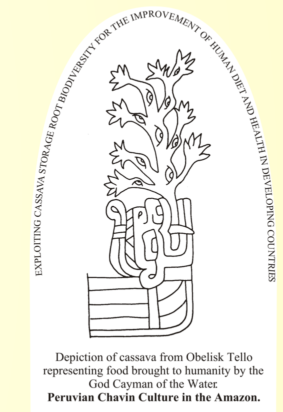
Celebrating diversity in storage root of cassava (*Manihot esculenta* Crantz)[1].



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ABSTRACT

Cassava (*Manihot esculenta* Crantz) belongs to the Euphorbiaceae plant family and is the only cultivated species of the genus. Eighty, out of 98 species of the genus, occurs in Brazil with distribution from the high lands of the central plateau of Brazil down to low lands in Amazon Basis and Northeast cost. This pool of genes from the diversity of the genus and the cultivated species is under intense studies in our laboratory to gain knowledge in the storage root potential for improving storage root quality associated to human health. Herbarium database, field trip expedition, DNA molecular markers technology, organization of a GENEBANK of clones, functional genomics technology, and development of new commercial products from the diversity has been carried out in the past six years. In the present document we are reporting the compiled information generated to illustrate our concept working-model to improve cassava. Results, so far, indicate that: 1. The Central plateau of Brazil presents the largest diversity in terms of number of species of the genus. 2. The low lands of Brazil, mainly Amazon Basis, present the largest diversity within the cultivated species. 3. The largest diversity within the cultivated species occurs in Amazon and Northeast of Brazil. 4. Unusual storage root traits have been identified in traditional clones. 5. Natural mutations have been described for the first time in cassava storage root. 6. Processing technologies have been approached to add value to the new cassava clones. In addition solid collaboration among Brazilian and USA institutions have created. 7. Functional genomics has been

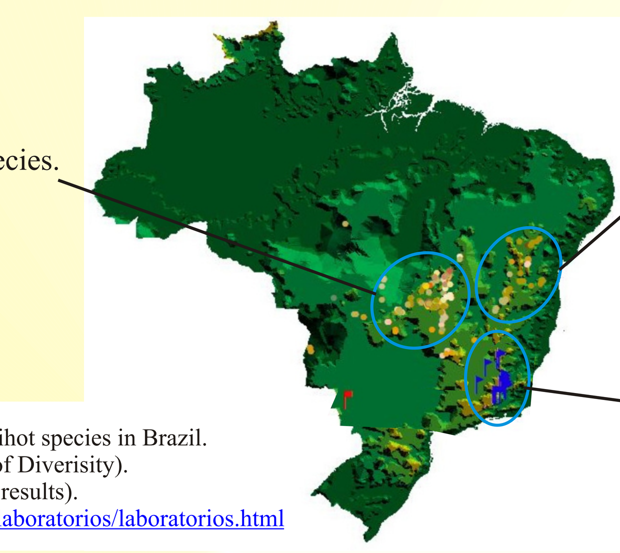
INTRODUCTION

The biggest challenge in modern agriculture is to improve food supply in terms of quantity and quality for the 828 million people that leave under the limit of poverty in the tropical world, and its aggravation by the growth rate projection for the next 50 years. Modern biotechnologies have the highest technology innovation capacity to do this job, because all the improvement it allows to be made is incorporated directly into the plant, avoiding high-energy agriculture input and environmental management and manipulation. However, there are two antagonistic situation related to this claim. One is that biotechnology is a very expensive technology, and a high technical experimental demand research activity to do all by itself. This fact intimidates pour country government to make public investment in the agriculture experimentation needed to apply this technology. Therefore, this research investment has to be done by someone else or properly financed to a particular tropical country with appropriate build or building capacity to apply this technology. Here comes the antagonistic point in terms of economics. Since the public sector is restraining from invest, the private companies are indirectly asked to take over. Obviously, the consequence of this trend does not favor the claim for biotechnology being the most useful technology to the poor farm in the tropics, simply because the poor farmer has no money to buy this technology from private companies. On the top of that is that the companies are committed to make improvement in the five major crops (wheat, corn, soybean, cotton and potato), while poor farmers are traditionally using different crops in their environment. It means that for them to get benefit from biotechnology, they have to replace their own traditional crops to adopt high biotechnologically improved crops. But we still have an alternative to benefice small farm in the tropics with biotechnology by exploring natural variation in their local promise crops. Besides this circumstantial advantage, this kind of exploration would allow one to add information to basic plant biology in a completely new perspective as well as to understand the genetic basis of plant biology in its full range from nature to manipulated trait. With this mindset, comes the question where to start? Here comes our novel approach to this problem. Six years ago we took the crop cassava as an example from the tropics to apply molecular biology and molecular genetics as well as plant physiology and biochemistry in a context of crop domestication to improve food quality. We first, looked for the phylogeography and taxonomy of *Manihot* to clarify the questionable species relationship including the cultivated species. Second, we looked to recognize the origin of the cultivated species, their ancestor, and its center of domestication. Finally we returned to this center of origin and domestication to look for diversity in the cultivated species, specifically in relation to traits most close to domestication that was storage root.

