Core Collection Approaches and Genetic Diversity in *Flemingia macrophylla*

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THEME # 23

CORE COLLECTION APPROACHES AND GENETIC DIVERSITY IN *FLEMINGIA MACROPHYLLA*

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Abstract

Core collections are a useful means to optimise the management, including conservation, of forage germplasm collections. Such optimisation is warranted in view of increasingly limited research resources. As there are several potential options to create core collections, a project is presented in which three approaches are compared: (i) based on germplasm origin information; (ii) genetic diversity assessment by agronomic characterisation/evaluation; and (iii) DNA markers. As example-species for the project, the tropical legume shrub *Flemingia macrophylla* is selected because of its particular multiple-use potential in smallholder production systems. An important diversity descriptor is the content of tannins influencing feed and litter quality of this species. Data will be analysed using multivariate statistics and GIS tools. The results from the core collection approach comparison are expected to be applicable also to other wild legumes.

Keywords: Biodiversity, genetic resources, tropical forages, multipurpose legumes, agronomic evaluation, molecular markers, nutritive value, Geographic Information Systems

Genetic diversity and core collection

Assessment of genetic diversity of tropical forage legumes has hitherto consisted mainly of morphological, physiological and agronomic germplasm characterisation (e.g., Thomson et al., 1997). It is increasingly complemented or substituted by laboratory studies in the form of isozyme electrophoresis (e.g., Maass and Ocampo, 1995), and, more recently, by DNA markers (e.g., Liu, 1996). As far as large germplasm collections of any given species are concerned, because of continuously increasing limitations regarding research resources such as for the management of collections (assessing genetic diversity, documentation, seed multiplication and periodic rejuvenation, *ex situ* conservation in cold-storage rooms, etc.) a core collection concept has been suggested by which a large collection is reduced to a smaller size that can be easier and more cost-efficiently managed, whose diversity, however, is, *per definitionem*, representative of the total collection (Brown, 1989).

Whereas there is, in principle, a range of possibilities to create core collections (Johnson and Hodgkin, 1999), published experiences regarding tropical wild legume species seem to be so far limited to one example, viz. *Desmodium ovalifolium* where the core collection was put together on the basis of collection site information in connection with some preliminary evaluation data from only one experimental site (Schmidt et al., 1997). Concepts are required regarding the most appropriate and resource-efficient way(s) of identifying a core collection for tropical wild legumes, including the consideration of using molecular markers and Geographic Information Systems (GIS) tools.

Flemingia macrophylla

Flemingia macrophylla (Willd.) Kuntze ex Merr. (syn. *F. congesta, Moghania macrophylla*) is a tropical multipurpose legume particularly suited for low-input smallholder production systems in the sub-humid and humid tropics. It is a perennial, leafy shrub that grows up to 3 m high and is used for soil cover and mulch with fuel wood as by-product, as

shade-providing plant in young plantations of coffee, cocoa, etc., and as erosion barrier hedge. There are also reports on several other uses such as dye, for medicinal purposes and nematode control (Budelman and Siregar, 1997). Although the species is sometimes referred to as a "forage" or "fodder" legume (e.g., Bazill, 1987; Schultze-Kraft, 1996), there are no reports on large-scale forage use.

The particular advantages of *F. macrophylla*, based on experiences, throughout the tropics, with a semi-commercial genotype from the Philippines, and on preliminary germplasm collection evaluations at CIAT, are: vigour, leafiness, adaptation to very acid, low-fertility soils, drought resistance, excellent coppicing capacity and regrowth after cutting, and slow leaf decomposition. Its main limitation is low nutritive value in terms of digestibility because of high tannin content combined with very low palatability to cattle (Thomas and Schultze-Kraft, 1990).

The species' centre of diversity is Southeast and South Asia where germplasm has been collected in South China, Vietnam, Thailand, Malaysia, Indonesia, and Papua New Guinea. However, plant populations that were apparently wild (but probably represent naturalised material) have also been found in Africa (Ghana and Cameroon) and South America (Colombia). The germplasm collections available at CIAT and other gene banks comprise about 80 accessions.

Significant research on *F. macrophylla* is presently only done in Vietnam for goat nutrition and soil improvement (Nguyen Thi Mui, NIAH, Hanoi, pers. comm. 1999), but in view of its evident potential for sustainable smallholder production systems, the species warrants further attention by scientists. This is also true for the genetic resources conservation aspect: Due to population pressure with subsequent expansion of agriculture and increasing destruction of native vegetation, *F. macrophylla* – like many other South and Southeast Asian legumes – is in its native habitat under severe threat of genetic erosion. It is, therefore,

important to assess the presently available genetic diversity of the species and eventually consider further germplasm collection missions for *ex situ* conservation and appropriate subsequent germplasm characterisation.

In the case of *F. macrophylla*, documentation of genetic diversity is insofar particularly challenging as (i) many accessions, independent from their original collection sites, look quite similar; (ii) the issue of the value of (naturalised?) African and South American material awaits clarification; and (iii) the extent of variability in tannin content needs to be explored.

The project

A project is being implemented by the University of Hohenheim and CIAT with the goal to develop a concept to optimise germplasm collection and management, taking *F. macrophylla* as an example. The objectives are:

- To verify and improve the core collection concept by comparing (and eventually integrating) three approaches to create a core collection, namely based on (i) germplasm origin information, hypothesising that geographic distances and environmental differences are related to genetic diversity; (ii) germplasm characterisation and evaluation at field plot level; and (iii) DNA markers.
- Based on DNA marker similarities and GIS predictions, to provide suggestions for (i) focussing future collections on areas with particularly high diversity and, as a by-product, for (ii) collection (= sampling) strategy improvements; (iii) to clarify the origin of material from Africa and South America, and (iv) to identify accession duplicates in the world collection.

- To describe the variability regarding especially important plant characteristics, mainly

Materials and Methods

The project consists of five phases:

- Phase 1: Assembly of the *F. macrophylla* world collection by introducing from gene banks seed and relevant passport data of all available accessions.
- Phase 2: Creation of a core collection based on data analysis of available origin information.
- Phase 3: Characterisation and preliminary evaluation of the entire collection in space-planted, single-row plots at the CIAT-Quilichao research station and subsequent creation of a core collection based on the results; nutritive value analyses (contents of crude protein and tannins; *in vitro* dry-matter digestibility, decomposition studies).
- Phase 4: Genetic analysis based on DNA markers (RAPD's) and creation of a core collection based on the results.
- Phase 5: Individual and combined data analyses, including the use of GIS tools and multivariate statistics.

Expected results

The expected project results will refer, in part, to *F. macrophylla* only, i.e., genetic diversity described, promising accessions for future research and duplicates identified, value of African and South American materials clarified, information for future collection strategies

obtained, and accessions with higher feed and litter quality identified. However, the results from the core collection approach comparison will probably also be applicable to other species and may thus help to improve germplasm management of tropical non-grain legumes in general.

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