Agrociencia Uruguay 2022 | Volume 26 | Number NE2 | Article 1119
DOI: 10.31285/AGRO.26.1119
ISSN 2730-5066

25 years in 25 articles

Latin America and its plant genetic richness: conservation, domestication and productive systems a policy-tecnical challenge

América Latina y su riqueza fitogenética: conservación, domesticación y sistemas productivos: un desafío técnico-político

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Article originally published in:

Agrociencia (Uruguay). 2005;9(1-2):19-28.
doi: 10.31285/AGRO.09.1116

Abstract

Latin America's plant genetic richness and its contribution to world diet are presented. Some acute problems of the modern world are described, namely genetic erosion and controversies on the appropriation of plant genetic resources. A diagram is proposed for the management of plant genetic resources, from collection to productive use. The current situation with respect to the phases of this process is analysed for Latin America, with emphasis in southern countries; this analysis indicates that the collection effort is disproportionately large in relation to the final products obtained (domestication and productive use of native species). The domestication of particular species is discussed, focus being made on the historic case of yerba mate (Ilex paraguayensis). The plant genetic resources of Uruguay are discussed in detail; it is pointed out that, in spite of species identification having been completed several decades ago, cases of domestication of new species are scarce. Reflexions and proposals are made towards the integration and speeding up of different phases of the process leading to plant genetic resources utilization. These proposals should be oriented by long-term regional goals, and be applicable to specific sustainable production systems. Emphasis is placed on the need for cultural change among political and technical decision-makers, leading to a reappraisal of priorities, and to the establishment of appropriate strategies; to be successful, these strategies need gather strong support both from the governmental sector and from farmers and local communities. It is concluded that bringing about change towards the successful use of Latin American plant genetic resources constitutes a major challenge to our political-technical creativity.

Keywords: appropriation, erosion, strategies, regional, sustainable

Resumen

Se presenta la riqueza fitogenética de América Latina y su aporte a la dieta mundial. Se describen algunos problemas agudos en el mundo moderno: erosión genética y controversias con respecto a la apropiación de los recursos fitogenéticos. Se establece un esquema con fases del proceso de manejo de los recursos fitogenéticos, desde la recolección al uso productivo. Se analizan para América Latina, con mayor énfasis para los países del Cono Sur, debilidades en diferentes fases y se concluye que el esfuerzo de recolección excede al producto final en términos de domesticación y uso productivo de especies nativas. Se hace referencia a la domesticación de especies y se ejemplifica con un caso histórico: el de la yerba mate (*Ilex paraguayensis*). Se analizan con detalle los recursos fitogenéticos de Uruguay, cuya identificación proviene de hace muchas décadas, lo cual contrasta con el escaso número de nuevas especies domesticadas. Se presentan reflexiones y propuestas para integrar y dinamizar las fases del mencionado proceso, a partir de objetivos regionales de largo plazo, orientados a servir sistemas productivos específicos y sostenibles. Se enfatiza en la necesidad de un verdadero cambio cultural, a nivel de decisores políticos y técnicos, que conduzca a repensar prioridades y a

establecer estrategias adecuadas, con firme apoyo de las instituciones públicas y la participación dinámica de productores y comunidades locales. Todo lo cual constituye un potente desafío a nuestra creatividad técnico-política.

Palabras clave: apropiación, erosión, estrategias, regionales, sostenibles

A SURPRISING WEALTH

Although the gold rush dominated Columbus, he had already transported sweet potatoes, and corn and bean seeds, on his return from his first voyage to feed the crew on the long journey. On the next voyage to the New World, he brought wheat, barley, rye, oats, olive trees, onions and citrus, and brought corn, potato, squash, sweet potato, cassava, beans, peanuts, peppers and cacao to Europe.

The first "civilizational" globalization is then imposed, which leads to a true "dietary revolution" (Harlan, 1975), which promoted a tremendous increase in the European population from 1750, especially on a potato-based diet. That explains the Irish famine a century later, by a massive attack of *Phitophtora infestans*. Apart from that, Portuguese sailors changed Africa's diet, supplying corn, cassava, peanuts and cashew, and using Cape Verde (where fleets resupplied themselves) as a place where the new introductions could be tested, before distribution in the continent (Portugal, 1988).

The subsequent exchange between colonial possessions brought bananas and sugar cane from Southeast Asia to America and Africa; coffee from Ethiopia to the Caribbean, South and Central America and Africa. This exchange included the picturesque seedling theft of *Hevea brasiliensis*, by Henry Wikham, circumventing Brazil's control. That was the basis of the flourishing English rubber industry in Malaysia (Galeano, 1971).

It was from this diversity that Vavilov established his centers of plant origins, grown in the New World: South Central Mexico and Central America; South American Center of Peru, Ecuador and Bolivia; Chiloé Center in Chile; Brazilian-Paraguayan Center.

