Article

Keeping Options Alive: A case for Averting the Extinction of Wild Cassava in South and Central America

By

Nagib M. A. Nassar

Departamento de Genetica e Morfologia
Universidade de Brasilia, Brasilia, Brazil

Since international attention began to focus on genetic resources in the early 1960's, wild crop relatives have garnered increasing notice as an additional resource for conservation and use. The author has drawn upon wild species of cassava –an important food crop for more than 800 million people in the tropics and subtropics –for many useful traits, including some conferring high protein content (Nassar and Dorea 1982) tolerance to drought (Nassar 1991,1996), and apomixis (Nassar 1995; Nassar et al. 1997,1998). With the help of the International Development Research Center (IDRC), Ottawa, he also established a living collection of these species at the University of Brasília.

Every year from 1978-98, wild *Manihot* species were collected, propagated, main tained at living collection, evaluated for economically significant traits, and hybridized. (Of about 35 wild species in this collection, at least 18 have thus far been found to have valuable traits; see Table1). This process both transferred useful traits and broadened the crops genetic base. Results of the project were published in a series of publications, most recently in a chapter of *Advances in Agronomy* (Nassar 1999).

Valuable Traits Being Lost in the Americas

One of the greatest causes for concern noted during the course of this work was the drastic reduction –year after year –in these species population numbers. The treat of extinction is real, and a number of wild *Manihot* species probably are now extinct. The problem is well documented (Nassar 1978a, 1978b, 1982), particularly is a study that measured the species occurrence and survival in habitats from which they were collected in previous years and demonstrated their disappearance from o number of regions of Brazil (Nassar 1978c). In 1998, the author re-visited the same habitats and documented the total absence of six species present only 20 years before: *M. oligantha* Pax (5); *M. sparcifolia* Pohl (4); *M. tomentosa* Pohl (4); *M. stipularis* Pax (5); *M. attenuatta* Muell. Arg. (4); and *M. neusana* Nassar (4). (The numbers in parentheses indicate the number of habitats visited).

The author used *M. oligantha* – which conferred high protein content – for interspecific hybridization during the 1970s. The resulting hybrid's protein percentage was at least double that of other cassava cultivars (Nassar and Dorea 1982).

M. stipularis Pax is a source tolerance to soil toxicity in the Brazilian savanna: As much as 8 ppm. Of manganese was found in the habitats in which this species was collected (Nassar 1986). This trait could be critical in the future, given rising soil toxicity levels in many parts of the world.

M. neusana Nassar (Nassar 1984) contains at least two valuable traits. It is very resistant to *Xanthomonas manihotis*, and its hybrid with cassava exhibits a notable vigor and abundant foliage, which makes it an excellent candidate for use as a forage plant. Recently, *M. neusana* (as well as *M. glaziovii* and *M. dichotoma*) has conferred apomixis genes to cassava (Nassar 1994; Nassar et al. 1998). Apomixis is one of the most important phenomena in modern agriculture. In addition to preserving heterozygosity, it has the added advantage of avoiding the pathogens that can accumulate year after year on stems used for vegetative propagation. By preserving the integrity of the genetic structure against breakdown and segregation, apomixis makes it possible to reproduce cassava via true seed. Asexual reproduction requires less time and effort than vegetative propagation and is as efficient method of establishing cassava in a new cultivation areas.

Extinction also has been documented in Mexico. Now totally extinct in its natural habitats (Nassar 1999), *Manihotoides pausiflora* Rogers & Appan is represented in world collections by only one individual, which is maintained at the experimental station in Iguala, Mexico. Since the species is dioecious (i.e. individual plants are single-sex), this lone specimen is useless from a traditional breeding point of view, due to its inability to self-fertilize and produce seed.

M. pringlei Watson is another endangered Mexicans species (Nassar 1985). Judging from the odor of freshly dug roots, these are almost free of hydrocyanic acid (HCN), a poisonous substance normally found cassava. It may be an important species in evolutionary terms, since it grows in the same region in which McNeish (1985) reported finding cassava seed in archeological digs. This species probably contributed to the gene pool of the cultivate.

A third endangered Mexican species is *M. subspicata* Rogers & Appan. It grows in a dry region (with annual precipitation of less than 200 mm. Per year), and thus is an excellent source of drought tolerance. Moreover, it forms prominent tubers, which makes it likely to hybridize easily with cassava.

More conservation, Research Desperately Needed

The drought tolerance of *M. Subspicata* and other wild relatives should not be overlooked. A center of research attempted to improvise cassava's drought resistance by selecting clones with low frequency of stomata, but the 10-year project proved that this species drought-tolerance mechanism is different from that of *Gramineae*(grasses). As the author documented in 1983 and 1990, cassava's best proof against drought may be a deep taproot that extracts water from distant subterranean levels (e.g. that of the wild *Manihot glaziovii* (Nassar)), or a short life cycle that lasts three or four months during the rainy season (such as that of *M. subspicata*).

None of the endangered species mentioned above is maintained in the world living collection. Moreover, of the recognized 98 species of wild cassava, only approximately 20 species are represented in that living collection. It is indeed regretable that the potential of these wild species is not being explored and exploited more aggressively. But the world can no longer afford to neglect opportunities to improve this crop:

These valuable genetic resources must be conserved and studied. The 800 million people who depend on cassava for food deserve as much. ¤¤¤

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Wild cassava (*Manihot spp.*) with economically Significant Traits Maintained in the University of Brasilia's Living Collection

Species	Trait	Natural Habitat
M. oligantha Pax	High protein content	Cristalina, Brazil
M. tripartita Muell. Arg.	Apomixis	Goiás state, Brazil

M. anomala Pohl	Shade tolerance	Goiás and Minas Gerais states of Brazil
M. zehntneri Ule	Abundant tubers	Goiás, Minas Gerais and Bahia states of Brazil
M. paviaefolia Pohl	Adapted to poor, sandy soil	Goiás Velho, Brazil
M. pruinosa Pohl	Adapted to limestone soil	Goiás Velho, Brazil
M. falcata Rogers & Appan	Adapted to slopes and well-drained soil	Goiás state, Brazil
M. reptans Pax	Adapted to a wide range of soils; hybridized easily with other Manihot spp.	Goiás state, Brazil
M. alutacea Rogers Appan	Adapted to rocky slopes at elevations of 1,200m	Goiás Velho, Brazil
M. pentaphila Pohl	Adapted to limestone soil	Goiás Velho, Brazil
M. cearulescens Pohl	Drought tolerance	Pernambuco, Bahia and Ceará states, Brazil
M. procumbens Muell. Arg.	Adapted to poor soil with high aluminum concentrations	Goiás state, Brazil
M. stipularis Pax	Adapted to high altitude	Goiás state and Federal District, Brazil
M. glaziovii Muell. Arg.	Drought tolerance; resistance to cassava African mosaic bigeminivirus	Pernambuco and Ceará states, Brazil
M. pseudoglaziovii Pax & Hoffmann	Drought tolerance	Pernambuco state, Brazil
M. dichotoma Ule	Apomixis	Bahia state, Brazil
M. neusana Nassar	Apomixis; resistance to cassava bacterial blight	Paraná state, Brazil
M. aesculifolia Pohl	Vigor of its hybrid with cassava	Sinaloa and Nayarit states, Mexico
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