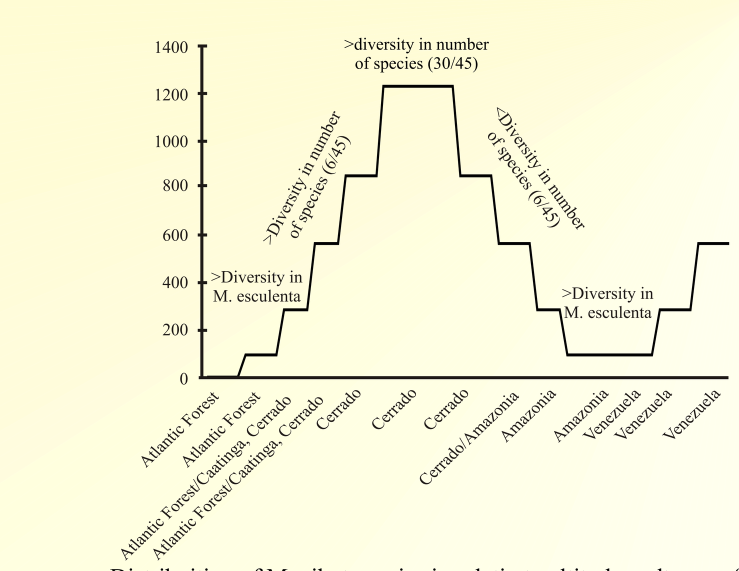
This document shows the use of concepts on biodiversity and biotechnology to add value to cassava crop and beneficiate the small farmers. Values from the domestication events affecting flowering setting habit in the modern cultivars with strong effect on conventional breeding to scientific knowledge by isolating natural mutations in storage root and novel food products are brought together to **CELEBRATE DIVERSITY** in the storage root. Potential diversify to efficient application of functional genomics in isolating new gene directly from the diversity is shown. Potential to diversify the utilization of cassava traditional products derived from carbohydrate, high carotenoid clones associated with high protein content in the storage root are also showed. Finally, potential commercial values are added to products already processed in local rural communities are initialized to help small farm in Amazon. An accompany VHS video press document complementing with the social cultural value of this celebration of the diversity of cassava storage root is also showed.

PRESENTATION

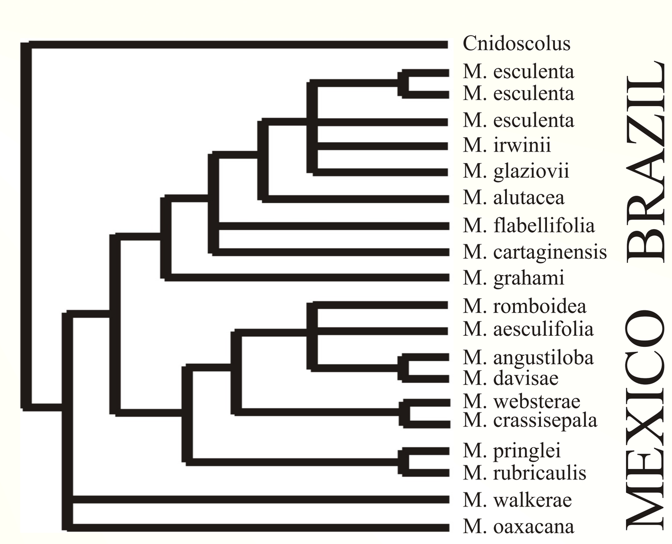
Manihot species diversity and phylogeny: Three major centers of species diversities are recognized in Brazil being the Central Plateau for the larger number of Manihot species together with northeast and southeast as well as the Amazon as the center of diversity of the cultivated species and its ancestor. Preliminary phylogeny reconstruction of *Manihot* species points out to Brazil with the largest number of *Manihot* species closely related to the cultivated species.



