cereal varieties in Mali. Strong competition from varieties of high-yielding maize has resulted in the varietal erosion of 60% of ecotypes of sorghum in southern Mali over the last 20 years (Kouressy, 2002). Faced on the one hand with a national seed system that is barely able to fulfil its mission to supply seed to the whole country, and with increasing awareness of the importance of local-level action on the other, I explore the scope for developing new partnerships between the various rural actors to collectively manage cereal biodiversity.

LESSONS FROM MALI

Seed management at the grassroots level

Seeds are the basic building blocks of farming: without them, there would be no agriculture. In the context of African cereals, seeds are the least expensive factor of production and one of the most effective means of increasing agricultural production. Seed management is of great significance in farming as it fulfils two major functions: promoting agricultural production and conserving genetic heritage. Farmers have domesticated, improved and conserved varieties of plants suited to their lands since Neolithic times, monitoring the quality of their seed at every harvest and carefully setting it aside for the next season.

Numerous cultivated species of global importance originated in West Africa, such as millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor*) and African rice (*Oryza glaberrima*). Most local varieties of these species show a high level of genetic diversity. In 2003 we conducted a study in Mali to analyse the range of cereal varieties sown by farmers, to understand their reasons for sowing and possible ways forward for *in situ* conservation. The study included an exhaustive survey of 640 farms in 12 villages spread along a north-south climatic transect in eastern Mali. Our hypothesis was that in order to deal with the vagaries of the climate, farmers exploit the complementarity of local varieties.

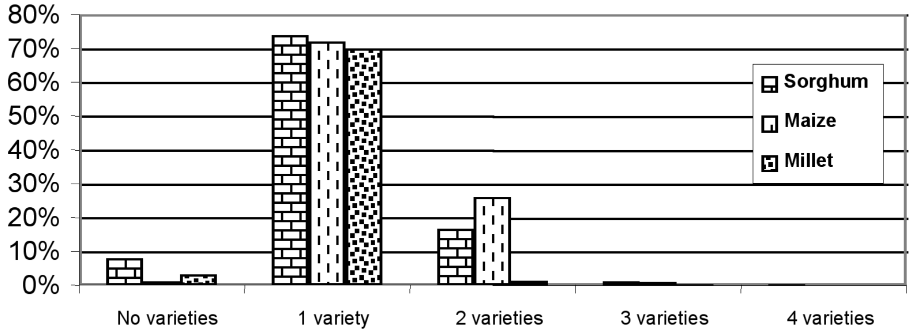
There are several centres of decision-making on African farms, which can be seen in the division of land into collective fields managed by the head of the farm (patriarch) and individual fields that may belong to the (male) head of household or his wife. This is all part of the diversity of smallholder farming strategies, and encourages the use of distinct varieties according to the objectives assigned to each plot. The men select seed panicles for sorghum when it is grown in their collective fields, which are often large plots where there is less risk of varieties mixing. Women only select their own seeds if the variety is not found in the men's fields.

Family farms in Mali harness the strong links within the clan structure to get farm work done. Thus, 40% to 60% of farms in every village belong to family groups of four to five farms that pool their labour at peak times, particularly harvest. This is an opportunity for farmers to observe and obtain new varieties within these farms, but as a general rule they have great difficulty in getting information about varieties grown elsewhere in their geographic area. We were able to demonstrate that the average farmer only knows about 30% of the varieties grown in their own village.[4]

We found that even though there were always 10 to 15 varieties of cereal available in each village, in over 70% of cases, farmers limit themselves to just one variety of each cereal (Figure 1). They sow two varieties in the same year if their holding contains different soil types or if they are testing a new variety. Seed diversity is thus mainly found at the level of the village, rather than at the level of individuals. Farmers in this study managed their own seeds, dipping into the pool of varietal diversity available in the village or exchanging with neighbours or family members when they needed to replace seed. Very few (less than 5%) of the so-called 'improved' varieties listed in the official catalogue were grown because they are often unsuited to farmers' practices.

