5.3 Participatory domestication of the fruit tree species feijoa (*Acca sellowiana*) in Brazil

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Feijoa: a native species in the process of domestication

Brazil is home to hundreds of fruit tree species. Despite their economic potential, several of these species are being threatened by changing landscapes. A number of efforts are being made to domesticate them, by contributing to their conservation. Feijoa, or pineapple guava (*Acca sellowiana*, synonymous with *Feijoa sellowiana*), is such a fruit tree species. Feijoa is native to southern Brazil and northern Uruguay. Since the 1950s, the potential of feijoa has been explored in several countries. The most successful breeding programme resulted in wide-scale commercial production in New Zealand, as well as in Colombia, albeit on a smaller scale. In Brazil, feijoa is cultivated on just a small scale at local level, even though the fruits have a unique flavour and aroma, and are attributed with having a number of medicinal values (Vuotto *et al*., 2000; Bontempo *et al*., 2007). Although feijoa is well adapted, its use remains limited. Since it has the potential to contribute to forest conservation and to ensure sustainable livelihoods for small-scale farmers in rural areas through its use as a non-timber forest product, several activities are being carried out in Brazil in order to promote its use (Ducroquet *et al*., 2000).

Research programme on feijoa domestication

In this chapter we share our experiences as professors and doctoral students associated with the Federal University of Santa Catarina (UFSC) in using a participatory approach for the domestication of feijoa. Domestication can be achieved when the selection, propagation and improvement processes result in phenotypic and genotypic changes. Those plants that possess the desired traits can be used to promote commercial cultivation and are therefore selected (Clement, 1999). Since we are only at the initial stages of developing feijoa as a crop, we refer to the process as domestication, but the participatory structure of the process has several similarities with grassroots breeding, as described by Sthapat *et al*. (Chapter 5.2). We focus on participatory domestication in this chapter and do not address aspects of conservation and marketing, though we recognize that one cannot be separated from the other. We share our experiences working with participatory feijoa domestication in the states of Santa Catarina and Rio Grande do Sul, in southern Brazil.
Feijoa in Santa Catarina and Rio Grande do Sul

Genetic diversity of *A. sellowiana* can be found in the Atlantic Forest, situated in the states of Santa Catarina and Rio Grande do Sul in southern Brazil. The historic development of livestock and monoculture cropping systems in this region has limited the marketing of feijoa products. In addition to being dominated by livestock, commercial apple orchards, pine plantations and cereals are important economic activities in the region; these result in monoculture systems that are predominantly embedded in a matrix of forest vegetation on steep slopes. As such, little room exists in this agricultural landscape for the commercial use of indigenous tree species like feijoa. Recently, development has begun to focus on rural tourism and organic agriculture, creating more room for alternative production systems in which feijoa may become a driver for more ‘biodiversity’-friendly fruit production, with value chain development that supports small-scale producers. In Santa Catarina, UFSC and Santa Catarina State Enterprise for Agricultural Research and Rural Extension (Epagri) are working together with several groups of farmers engaged in feijoa cultivation and management.

In the municipalities of Ipê and Antonio Prado, in Rio Grande do Sul (Figure 5.3.1), wild populations of *A. sellowiana* exhibit substantial genetic and phenotypic variation. The Centre of Ecology (CE), a local non-governmental organization, has been promoting organic, agroforestry-based production systems for the past 20 years. CE emphasizes the use of native fruit species, including feijoa; disseminates seedlings and cuttings of indigenous species; and provides assistance in developing value chains for marketing.

![Figure 5.3.1 Map illustrating the municipalities where participatory genetic domestication of feijoa is being carried out.](image-url)
fruits and fruit products. CE uses participatory methods in its developmental work and relies on the availability of genetic diversity maintained on farm and in native forests. In 2008, CE and UFSC formed a partnership, in which Econativa Cooperative, the State Foundation of Agricultural Research (FEPAGRO) and other institutions joined, to further structure the participatory domestication of feijoa.

