Bioversity International

MODULE 3
Tree seed supply chains

Teacher's notes 3.2

Tree planting on farms in East Africa: how to ensure genetic diversity?

David Boshier and Ian Dawson

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Introduction

These Teacher's notes aim to assist teachers in using the Case Study 3.2 Tree planting on farms in East Africa: how to ensure genetic diversity in classes. The notes:

- Describe the key concepts covered in the case study, with references to forest genetic resources textbooks where explanations of these principles can be found (full references at the end of these notes).
- Give tips on how to prepare and run the exercise and discuss the main learning points (genetic and other) that students should be able to derive from the case study.
- Give an outline commentary to the PowerPoint presentation which is used to introduce the case study to the students. The presentation contains pictures of the species, nurseries, relevant land-use issues in the area, and figures/ tables from the exercise.

The following support materials can be found on the accompanying DVD, or at the Forest Genetic Resources Training Guide webpage at www.bioversityinternational.org

- Teacher's PowerPoint presentation
- Videos
- The Case Study

Key concepts to cover/introduce in this Case Study

The exercises explore the following issues, with respect to how seed collection and the seed supply chain can affect genetic diversity in species.

General conservation
- **Reproductive materials - source and collection**: see FAO et al. (2004a) pp. 47.

Genetic concepts
- **Genetic processes associated with small populations – bottleneck, increased genetic drift, increased inbreeding and consequently homozygosity:** see FAO et al. (2004a) pp. 43-44.
- **Effective population size compared to census size:** see FAO et al. (2004a) pp. 43-44; FAO et al. (2001) pp. 7, 10, 61; FAO et al. (2004b) pp. 10-12; Finkeldey (2005) pp. 177, 181-198; Geburek & Turok (2005) pp.162-164, 420-431.

- **Sexual systems – dioecy, hermaphrodite:** see Geburek & Turok (2005) pp. 130-131, 173, 176; Finkeldey (2005) pp. 55-62.
- **Self-incompatibility mechanisms:** see Geburek & Turok (2005) pp. 177-180; Finkeldey (2005) pp. 91-93.

How to run the exercise

The exercise can be run in a number of ways depending on the time available and size of the class. The exercise works best if students work in groups of 4–5 (no more than six). It is best if the students have already read the case study before they start the exercise. *This way valuable class time is not lost with students reading the case study during the class*. So give the case study out in a prior class with instructions to read it before the next class. It perhaps goes without saying that it is vital that the teacher and any assistants are fully familiar with the whole text! NB: the exercise is set in the context of the mid 2000s, both in terms of nursery practice and social context. Therefore, more recent information and changed contexts are **not** included as they are not relevant to the exercise.

Ideal number of students: 4–15

Ideal length of class: 3 hours, broken down as follows:

- ***Introduction*:** use one of the videos followed by the PowerPoint – *approx. 30 minutes*.
- ***Group work*:** suits 1–3 groups of 4–5 in each group. Each group devises a plan for the collection and supply of seed and improvements in nursery practice. Each group tends to take a different approach and different issues are raised, so that overall, most points are covered. Students discuss the case study amongst themselves, responding to the specific points and developing their plan. The teacher should be around to answer any queries the groups have. However, it is not essential that all of the time is spent with the whole class together with the teacher. Once the teacher and groups are happy they understand the assignment and issues, each group could meet, discuss and prepare the map and strategy outside of class time – *1.5 hours*.
- ***Presentations*:** each group presents its plan verbally to the class (supported by the main points written on large paper or in a PowerPoint presentation) – *10 minutes per presentation*, with *5 minutes* after each one for questions/ comments by the rest of the class and teacher – *15 to 45 minutes*, depending on the number of groups.
- ***Final discussion*:** led by the teacher allowing them to make general comments about what was good, what was missed, etc. – *10 minutes*.

Background information

Depending on the time and facilities available, use any combination of the following resources to provide background to the exercise: i) any of four videos that give general background to the benefits of tree planting for resource-poor farmers in East Africa; ii) PowerPoint presentation.