4. In this context 'knowledge' means knowing where farmers can get hold of seed.

Figure 1: Percentage of farms (N=640) growing different varieties of cereal in 2003



By moving varieties from one ecosystem to another, farmers are able to respond to new needs and deal with interannual variations in the climate (Bazile *et al.*, 2003). Their management attitude is characterised by openness to trying out external varieties and curiosity in the constant quest to build biodiversity. Through their non-market exchange networks (Box 1), farmers constantly feed the seed pool with new varieties acquired at markets or seed fairs, or by simply exchanging seeds with other farmers.

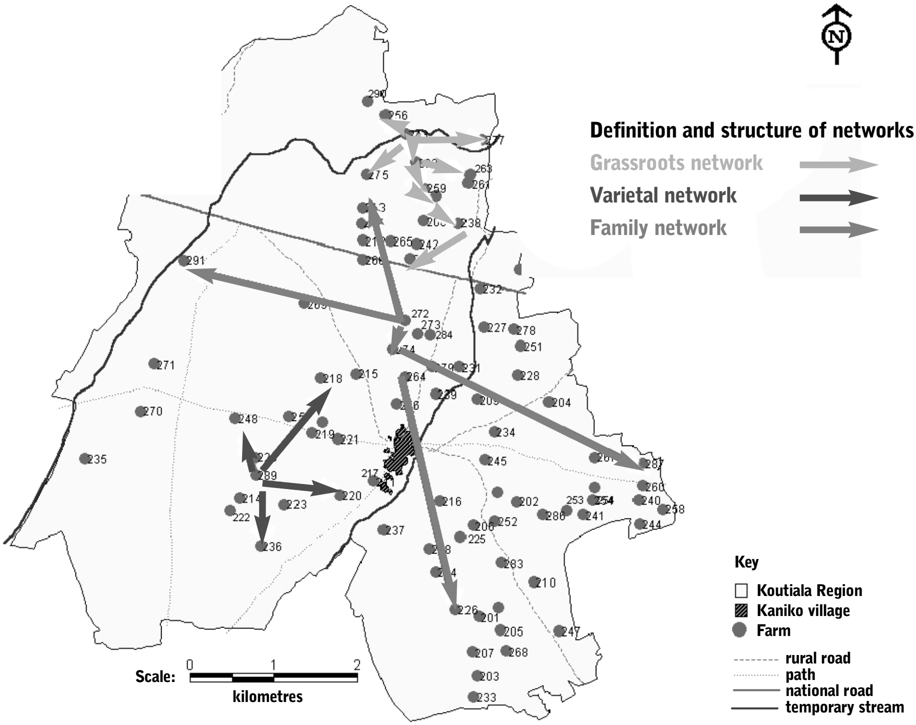
We monitored the 'demography' of varieties to understand the phases in the life cycle of a variety within a village (from transmission from father to son, through to introduction, sowing or storage and eventual disappearance). Over five consecutive years, we gathered data on men's individual and collective fields[5] in a comprehensive study of sowing on every farm in eight villages. Referencing the farms with a global positioning system allowed us to follow the supply routes and trace farmers' preferred networks for exchanging varieties. Statistical analysis confirmed that the resource persons supplying the seed (Box 1) had not been singled out by chance. Groups of farms function together around resource persons who constitute the hub of exchange networks. Apart from exchanges within the village, varieties on a farm are also constantly evolving because they benefit from genetic input from outside the village. Over the five years of the study we noticed that for a given village, external seeds come from between 7 and 10 other villages, most of which are located near a large daily market. New varieties are introduced to the village by the focal points of these seed exchange networks.