Geographical Distribution of Manihot species in Brazil. (The Three Major center of Diversity). (LJCBC, unpublised results). Source: http://www.cenargen.embrapa.br/laboratorios/laboratorios.html

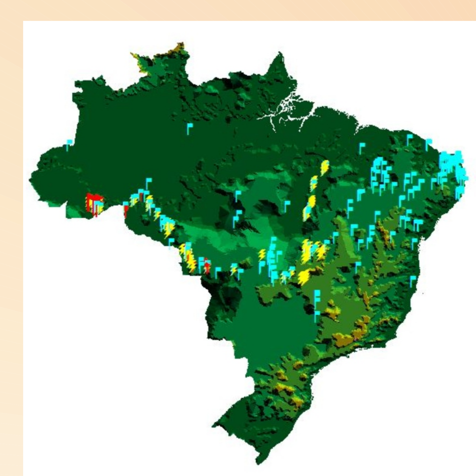


Distribution of Manihot species in relatin to altitude andtypes of vegetation in Brazil (LJCBC, unpublished results). Source: http://www.cenargen.embrapa.br/laboratorios/laboratorios.html

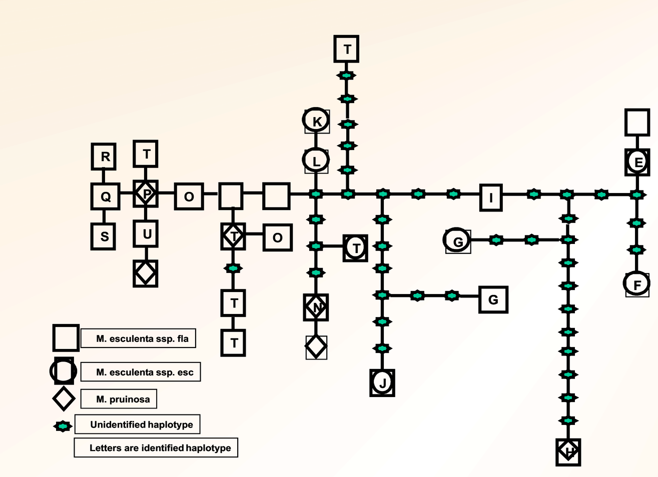


Phylogeny reconstruction of Manihot based on ribosomal DNA sequence (Schaal & Carvalho, 1996)

Manihot esculenta domestication center and diversity: Geographical distribution of cassava and its ancestor shows that the southern border of Amazon region has the largest diversity within *M. esculenta* species, and probable one of the center of domestication of this species. It also indicates that a more exhaustive collecting expedition is urgent needed deep in the Amazon River valley to explore the diversity of cassava. The three most important domestication changes in the cassava ancestor to modern commercial cassava was observed as growth habit of ancestor,



Geographical Distribution of *Manihot esculenta* in Brazil. (LJCBC, unpublised results). Source: http://www.cenargen.embrapa.br/recgen/curadoria/curadoria.html



Gene tree for G3pdh with M. esculenta and M. pruinosa.

Growth habit changes due to domestication

Climbing cassava wihtout storage root

Regrowth after forest remove

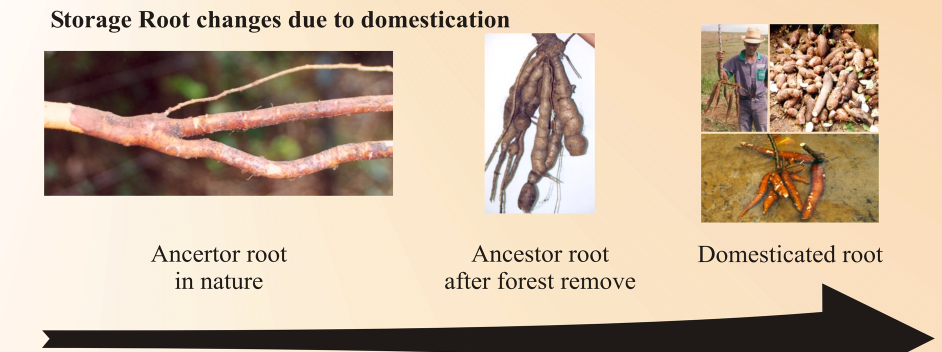
Upright growth

Flowering setting changes due to domestication

Cassava ancestor

Domesticated cassava

Storage Root changes due to domestication



Ancertor root in nature

Ancestor root after forest remove

Domesticated root

Innovating technology with biodiversity (sugary cassava): Glucose syrup and glycogen from the sugary cassava, discovered in Amazon as well as documentation of traditional beer processed in rural community in Amazon. Both, glucose and glycogen are natural products extracted directly from the sugary cassava storage root.