One of four videos:
- *Farming with trees*. Produced by the World Agroforestry Centre (ICRAF) and gives background to tree planting on farms in East Africa – *18 minutes*.
- *Uganda: protecting and planting trees to limit land degradation* – *7 minutes*.
- *Trees for life*. Produced by ICRAF and set in Malawi, it is mostly about the wider development context, fodder, firewood, fruit, with brief images of nurseries – *7 minutes*.

- *Fodder shrubs milking success* – about fodder production in Kenya, mostly *Calliandra*. Covers seed/seedling sales as enterprise development and wider issues – *5 minutes*.

***PowerPoint*:** about 20 minutes to go through. It covers general concepts behind the case study, and in particular, information on the main species identified in the survey. It also allows explanation of some specific issues raised in the case study and, in particular, understanding the data from the surveys.

Slide 1: the title shows the focus of the case study and a community nursery in Uganda.

Slide 2: shows the location of the three countries in East Africa and specifically locations of the nursery surveys.

Slide 3: shows some typical sites from the study areas where trees are planted on farms. It gives an idea of the context of planting and landscapes.

Slide 4: shows some of the nursery sites from the study.

Slide 5: asks the fundamental question as to why maintenance of genetic diversity within a species is of concern. The teacher can ask the class to give answers to this question before revealing the three bullet points given.

Slide 6: shows the impacts of lack of genetic diversity and inbreeding on growth of *Acacia mangium* in the nursery. The species was introduced to Sabah, Malaysia using seed from only one tree. Seed was then collected from the stand established with that seed, with successive generations collected from the previous generation. Reduced growth due to inbreeding depression was severe by the second generation.

Slide 7: theoretical genetic impacts from particular human interventions – on the left, the direct impacts that are observable from some human interventions – on the right, the expected genetic effects that follow these particular human impacts on tree populations.

Slide 8: allows explanation of the basic idea of a genetic bottleneck where alleles are lost through sampling, but also through the increased impact of genetic drift.

Slides 9-10: raise the issue of whether more physically isolated trees on farms show changes in mating patterns that lead immediately to lower genetic diversity through reduced heterozygosity. Is seed from these trees mostly inbred with consequences of lower fitness due to inbreeding depression and low levels of genetic diversity? The second slide shows theoretical predictions of how mating patterns may alter for such farm trees.

Slide 11: allows the teacher to show how the number of trees to collect from is a sampling issue in terms of the amount of genetic diversity represented in a collection with reference to the recommendations of Mbora and Lillesø (2007; Box 1 in the case study, see also Box 1 in these teacher's notes below for more details, including the difference between the two curves).

Slide 12: shows Table 1 from the study – it allows the teacher to explain the different variables that were assessed to make sure the students have understood them.

Slide 13: shows Figure 1 from the study – it allows the teacher to explain the graphs to make sure the students have understood them.

Slides 14-18: photos of trees, seed and main reproductive biology features (from Table 2 in the case study) of the five main species highlighted in the study.

Slide 14: photos of *Cupressus lusitanica* trees as windbreaks, cones, seedlings in a nursery and main reproductive biology features (from Table 2 in the case study).

Slide 15: photos of *Calliandra calothyrsus* flowers, open seed pods and main reproductive biology features (from Table 2 in the case study).

Slide 16: photos of *Dovyalis caffra* fruit, extracting seed on farm by crushing fruit and main reproductive biology features (from Table 2 in the case study). Make sure the students understand what dioecy means – male and female trees. Then pose the question "What may happen if farmers manage this species, preferring to keep those trees that produce fruit?" You do not necessarily have to answer this as this relates to one of the questions in the case study, i.e. "How could other factors of species biology (Table 2) affect genetic diversity in collections?" The idea is to get them thinking about what implications this system may have for management and genetic diversity.

Slide 17: an actual example of what can happen with dioecious fruit trees. A male *Sclerocarya birrea* tree being cut as it is not producing fruits.