Several authors later relativized this concept, but maintaining the validity of the regions of diversity: "... basically what Vavilov did was to draw the lines in which agriculture had been practiced for a very long time and in which indigenous civilizations emerged. The geography of crop variation depends on the geography of man's history." (Harlan, 1975). Practically all these centers of diversity are located in the intertropical strip, of L35º N to L35º S; the rest seem to have suffered the impact of the last glaciation's grinding and extreme cold (Querol, 1988).

Table 1 shows the food production of the eight species that top the world statistics. As it can be noticed, there are four Latin American species among these eight ones.

Table 1. World production in thousands of tons of food species.

Cultivar	1989/91	2002	increase or decrease %
Corn	484859	602589	+ 24.3
Rice	516937	576280	+ 11.5
Wheat	559116	572879	+ 2.5
Potato	266153	307440	+ 15.5
Cassava	155276	184853	+ 19.0
Soybean	106340	177917	+ 69.2
Sweet Potato	123872	136130	+ 9.9
Barley	170565	132216	- 22.5

(Source: FAO, 2002).

Soybean's explosive increase, sometimes covering soils of dubious agricultural vocation and displacing traditional productions destined for local consumption, could be said to be leading a second "green revolution", with a "*cash crop*" predominance, based on a well-adjusted technical package, which includes GMOs and good prices, for the time being.

Crops originating in Latin America contribute 35% to world food production, a higher percentage than those of the rest of the regions (Kloppenburg and

Kleinman, 1987). It is remarkable to note that 56.3% of Africa's food basis corresponds to Latin American species. The study, which compares the reciprocal contribution of ten different regions of the world (according to the location of the centers where these crops come from) shows that, in contrast, North America and Australia have zero contribution and the Eurosiberian region only 2.9%

Dependence in terms of phytogenetic resources is therefore maximum in these last regions, which is why currently, some countries are considered as poor in genes and rich in technology and ours, as rich in genes and poor in technology. In fact, tensions and controversies surrounding phytogenetic resources reflect the agricultural face of a global development model. It operates through financial systems and market control, subsidy and price management, as well as technological package integration, in the hands of a few multinationals for the production of large extensions of monocultures. As previously mentioned, it is part of an exhausted development style that “has proven to be ecologically predatory, socially perverse and politically unjust” (Guimaraes, 1992).

THE PRESENT WORLD: GENETIC EROSION AND OLIGOPOLISTIC CONCENTRATION

Genetic erosion is the dramatic denomination of genetic diversity loss at all levels (ecological, inter and intraspecific), and it is a complex process that simultaneously operates on several fronts.

Civilization processes have led to extensive loss of natural areas due to population increase, increasing urbanization, extensions of mechanized agriculture, forests logging, drying of wetlands, soil erosion due to mismanagement and overgrazing, soil and water contamination, and introduction of invasive alien species.

In addition, modern agriculture entailed food dependence on a few 'elite' species, of universal diffusion and of high cultivation and high yield per area. It is striking to recall that, from 300,000 species of higher plants, around 5,000 of them have been studied in detail, 3,000 humanly exploited at one time or another and 100 have been subject to selection. However, today, the four species that lead the FAO statistics - maize, rice, wheat and potato - feed more people than the rest of the species cultivated worldwide.

At the same time, modern agriculture has meant the use of fewer cultivars within each species, appropriate for high-input systems, and the consequent loss of local or native varieties adapted to specific regional conditions. On the other hand, these modern cultivars generally have a less diverse genetic basis, whether they are a few pure lines of an autogamous species such as wheat, or a limited number of inbred lines to obtain maize hybrids with high combinatorial ability.

This also results from: “The growing competition among seed companies promotes less innovation through original crosses than by adding one or more characteristics to a well-polished and well-defined variety.” (Nouaille, 1991).

I think we should add a "hypermodern" erosion type that occurs *ex-situ*, in the gene banks, whether due to technical defects, lack of resources, effort discontinuity or incompetence; which happens much more frequently than what is generally recognized and thought.

Finally, this globalized world, at least in its sorrows, presents us with exclusionary societies, with the permanent migration of thousands of small producers, from rural areas to the cities. Alongside them, their traditional varieties and knowledge are lost, which form an indissoluble association of genetic wealth. Macroeconomic equations expel them to the cities, where they thicken the misery and marginalization belts. How much does this process of social and cultural degradation, associated with genetic erosion, cost our countries?