5. Among these ethnic groups, women didn't have their own fields, or else they selected seeds jointly with men.

Box 1. Tracking varieties across social networks

An essential part of conserving varieties within a territory involves understanding the networks through which they are exchanged. A farmer is recognised as a 'resource person' for a variety if he can produce enough seed (big producer) and cultivates a limited number of varieties (reduced risk of cross-pollination in the field or varieties mixing in grain stores). There are several types of interconnected networks within a village, and the combination of these networks helps maintain the quality of seed and overall resilience of the system.

Location of 91 farms in the village of Kaniko (region of Koutiala in Mali)



- *Grassroots networks.* A farmer is more likely to use a variety if he has already seen it growing in his neighbour's fields: 90% of new varieties are introduced this way. This is a neighbourhood network that functions like a snowball, moving from one close neighbour to the next.
- *Networks for specific varieties.* Each variety has an ecological niche, and farmers will seek to procure the variety that fits the ecology of their farm. Thus, one farmer, who is often the biggest producer, will network with and supply other farmers in the same village territory.
- *Family networks.* Access to the 'family gene pool' is very important as it means that individual farmers don't have to grow every variety each year to ensure a supply of seed, knowing that they can rely on this family link to meet their possible future needs.

This system of seed management is designed to allow individuals to exploit biodiversity for their own production strategies without the constraint of having to manage a large number of varieties themselves. At the village level, genetic diversity is built up through the sum of individual seed conservation strategies. Thus, it is not a matter of concerted management by the village, but a system of selecting and conserving varieties within farms which helps farmers respond to the diversity of micro-environments across the village (ecological niches).

Varietal management by farmers is a dynamic process of adjusting to uncertain climatic conditions. The conservation of genetic diversity (a shared asset) is collectively managed, and non-market exchange systems allow every individual to gain access to free or inexpensive genetic resources. Operating at the local level, farmers can use varieties that they have seen their neighbours grow and which are therefore both known to work and are available. On the other hand, certified seeds tend to be expensive and improved varieties are often inappropriate (for example, many are no longer photoperiodic).[6]

THE STATE: BETWEEN CONSERVATION AND IMPROVEMENT

The government's approach to cereal seed management is based on two centralised approaches: (1) research programmes to create high-yielding varieties for distribution to farmers; and (2) collection and storage of germplasm in centralised genebanks.

Improved varieties

After independence, a priority for the government was to produce certified seeds in order to achieve a quantitative and qualitative increase in national cereal production. The objective was to produce improved varieties capable of keeping up with the rapid population growth. Since then, programmes to improve both cash crops and food crops have run on centralised lines, with the government developing improved seeds in agricultural research stations and supplying them to farmers. The focus has been on seeking high-yielding varieties and adapting products to the tastes of urban consumers, copying the development model used to such effect in the context of the Green Revolution in Asia. However, despite the development of various innovations, less than 5% of cultivated land in Mali is used to grow the improved varieties of food crops millet and sorghum (Matlon, 1985) with traditional varieties still grown on the remaining 95%.

6. Photoperiodism refers to plants' ability to measure the length of periods of light. It allows to the plants to adjust their cycle to the length of the rainy season.

Improved seeds require a huge amount of inputs to maximise their genetic potential. This is why many formal seed sectors in Africa have linked the distribution of fertiliser and pesticides with the commercialisation of seed, as in the West African cotton commodity chain (Ferrigno *et al.*, 2006). The same system has been applied to maize in Mali since the 1980s, and has worked well. However, while improved varieties of seed can adapt to specific environments found in family farming, the need for fertiliser has been heavily criticised for increasing production costs. This is a critical issue for the varieties of millet and sorghum grown in rural Africa. Another problem with these improved varieties is the water management and conservation measures needed in semi-arid areas, where the poor water retention of the soils makes it hard for farmers to increase planting density or apply more inputs, and the element of risk increases as production costs rise.