Slide 18: photos of *Grevillea robusta* pods, seed and main reproductive biology features (from Table 2 in case study). Protandry (pollen shed before stigmas are receptive) reduces self-pollination. On farms, trees may be at low densities so cross-pollination is low and hence seed set is low. Poor management may also limit seeding.

Slide 19: photos of *Senna siamea* flowers and pods, and the main reproductive biology features (from Table 2 in the case study).

Slide 20: shows the different procurement pathways identified for NGOs and community-based organizations (CBOs). Ask the student to think about how they are different.

Slide 21: shows the distribution pathways identified for NGOs. Ask the students to think about which are the most important pathways. Note that no distribution pathway is shown for CBOs as material is distributed locally within the community.

Slides 22-23: allow the teacher to go over what the students should be doing in the exercise.

Slide 22: covers the main points they should be discussing to ensure they can identify the key points and actions needed for a plan.

Slide 23: gives an overall objective for the plan and summarizes what they should cover in their plan and presentation.

Important points to draw out in discussions and to cover in students' plans

Comments about the questions

- *What are the bottlenecks to ensuring genetic diversity? How will you overcome these?*

The study shows that current seed collection practice is the most obvious limiting bottleneck for delivering high levels of genetic diversity to farmers. Low numbers of seed trees are sampled for nursery lot establishment (mean

Box 1. How many trees to collect from?

This question is often raised by seed collectors, policy makers and others. There is no single correct answer since it depends both on the aim of the collection and the way in which genetic diversity is distributed within a stand. It is not possible to sample all the diversity present in a population unless the whole population is collected, and this is clearly impractical. So while ideally one might look for '***conservation of as much of a population's genetic diversity as possible***', in terms of sample size there are diminishing returns. As the number of seed trees sampled increases, the amount of extra diversity collected is reduced (*Slide 11* in the PowerPoint presentation). There is therefore a need to define a criterion for an adequate sample size. We can consider two different scenarios:

- Collection of clonal material e.g. cuttings from selected trees to establish a clonal seed orchard.
- Seed collection.

In the first case, genetic theory tells us that sampling 30 trees in a species with random outcrossing, and 60 trees in a completely selfing species, allows us to conserve an arbitrary 95% of alleles with a frequency >5%. In outcrossing species, cuttings taken from 30 trees per population to establish a clonal seed orchard would therefore meet this arbitrary level.

In the second case, however, when fruits/seed are collected, adequate sampling also depends on the number of seeds collected per tree and the mating/pollination system of the species. Wind pollination is likely to result in trees producing seed from many fathers, whereas insect pollination is more likely to produce seed of fewer fathers per tree. To make a seed collection with the same levels of genetic diversity, it is necessary to collect from approximately 50% more trees in insect pollination than in wind pollination. In insect-pollinated species, seed from 15 trees will contain 95% of alleles with frequency >5%, while a collection from 30 trees will include additional rare alleles (95% of alleles with frequency >2.5%) – only a slight increase in the genetic diversity. For wind-pollinated species, the corresponding numbers are 10 and 20 trees. These calculations assume collection of at least 500 viable seeds per tree.

Spacing between seed trees is also important in ensuring a diverse collection. Collecting at distances greater than seed dispersal will help ensure that sampled seed trees are not directly related, although the pollen pools siring seed may still be related. Obviously seed dispersal distances vary by species, depending on the dispersal mechanism (e.g. wind, animal, human), but are generally over short distances (e.g. means of 30-50 m are typical). Generally, collection of seed from trees which are 100 m apart is likely to ensure the seed trees are relatively unrelated, but they are still likely to be mating with a similar selection of fathers (pollen pool). In wind-pollinated species, seed trees need to be at least 150 m apart to ensure collection of seed from both unrelated females and different pollen pools. Where most seed trees mate with different fathers, it is sufficient to collect from trees that are separated by the seed dispersal distance to ensure a diverse collection.