The other major modern change is the growing economic importance of the genetic improvement of plants, and the "race towards it" of large complexes of pharmaceutical and petrochemical companies, along with their merger and concentration in a few firms, constituting a powerful oligopoly (Estramil, 1987; Evenson and others; 1998). This is not the central topic of this discussion, but it is part of the indispensable framework to address any strategy on phytogenetic resources. There is a strong controversy regarding the appropriation of such resources, with a succession of institutional milestones, clashes and agreements whose ambiguity casts doubt on their applicability and usefulness. In any case, it must be said that based on the claim that what is "mine is mine" and what is "yours is mine", on which countries rich in capital and technology -but poor in genes- have operated, a rational and fair agreement is not possible.

FROM HARVEST TO PRODUCTIVE USE

We can order the process of phytogenetic resources management in different phases, which correspond to two main events, as presented in the following diagram:

I) Availability and basic scientific knowledge

1- Prospecting and collection.

2- Conservation: ex-situ; in situ.

3- Characterization, preliminary evaluation, documentation.

4- Basic research: genetics, cytogenetics, phytochemistry, others.

II) Productive use

5- Domestication: agronomic evaluation, improvement, basic seed production.

6- Marketing, promotion and distribution of new cultivars.

The scheme does not mean that these phases occur or should always occur, or that they are independent of each other in every case; nor does it mean that the succession is necessarily the one presented here. In different cases, overlaps, simultaneities, changes in order, absence or only partial development of some phases and hypertrophy of others may be indicated, therefore other models for different situations could arise. Bearing this in mind, the one presented here tries to express an average situation that allows pointing out weaknesses and strengths and also eventual blockages in the phytogenetic resources management.

I will refer to Latin America in a very general way according to the incomplete data available to me, more abundant for the enlarged MERCOSUR (Southern Common Market) and more scarce compared to regions of great importance such as Mexico and Central America, northern South America and the Caribbean.

The overlook regarding the "elite" species has differential characteristics, since, in the collection, conservation *ex-situ* and subsequent management, the CGIAR centers (Consultative Group on International Agricultural Research) and first-world countries have a strong presence. it is enough to point out that, if we take the seven Latin American food species with the highest number of samples in germplasm banks in only one, corn, the highest percentage of samples (12%) is found in a regional national bank in Mexico. In the rest, the largest collections are located as follows: *Phaseolus* (15%) at the International Center for Tropical Agriculture (ICTA); peanuts (27%) and tomatoes (30%) in the United States; sweet potatoes (20%) and potatoes (20%) at the International Potato Center (IPC); cassava (21%) at ICTA. As a curious fact – historic success of Mr. Henry Wikham – I will point out that the highest proportion of rubber accessions is in Malaysia (76%) and not in Brazil (6%). In contrast, Brazil has the largest collection of sugar cane (26%), originating in Southeast Asia (FAO, 1996). Before the conquest, American man cultivated about 300 species for his food, many of which were displaced, either by substitution or marginalization, by introduced species suitable for extensive mechanized cultivation and demanded by an increasingly globalized market.

Among those pre-Hispanic species, the so-called pseudocereals stand out, such as quinoa (*Chenopodium quinoa*), which seconded maize as a basic grain in Andean areas, and huautli or amaranth (*Amaranthus cruentus*; *A. hipocondriacus*), essential food for the Aztec civilization, which was persecuted and prohibited by the conqueror for its supposed heretical character (Annex 1). Both quinoa and amaranth have a high nutritional value due to the quality and percentage of their proteins (FAO, 1992). Andean tubers such as the oca (*Oxalis tuberosa*), the isaño or mashwa (*Tropaeolum tuberosum*) and the ulluku or papalisa (*Ullucu tuberosum*) (Montaldo, 1977) may also be mentioned. Important species for the Amazon and Orinoquia indigenous communities are worth mentioning, such as the copoazú (*Theobroma grandiflorum*), the pejibaye (*Bactris gassipaes*) and the seje (*Jessenia batava*) (Segovia and others, 2004).

Several of these species maintain their regional importance, particularly in the very large areas of our America where family and community farming predominates, and certainly have great potential. In this way, some of them have been extensively collected (Astorga and others, 2004) and there are collections in national gene banks and conservation *in situ* in some genetic reserves. Direct participation of farmers and local people in harvesting experiences, and even more so in conservation *in situ*, initiated particular interest in some countries such as Peru, Brazil and Colombia (CIPRF, 1995). The proposal to create a network of micro-centers of conservation in areas of family farming of great diversity in Bolivia, to keep producing under a sustainable model, should also be considered very valuable (Gabriel and others, 1999). However, the largest percentage of collection, conservation and improvement efforts in our Latin American region has been directed to "elite" species, either introduced or native to the region.

An examination of a general overview that covers the Latin American species set, shows a tremendous collection effort – 835,000 accessions – (Astorga and others, 2004); frequent gene bank losses and significant weaknesses in the monitoring and regeneration of collections, with percentages ranging from 60 to 90% delay, with few exceptions such as Mexico (FAO, 1996; CIPRF, 1995), failure in the characterization and dispersion of existing information (PROCISUR, 1995), almost no *in situ* conservation development, with some exceptions such as Brazil (CIPRF, 1995) and shortcomings in establishing priorities, since the preferences of potential customers and consumers are not taken into account (Clement and others, 2004).