**Steps towards the participatory domestication of feijoa**

We identified the following steps as being necessary for the participatory domestication of feijoa based on our experiences in carrying out research on feijoa genetic resources in Santa Catarina and Rio Grande do Sul. We identify seven steps, but have so far we have only completed up to step 6 of this programme, since we are dealing with a perennial species and the process takes time.

**Step 1: Development of a collaborative framework**

To begin with we identified and mobilized partners, especially farmers, as well as representatives of local development and research organizations. An agreement was then drafted, in order to define everyone’s responsibilities and rights. In Brazil, such an agreement, concerning genetic resources and associated traditional knowledge, is governed by federal legislation related to access and benefit-sharing (ABS).

**Step 2: Formation of key farmer working groups**

For the selection process, we found it was crucial to work with groups of farmers only. This made it possible to avoid having to deal with any individual farmer’s demands that were not in line with conservation, for example. The diverse nature of these small groups enabled us to encounter a variety of demands and, as we made progress in crop improvement, to become more efficient in disseminating selected materials.

In Santa Catarina, the characterization of four types of feijoa users facilitated the identification of farmers willing to take part in the participatory domestication. In Rio Grande do Sul, CE actively supported the establishment of a group of farmers who meet on a regular basis to plan and direct the actions of the feijoa participatory breeding programme.

**Step 3: Assessment of production system**

We conducted an inventory of traditional knowledge associated with *A. sellowiana* in Santa Catarina in the municipalities of São Joaquim, Urubici and Urupema (see Figure 5.3.1). Both qualitative and quantitative ethnobotanical methods were used; 54 informants were included in this assessment. The inventory used the following typology of informants:

- **custodians**, who simply use the plants for home consumption and derive little or no income from feijoa;
managers, who collect and propagate selected plants and, to some degree, manage their feijoa plantations; they use the fruits in domestic value addition activities (such as making jams, juices and medicinal infusions) from which they are able to generate some income;

- *cultivators*; who actively establish feijoa orchards and market fruits, have strong links with research and extension agents, and use released, improved genotypes;

- *users*, who utilize the fruit, for example, in cooking, reforestation, and in the production and sale of seedlings, but who do not actually cultivate the species.

We found no significant difference in knowledge between the four groups concerning the use of feijoa, implying that conservation and use activities can involve everyone. However, we did find a significant difference in knowledge concerning the management of feijoa by managers and cultivators, and as such any activities to promote the management and production of feijoa, in particular through participatory feijoa domestication, should start by addressing these differences (Santos *et al.*, 2009).

In Rio Grande do Sul, a number of working groups were set up by CE, with the aim of promoting the use and conservation of feijoa, using participatory methods to obtain higher yield genotypes and resistance to pests and diseases; and to enhance the community’s capacity in marketing feijoa products. In addition, we interviewed 39 farming households, with a total of 70 informants, in order to systematize the traditional knowledge associated with the use and management of the species. Through the assessment we were able to identify 11 different management practices.

**Step 4: Participatory and market-oriented identification of key traits**

We are currently in the process of incorporating the demands of farmers and consumers into the selection criteria, and have found that priorities can vary among groups and consumers. With regards to the group of farmers that was formed in Rio Grande do Sul, we used participatory methods to establish the selection criteria. In this manner, farmers contributed to the selection of promising genotypes.

**Step 5: Development of a breeding strategy**

Since *A. sellowiana* is an out-crossing species – the simplest and least expensive breeding strategy is that of ‘mass selection’, using open-pollinated seed collected from selected (maternal) plants from each generation. For many genetically diverse species, this method is an adequate way of obtaining improvements in each generation, and of contributing to the maintenance of genetic diversity. The vegetative propagation (grafting) of unusually productive individuals can ‘secure’ or ‘genetically fix’ desired traits and allow for multiplying certain selections (Leakey and Akinnifesi, 2008). However, this method cannot be considered breeding, since it does not create new genotypes for selection. If we followed this method, we would minimize our contribution to conservation. Vegetative propagation carries the risk that only one or a few preferred selections will become widespread, thereby reducing the level of diversity overall. Among the various breeding strategies, mass selection offers the best
opportunity to balance cost, technical feasibility and genetic improvement, while also contributing to conservation.