N_m of 6.4, Tables 1 and 3) for both exotic and indigenous trees, common and rare species. In only two cases were seed collected from the minimum number of 30 seed trees suggested for adequately capturing genetic variation in trees (see Box 1 in the case study). Twenty two per cent of nursery lots were established from a single tree. Thus, current seed collection practice may restrict on-farm tree genetic diversity, constituting a significant risk to the productivity and sustainability of agroforestry systems in the East Africa region. Increasing the number of trees collected from is the obvious solution to this bottleneck. This may be achievable through a number of methods, e.g. training/dissemination – see below. However, although simple in theory, this may be more difficult to ensure in practice. It may be more realistic to recognise the sampling limitations for individual collectors (economic and physical) and find other ways around these, e.g. see text on mixing of germplasm below.

The number of trees in a seed source is also revealed as a potential genetic bottleneck. Table 3 shows that many seed sources contain a small number of trees, so even if all trees are collected from, genetic diversity will be low. If nursery managers, at least of on-farm nurseries, frequently return to their own or neighbouring farms for seed, as is likely and has often been demonstrated, a limited gene pool will be continually sampled. Effective population sizes will then be lower due to representation of the same trees in successive generations. Farm size associated with use of species, may also impact on diversity. Although farms are small within the survey areas, genetic exchange may occur via pollen flow. However, if only a small number of farms maintain and plant particular species, population sizes and hence genetic diversity will be low. With densities for some native species of 0.05–0.25 trees per ha, large areas of agroforests are required to maintain adequate numbers of individual species as seed sources, e.g. at least 1000 ha for the lowest density species (0.05 trees per ha) to have a census population of 50 trees (see Box 1 guidelines in case study).

Other potential bottlenecks are raised within other points below.

- *For the five main species how does seed production per tree influence the number of trees that seed is collected from? How could other factors of the species biology affect genetic diversity in seed collections?*

In species such as *C. lusitanica* or *G. robusta*, large quantities of seed can be collected from a single tree and satisfy the needs of any one nursery (Table 2). Such species are more prone to collection of seed from a small number of trees. By contrast, *D. caffra* produces relatively small amounts of fruit, and hence seed, per tree. Thus collectors are forced to collect from more trees to obtain sufficient seed to fulfil nursery requirements (see also Box 1 in case study). This is reflected in the number of trees collected from for each of the five species (e.g. *C. lusitanica*, mean N_m is the lowest at 3.1, while *D. caffra* is the highest at 21.6).

D. caffra is dioecious which means that only some trees will produce fruit and hence seed. How farmers manage dioecious trees such as this may influence genetic diversity and even fruit production. For example, farmers may favour or actively manage to leave only fruit-producing trees. For farmers there is no apparent reason to maintain male trees of dioecious species that they grow specifically for fruit consumption (both indigenous and exotic fruit trees), since they have lost their functional value. Removal of male trees (as in the example of the male *Sclerocarya birrea* tree in the PowerPoint) would reduce the number of potential pollen sources. This can: a) reduce the effective population size and cause another genetic bottleneck, and b) reduce fruit/seed production in female trees through a lack of cross-pollination.

In *G. robusta*, Table 2 shows that fruit set is higher with controlled cross-pollination (5.9% – 17.5%) than found on farms where open pollination occurs (0.1% – 3.3%). Examination of open-pollinated flowers shows stigmas have mostly no pollen or only self pollen. In farm landscapes, the low population density of a species (e.g. Table 3), may lead to a lack of cross-pollination that limits seed production. In such circumstances, certain trees may also dominate the pollen pool reducing effective population size and causing a genetic bottleneck that may be less apparent (see discussion above on tree densities in farmland). The most common species are, however, not those most likely to suffer across-generation bottlenecks as they are likely to be at higher densities in farm landscapes.

- *How do seed collection and the production of seedlings occur?*

Figures 2-4 and the associated case study text show that seed collection and seedling production vary depending on the type of organization that is the main channel. In the case of NGOs that are working directly with farmers, seed comes principally from 'private entrepreneurs and own collection' and 'government and research' in roughly equal measure (38.7% and 36.4% respectively). This seed is collected equally from within the area where it will be used (local) or from elsewhere in the same country (regional). In contrast, a much higher percentage of the material that CBOs access comes from 'private entrepreneurs and own collection' (63.3%) and is collected locally (84.8%).