The objective for West African farmers is to minimise the overall risks of production while exploiting the micro-variability of their environments (Bazile and Soumare, 2004). As a result, they have the lowest rate of chemical fertiliser use per unit area of all the developing regions in the world. The improved varieties that give high yields in research stations have been found to be very unstable, which is why on-farm trials have shown that the yields of traditional varieties grown without fertiliser are higher than or equal to improved varieties grown with fertiliser. Matlon (1985) reports that out of 7,000 samples of sorghum screened by ICRISAT, only two varieties performed better on-farm.

Despite the significant resources invested in them, it seems that the improved varieties have not been entirely successful. The varieties created by research that were selected for adaptation to intensive farming have lost all the hardy characteristics required by farmers' risk management strategies (Traoré *et al.*, 2000). In addition to this, the photoperiodism present in local varieties has been progressively eliminated to produce fixed-cycle varieties (Vaksmann *et al.*, 1996). This has produced a range of varieties with staggered flowering times that can be synchronised with the beginning and end of the rainy season (Bacci and Reyniers, 1998).

The role of collected varieties

Although farmers are fairly self-sufficient in the way they manage their seed, several factors may cause them to run short: poor harvests, unsuitable storage conditions on the farm, lack of resources to increase the supply of good quality seed and poor seed distribution systems. These problems can affect local strains as well as the commercially produced, 'improved' varieties. The issue here is understanding where the varieties are managed, including the local varieties (ecotypes) collected during surveys, and how farmers can get hold of them when they need to.

Since the 1960s international organisations[7] have organised numerous surveys in Africa to enumerate and gather seeds in collaboration with national agricultural research institutes. The ecotypes of African cereals collected in this way are conserved in major conservation centres: at ICRISAT (India) for millet and sorghum, and at IRD (France) for fonio, millet and sorghum. Unfortunately, *ex situ* conservation poses specific problems because it maintains seed outside its natural environment, preventing it from evolving with the micro-flora of the soil (Wood and Lenne, 1997).

Over 800 ecotypes of sorghum were listed in Mali following one of these exercises by ORSTOM in 1978. A complete collection of new items gathered during these surveys is housed in the six regional agricultural research centres in Mali (IER, Ministry of Agriculture) as part of the National Seed Service.

The two main missions of Mali's National Seed Service are:

1) to help supply farmers with new improved varieties of cultivated plants

2) to store seed material *ex situ* to increase stocks and improve supply for farmers

However, neither of these missions is being fulfilled adequately. The Malian government is struggling to maintain the collection in the form of an *ex situ* gene bank, lacking the resources to either list or conserve the existing collection even though it is the basis for improving varieties in the future. Furthermore, the National Seed Service has had problems supplying varieties specifically adapted to particular environmental conditions. To be effective, it should be able to deliver timely, sufficient and good quality seed wherever it is needed. Furthermore, seed must be adapted to specific environmental conditions. In the event, farmers have had to take their own local measures to make up for the government's inability to produce and distribute these seeds in such a fashion.

These challenges highlight the limitations of the National Seed Service (UNEP, 1993), which is unlikely to achieve even the timid objectives recommended by the

7. Including the United Nations Food and Agriculture Organization (FAO), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and ORSTOM (now the Institut de Recherche pour le Développement, or IRD).

FAO (2001): "*to support and promote farmer organisations so that they can more effectively express their need for seed, paying particular attention to the needs of women and vulnerable or marginalized groups*". To overcome these challenges, and given the range of actors involved in meeting farmers' seed requirements, there is a need to strengthen the links between farmers and gene banks, organisations involved in genetically improving plants, seed producers and small businesses producing and distributing seeds.

FARMERS' ORGANISATIONS: THE MISSING LINK BETWEEN FARMER AND STATE?

Farmers' organisations need to do much more than simply list farmers' needs. They should actively participate in plans to conserve and distribute existing varietal diversity. Members of farmers' organisations are helping to enrich the local gene pool by contributing certified seed that can be used by other members. Since every member of a farmers' organisation is also a member of a family farm, these organisations can help alleviate the shortcomings in varietal management noted at the farm level. They often come together under the umbrella of unions at the national level (the Association des Organisations Professionnelles Paysannes, or AOPP) and their access to information that is not available in villages allows them to act as a link between farmers (Box 2).