In Rio Grande do Sul, before beginning its collaboration with UFSC, CE supported the establishment of more than a dozen small orchards, using cuttings originating from seed collected from approximately 15 selected trees. The selection criteria used to choose the parental plants were fruit size and quality, skin texture and distinct ripening time. As expected, the populations generated from the seed of selected trees showed wide segregation, especially for fruit size. Currently, UFSC and CE are engaged in Rio Grande do Sul in identifying potential parents by segregating populations for further selection. In addition, the group of farmers selected ten promising genotypes to be utilized in crosses. Using their own selection criteria, farmers selected from over 300 genotypes. Eight of the farmers decided to test 500 plants from the progenies obtained.

**Step 6: Cycles of mass selection**

We need to know which genetic parameters to use when selecting traits, in order to predict to what degree improvement would be possible. Those heritability estimates that are available for some traits, especially for fruit weight and the ratio of fruit length/diameter, suggest that mass selection would probably be effective in selecting among wild plants of *A. sellowiana* (Santos, 2005). The process of domestication takes several cycles and years with a perennial like feijoa, but in the long run we aim to have completed a number of selection cycles to balance genetic improvement concerns with the maintenance of genetic variation related to plant adaptation (Leakey and Akinnifesi, 2008). Ten field tests have already been carried out in the southern region of the country, with distinct progenies from selected parents.

In Rio Grande do Sul we are currently conducting such genetic studies on population structures and testing progenies for future evaluation. In Santa Catarina, these studies have already identified promising genotypes (Santos, 2009). The results of the studies from both Rio Grande do Sul and Santa Catarina will help us to identify parents to be used in the cycles of mass selection that we are planning for the future. Furthermore, the genetic studies will also be useful for defining strategies that contribute to the conservation of natural populations. We are currently providing guidance to our local partners in both locations related to the identification of priority areas for conservation, the genetic characterization of natural and managed populations, and the characterization of fruit traits of selected trees.

**Step 7: On-farm evaluation**

Members of the farmer working groups carry out trials in order to facilitate the identification of desirable plants in dissimilar environments and production conditions. Farmers evaluate distinct progenies from selected parental materials in ten field tests located in both states. These trials allow for the evaluation of agronomic performance under grower conditions, while providing estimates of production costs and the efficiency of agronomic treatments under realistic conditions.
Development of capabilities to maintain interest and conduct follow-up actions

For each of the steps of the participatory domestication process, we organize workshops to manage and discuss data and results and also to maintain the interest of all the partners. As such, we aim to be efficient in the selection process and provide an opportunity to share identified and selected materials at any one time. The workshops enhance the capacities of farmers’ groups, as well as research and development partners. They also encourage participants to think beyond the breeding process, to contribute to the development of value chains, and to promote the creation of local and sustainable markets for feijoa fruit and other feijoa products.

The research group and its role in participatory domestication

Since we work as a university group on topics related to plant genetic resources, we are able to conduct genetic and ethnobotanical studies that can contribute in a vital manner to designing a long-term process, such as the participatory domestication of a fruit tree species like feijoa in southern Brazil. In this way, we are able to contribute to the grassroots breeding of such a perennial species, which can be considered a reference species for the use of indigenous species within larger domesticated landscapes. Since we are dealing with a time-consuming process, the collaboration between universities, farmers’ groups and their organizations is vital, as other breeders may not be able to engage themselves in such a long process in a similar manner. It is crucial that we are able to link up through our studies and encourage our partners, so that we do not lose the context of conservation during such domestication processes. At the same time, we can foster value chain development, creating benefits for small-scale farmers for treasuring this potentially valuable genetic resource. It is our long-term goal that through the development of such studies, we will be able to balance conservation, crop improvement and economic benefits in promoting the use of feijoa in the region.