- *Are seeds and seedlings transferred and if so how? Does this provide limitations or opportunities in managing diversity?*

As Figures 2-4 show, the procurement and delivery chains are complex and variable, involving a large and diverse range of stakeholders. Although these chains are drawn from a study in Uganda, it is reasonable to assume that those in the other countries will not differ greatly. In 71% of cases, seedlings are provided by NGOs free of charge (Fig. 3). Mostly, NGOs transfer seed to farmers through nurseries that raise seedlings and only in a small percentage of cases (8.7%) do they transfer seed directly. The seedlings come from a range of centralized and decentralized nurseries. The text mentions that the germplasm is of undocumented quality and the survey identifies the potential bottlenecks and other problems associated with seed collection and raising of seedlings. A large number of organizations and individuals are clearly involved in both seed collection and the raising of seedlings and this ready flow of material also offers opportunities to avoid the problems. The type of training and other actions identified in the sections above and below may require differential targeting depending on whether NGOs or CBOs are the main procurers. However, targeting 'private entrepreneurs and own collectors' and local nurseries is likely to impact on the largest proportions of the chains and hence reach the highest number of farmers.

- *How can mixing seed of the same species ensure better use and maintenance of the existing genetic diversity? Think about mean N_s/N_c compared to mean N_s/N_m*

Nursery practice may also reduce the genetic diversity received by each client to below the levels collected, as the comparison of N_m (seed trees per nursery lot), N_s (seedlings per nursery lot) and N_c (clients per nursery lot) values in the nurseries survey show (Table 1). On average, each collected tree produced sufficient seed to provide all the seedlings received by an individual nursery client (mean N_s/N_c = 125 is less than mean N_s/N_m = 370). The potential impact on farm genetic diversity of non-mixing of seedlings within nurseries is therefore serious. All the seedlings received by a single client from a nursery could in theory be from one seed tree, even when the original seed collection was from several trees. However, from Table 1, and the text, in 106 cases the mean number of seedlings expected to be received by clients was $\geq N_m$ (≥ 2 N_m and ≥ 5 N_m in 96 and 74 cases, respectively). Therefore, if seedlings raised from separate seed trees of the same species are mixed (randomised) in the nursery, each client will generally receive seedlings from most of the trees from which seed was collected, thereby maximizing the genetic diversity of material distributed.

It would also be possible to increase the levels of genetic diversity by pooling seed of the same species from collections by different villages, NGOs, etc. Seed would be physically mixed, with each organization receiving back the same quantity it contributed. Mixing would mean that the number of seed trees represented in the collection would be much larger than any one of the original collections. The logistics of such mixing and interchange would require, and benefit from, the type of networks suggested below.

- *Do you need to give advice/training to improve the situation? Use Figures 2-4 and think if this advice/training should be to NGOs and/or directly to the communities? What specific advice/training will you give?*

Developing and strengthening networks that exchange tree seed and seedlings should facilitate the distribution of genetic diversity in farm landscapes. Training is needed to promote better germplasm collection methods for all actors involved in networks (farmers, NGOs, National Tree Seed Centres, small businesses, etc.) as current practices are inadequate for maintaining genetic diversity and for providing seed of good genetic and physiological quality. Emphasis needs to be placed on sampling more parents for seed, and returning to natural stands rather than remnants where this is possible (to minimize potential inbreeding effects associated with the latter). If these are not possible, then sampling should be from a large number of remnants, if available, with culling of the smallest seedlings in nurseries to reduce the amount of inbred seedlings that are planted in the field. Furthermore, training is required in how to establish community seed banks in which germplasm can be pooled, stored and redistributed, and in farm management approaches that elevate the effective population sizes of tree stands, such as bee keeping, which promotes pollination and, through honey production, provides additional revenue for farmers.