Box 2: Training test farmers

In 1997, the AOPP organised a workshop with all the other farmers' organisations in Mali to discuss the problems experienced at farm level. Priority themes were the disappearance of varieties, declining seed quality (particularly millet and sorghum), reduced rainfall, smaller harvests, the high cost of fertilisers and difficulty in gaining access to credit. In response to farmer demand, the AOPP proposed that its members reflect on the productive use of certified seed and set up a Cereal Commission that would develop a network of test farmers. Known as *Si fileli kela*, these started operating in 1999. Every year, about 20 local farmers' organisations receive training from the National Seed System services, in which about 15 participants learn about the use of certified seed and how to conduct tests in rural areas.

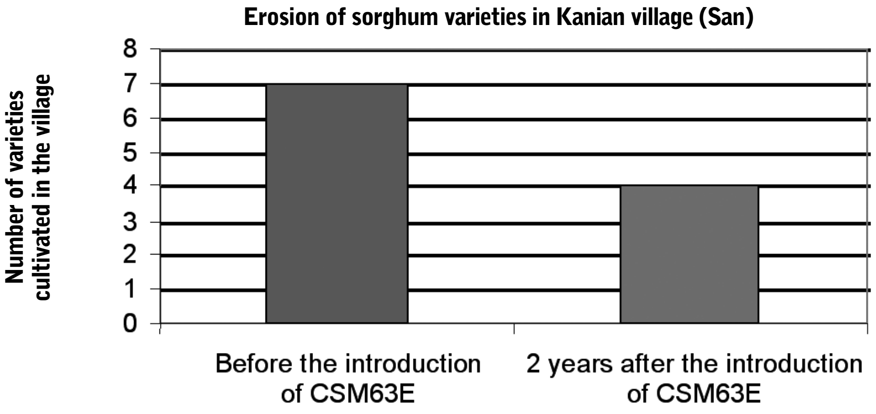
This experience has contributed to what is now a wide network of over 1,000 test farmers across Mali. The quality of this network shows that farmers are not hostile to innovation, and that they can devise their own monitoring tools to develop the results of their experiments. Although farmers' organisations have limited resources, the mechanism designed and developed by the AOPP reflects the spirit of sharing seeds and traditional practices within African communities.

The AOPP's success in planning on-farm tests shows that it is possible to link what were originally two independent systems: farmers' seeds and the government's National Seed Service. In a significant step forward in information dissemination, farmers' organisations now provide the information that farmers need, so that individuals no longer have to seek out and decipher the certified seed catalogue. However, the disadvantage of this strict control is that the AOPP reproduces individuals' decision-making processes at the national level, seeking to identify an improved variety that corresponds with the specificities of the geographic zone where the tests were conducted (Box 3). This improved variety, tested by farmers in one location for a specific ecological adaptation, is then multiplied for use across a wider area. This means that the cereal variety selected for a body of members does not take into account local variations between villages and farms.

Box 3. The flip side of the success of farmers' organisations

Studying the distribution of varieties according to their respective abundance is a rapid way of evaluating the effects of introducing a new variety into a village. For example, we monitored the dissemination of the improved variety of sorghum (CSM63E) by the Farmers' Union in the district of Tominian. This showed that three out of seven local varieties disappeared in the space of two years following its introduction (Figure 2). These minor varieties played a major role in the genetic diversity of the village because they characterise particular uses, and the homogenisation of local germplasm carries an obvious risk in terms of loss of adaptation to deal with climatic, economic or social change.