Glucose syrup processing from sugary cassava

Roots

Wash and peeling

Mill grinde

Glycogen from sugary cassava

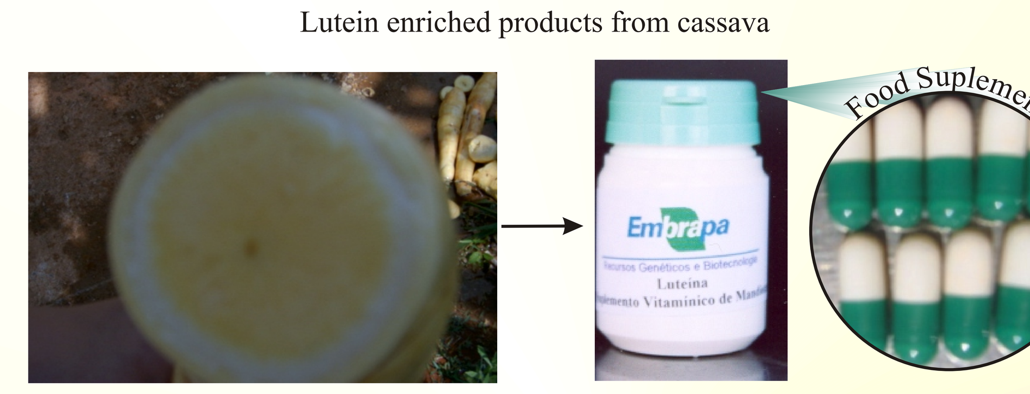
Indian traditional cassava beer

Centrifugation

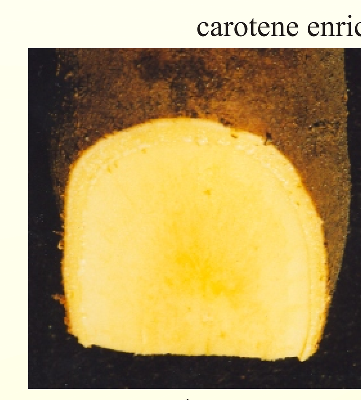
Natural glucose

Innovating technology with biodiversity (pigmented cassava): Three products of commercial values from pigmented cassava were developed. Two of them corroborate for direct use by small farmer community, being the Pickles and the TUCUPI powder. A third one directed to high technology demand market.

Lutein enriched products from cassava



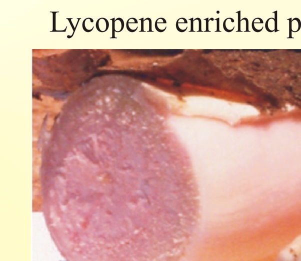
carotene enriched product from cassava

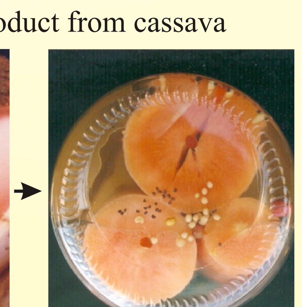


Pickles

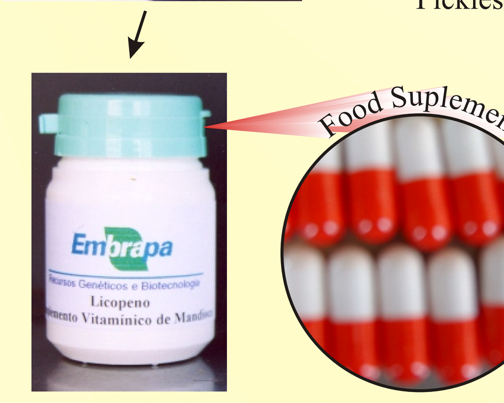
Tucupi Powder

Lycopene enriched product from cassava





Pickles



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LITERATURE

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Cassava geographical distribution source: http://www.cenargen.embrapa.br/recgen/curadoria/mapa-bags.html
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