Training of small commercial seed and seedling enterprises is important, as these businesses are more sustainable and able to reach more farmers than other germplasm supply actors. Governments in many tropical countries increasingly rely on them for the provision of tree seed nationally. These businesses need training not only in 'technical' aspects of supply (collection and handling), but also in small enterprise development, so they can operate efficiently and profitably in the market, and can work with other partners. These suppliers also need policy support, e.g. measures to encourage NGOs to stop their common practice of providing free tree seed/seedlings to farmers, as this represents unfair, donor-subsidized competition to commercial enterprises. A reorientation of the roles of the current stakeholders in tree germplasm delivery is required if supply is to be made more effective.

In your plan you should cover the following:

- *Identify influences on genetic diversity (bottlenecks, selection, genetic drift) associated with current seed collection and distribution paths. (See above for genetic bottlenecks).*

A number of other factors determine the extent to which current nursery genetic management practices for seed-propagated species impact on farm and landscape tree genetic diversity. Figure 2 shows the use of vegetative propagules for on-farm tree establishment and another survey revealed a higher reliance on vegetative propagation during planting. Additional research that considers sampling issues for clonal material is therefore required. The impact of current practices will depend on the origin and history of a given species. Indigenous species may be less sensitive to genetic erosion because of remnant trees that input seed and pollen into subsequent generations of on-farm material. However, the availability of viable remnant trees at locations may decrease over time as land clearance for agriculture increases. Loss of remnant trees may reduce outcrossing levels, increasing the degree of genetic differentiation between seed lots from different seed trees. As well as the impacts of inbreeding, this will exacerbate diversity losses when seed is collected from a small number of trees. Exotic species depend on the initial genetic base of introduced material, which may have been narrow. This is particularly likely if introductions took place before the possible impacts of a narrow genetic base were widely appreciated, e.g. see *A. mangium* example in PowerPoint, also Table 2 for *G. robusta*.

- *Identify key actors (individuals, institutions), processes (what actors do) and social limits in the seed supply chain (policy, trade, institutional, or capacity issues). What are the communication and training needs related to key actors?*

Both germplasm access and market-based interventions are required to manage tree genetic variation better in agroforestry systems. Implementation of support programmes can consider tree seed/seedling supply, and product (fruit, timber, medicine, etc.) sale as parts of one value chain. In this model, actors who: i) procure and distribute germplasm, ii) plant and manage trees, and iii) trade and purchase tree products, are all seen as part of a single system. For effective livelihood development and environmental protection, the linkages between these actors must function properly.

Germplasm networks can play a crucial role. In developing networks, it is especially important that 'nodal' farmers and nurseries, that play a particular role in maintaining and distributing a wide range of tree species and varieties, are considered. In the development of germplasm networks, proper consideration must be given to geographic scale. As significant variation in tree species availability is observed between communities, developing village-to-village linkages is important. Significant maladaptation is however possible if germplasm exchange occurs over too large a geographic area. In semi-arid regions like the West African Sahel, even relatively short-distance transfer of germplasm - from more humid to drier zones - may result in this maladaptation.

It is evident that for tropical agroforests to efficiently support livelihood and conservation functions in the future, germplasm access-based interventions are required to broaden the genetic base of tree populations and improve the connectivity between trees in farmland. These interventions must be placed clearly within a framework of the livelihood opportunities and other services that they provide to local people, and be developed in a participatory manner that builds on current farm practice, or communities will not invest in them. Also required are measures that preferentially improve access to currently under-represented and threatened indigenous taxa or varieties, as these are the most important for conservation and the most vulnerable to the consequences of low genetic variation. Intervention will clearly be most successful when current differences in abundance between tree species do not relate to differences in farmer preferences, but to particular problems in accessing rare taxa. Of course, planting of currently rare species should not be stressed to the degree that these become the new dominants in farm landscapes, so raising new management problems for the previously more common trees.