Figure 2. Dynamics of the dissemination of an improved variety (CSME63) by a local farmers' organisation



Therefore, despite the success of this experimentation process, there is a serious risk that the positive role played by village communities in maintaining varietal diversity in villages and small geographic regions will disappear. The sum of the individual strategies employed by farmers managing just one or two varieties leads to collective biodiversity at the village level, and there is a danger that the resilience of the village community may be lost when local farmers' organisations successfully disseminate a single improved variety. Analysis of diversity is a fundamental criterion that should be taken into account in the dissemination of new varieties.

It is very important to take account of the value of agrobiodiversity in farming in order to prevent experimental mechanisms like the one initiated by the AOPP from reinforcing varietal erosion, which is already badly affecting cereals in Mali. Awareness of this can only be raised by strengthening the partnership between research bodies, the state services, village communities, farmers and farmer organisations.

RECOMMENDATIONS

To conclude, family farming in Africa is part of a system in which networks of dependence and exchange allow farmers to work together to build a common asset: agricultural diversity. The relationships thus developed extend beyond the geographic and social framework of the village or small natural region, and may even flourish at the national level. These networks play an essential role in maintaining local varieties of cereal *in situ* in Mali. Farmers' organisations are increasingly participating in disseminating the improved seed produced by their members, and are thus accelerating the rhythm of exchange. But their leaders need to be made aware that there is a risk that the resilience of the traditional seed system will be lost unless changes are made. Raising awareness will involve analysing the mechanisms used to maintain diversity, in order to perpetuate them in a flexible system suited to the constraints currently affecting rural societies. Today it seems unlikely that the dynamic management of a genetic pool is possible either purely *in situ* on farms or only *ex situ* in agricultural research stations. Therefore, we need to find another way based on links between conservation, selection/creation and use, and fuelled by permanent feedback between research, development and farmers.

1. Develop varieties capable of increasing yields while maintaining the hardiness of local varieties:
   - Public research should integrate participatory selection for improving plants in a way that respects local geographic and/or cultural specificities.
   - Farmers' evaluation criteria should be taken into account: stability of yield, response to

inputs, nutritional value and fodder quality.

- Women should be involved and their knowledge taken into account, both in terms of the technological criteria for processing produce and the specific aspects of their growing systems.

2. Improve actors' capacity to evaluate seed diversity in order to encourage greater diversity in farming:
   - Make a clear distinction between building on the diversity of local varieties at the individual farm level and shared management of a genetic pool at the local level. This will involve showing farmers how their specific individual choices affect the overall seed system.
   - Define simple monitoring and evaluation tools to help communities monitor the evolution of varieties in their villages and equip themselves with the means to act when necessary.
   - Propose windows of biodiversity that match the management capacities of local communities and local customs: growing a range of strains in dedicated village fields, setting up diversity registers and even local gene banks, etc.

3. Develop tools that can be used to support dialogue between actors on the development of a new, more effective seed system:
   - Work collectively with all stakeholders in the seed system (farmers, farmers' organisations, NGOs, research bodies, private seed distributors) to capitalise on the resilience of the traditional system for maintaining local varieties.
   - At community level, define the priorities for conserving local varieties and reflect on who should take responsibility for their conservation.
   - Prioritise awareness-raising among village-level resource persons who can act as reference farmers and play a greater role in introducing new varieties.
   - Develop simple models of the multi-agent kind associated with role play to facilitate appropriation by farmers, and use these models to simulate and explore together possible scenarios in the evolution of the seed system (Bazile *et al.*, 2005).

4. Involve the state in the conservation of local varieties:
   - Give researchers the resources to continue work on listing and recording the characteristics of local varieties.
   - Define the basis for recognised on-farm scientific experimentation to advance understanding of the interaction between genotype and the environment.
   - Reflect on ownership rights in the context of the participatory creation of varieties.
   - With farmers, adapt the norms of commercialisation according to seed categories in order to adjust to the specificities of local and improved varieties.

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The NR group receives funding from the Swedish International Development Cooperation Agency.

ISSN 1357-9258

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