Although there is a strong case for action to improve the management of tree genetic diversity in tropical agroforestry ecosystems, interventions will only be successful at a significant scale if they support the livelihoods of local communities. As well as devising supply-side interventions based on germplasm access, therefore, it is also essential to consider the development of market structures that support genetic diversity. Incorporating farmers into markets may seem counterproductive for conservation, as higher market access is often coupled with intensification and greater emphasis on short-term productivity, resulting in losses in species diversity (a tendency to monoculture) and reduced genetic variation in farming systems. Tools are available, however, to align conservation and market goals in better ways than are practised presently and markets can effectively support genetic diversity if attention is given to the development of appropriate 'ideotypes' and niche markets that support a range of variation within a species.

- *Specific actions to improve the situation, addressing diversity issues in the seed system (e.g. practical ways to collect and distribute seed/seedlings that ensure genetic diversity in nurseries and in material planted in the field).*

To maximize genetic diversity in seed collections, the most important considerations are the number of trees collected from, the distance between trees and collecting equal amounts of seed from each tree. The studies suggest a number of interventions to increase the provision of genetic diversity to farmers through tree nurseries. During seed collection by nursery managers, the number of seed trees sampled depended at least partly on the quantity of seed required rather than the availability of seed-bearing trees. Thus, by training of nursery managers and providing access to basic collection equipment to facilitate sampling, there appears scope to encourage the collection from a larger number of seed trees during collection. However, access to seed is apparently a limiting factor in much tree planting, due to low tree densities and aggregated distributions. In this situation, an appropriate intervention is the establishment of local nursery networks, through which germplasm can be exchanged and combined. Encouraging nursery managers to mix seedlings within nursery lots may have a significant impact on the genetic diversity received by clients. Alternative sources of tree seed should be quantified, the history of exotic introductions assessed, and the detailed spatial distribution of nurseries and their clients analysed.

For species in high demand, communities and commercial suppliers may also need to establish dedicated germplasm multiplication stands. The founder material of such stands should be carefully collected, and such populations established at locations where common access can be ensured, e.g. in the grounds of schools, hospitals and government offices. Different villages may agree with each other to establish multiplication stands of different tree species, with the view of exchanging the seed produced through networks.

Methodologies – further ideas for access

Improving access through 'diversity fairs'

An extension of the network approach for improving access to germplasm is the use of 'diversity fairs'. This approach, employed in recent years to enhance diversity in traditional agricultural crops in smallholders' farms, involves organizing social events to which farmers are encouraged to bring local varieties of crops, and to exchange germplasm and associated knowledge. Prizes are often awarded for the most unusual or interesting cultivars exhibited. Although widely applied to annual crops, fairs have rarely been considered for managing tree genetic variation in farm landscapes. This is because fairs work best when the most important qualities of a variety/species are clear from the species propagules, e.g. when the seed or fruit itself is the product for which a crop is grown. A direct relationship between use and propagule is clearly not evident if it is timber, leaves, or bark of a tree that are important. Then other means of quality verification are required, such as displays of wood or bark samples. A pragmatic starting point in the use of diversity fairs is to encourage inclusion of fruit trees – where use and propagule are clearly related – in events designed primarily for promotion of other crops, an approach undertaken to manage genetic diversity in fruit trees in the West African Sahel.

Encouraging participatory tree domestication

Participatory domestication is about empowering local communities to consciously carry out breeding activities for themselves. Participatory approaches involve ensuring that local people are trained in a range of germplasm collection, selection, propagation, management, harvesting and processing techniques, and then encouraging communities to apply these skills to the semi- or previously un-domesticated taxa that they find in the landscapes around them. Such approaches have been adopted in circumstances where a very large range of species may be subject to promotion, a situation where application of these methods can make an important contribution to the genetic management of a range of taxa at the same time. Participatory domestication of tropical trees is most relevant when high genetic diversity is still available in the local landscapes that farmers occupy, e.g. when agricultural land borders wild or relatively unmanaged forest habitat, as in the humid tropics of West Africa and the Amazon. To assure germplasm availability under these conditions, policy interventions may be required to allow communities access to local forest, especially if trees occur within protected areas managed by government authorities.

Further information

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