All of which leads to a low use percentage of the collected germplasm.

To sum up, the broad base of genetic material, the product of a tremendous collection effort, narrows throughout the process and it is not reflected in subsequent domestication dynamic and varied and innovative productive use. There is a lack of resources to improve each phase, which seems obvious, first of all, awareness of the issue that encompasses political decision-makers, is necessary and a mentality change is also required at many technical levels.

Defending our phytogenetic resources means integrating efforts into efficient National Systems in each country and strengthening existing regional networks; effectively legislating and controlling the indiscriminate harvesting and emigration of valuable native species; establishing real areas, not only on paper, of conservation *in situ*, either as genetic reserves or farm conservation under agreements with producers and communities, associating sustainable production with conservation of native species and local varieties. Above all, it requires rethinking our priorities, to define them at the service of sustainable and specific production systems. In my opinion, this means combining different strategies with flexibility and practicality, which I will return to at the end of this paper.

DOMESTICATION: A LONG ANONYMOUS AND DISTANT STORY

We do not know who, how and when domestication of the main crops began, but we do know the geographical limits where the gradual passage process of the species from the wild state to the crop took place. We also know that the main crops that feed and clothe us were already domesticated by primitive people who, even without being aware of it, by the single act of harvesting and sowing, began a selection and transformation process of these wild species (Harlan, 1966).

We do not know either, how domestication processes for Latin America took place, except when historical data from colonial America are obtained, as in the yerba mate's case (*Ilex paraguayensis*). Traditionally used by the Guarani, Jesuit missions disseminated it and turned it into a product of significant regional commercial value.

The "yerba minerals", as it was known in Spanish legislation for its extractive production character, was harvested in native forests and processed *in situ*, at the cost of great effort and struggle (Whigham, 1991) (Annex 2). The mining character also used to correspond to the social reality of the indigenous yerbatero, given that: "...the landowner advanced these provisions to the yerbateros, who entered the forests already indebted because the landowner had charged them double for everything: ponchos, tobacco, liquor, cards and axes" (Robertson & Robertson, 1838-1839; cited by Whigham, 1991). It was from these conditions that the Jesuits began transplanting the yerba mate from the forests, to form *Ilex paraguayensis* gardens next to each mission, using thousands of Guaranis as labor. We can assume that this process began around 1710, with the definitive settlement of the thirty villages that made up these missions of the Society of Jesus and lasted until the expulsion of the Jesuits, which took place in 1768. (Campal, 1994.). The distinguished botanist Bompland, who was confined in the Paraguay of France simultaneously with Artigas's exile, pointed out: "...when the Jesuits determined to plant a mate forest in each of the villages that make up the Missions...they filled three important indications. The first was to obtain yerba preferable for its quality...; the second was to simplify its manufacture...; the third, finally, was to ensure a fixed annual income". Additionally, the transformation from a merely extractive activity to systematic exploitation based on horticultural crops of the species made it possible to produce and elaborate yerba at: "...lower cost and higher quality, due to its color, aroma, flavor and yield in the mate called "caá – miní " (branch-free and foreign body-free yerba, finely ground), whose price doubled and even tripled that of the "caá -invirá ", which also meant a great economy by the concept of leather containers, being this product also of great commercial value." (Campal, 1994).

It is worth reflecting on this domestication carried out almost three centuries ago in our continent. We must assume that, under those conditions, the process of choosing, extracting, transporting and transplanting yerba mate specimens, which then encompassed harvesting, drying, scarifying and germinating seeds, involved a complicated set of trial and error experiences. This species domestication, with its quality improvement and the reduction of risks and sacrifices, was guided by a pragmatic and commercial sense, with certainty through the empirical knowledge and guidance of the natives themselves who executed the task, supported by a fine observation capacity.

I hypothesize that, to date, our specialized scientific capacity has greatly exceeded our pragmatism and that we have serious difficulties in combining science with practical spirit in appropriate doses, within the framework of a holistic vision of the problems. As I will try to show later, that was not lacking in our great pioneering scientists. Perhaps we need more and better interdisciplinary interaction and the participation of specialists "in general ideas".

URUGUAY AND ITS NATIVE PHYTOGENETIC RESOURCES

I have more information and I feel more entitled to carry out a detailed analysis of the situation in my country. First, which resources: "In our country, an important group of species of forage interest (grasses and legumes) and species of interest such as medicinal, aromatic, timber, fruit, honey, ornamental and dye species are recognized as native phytogenetic resources" (Working Group, 1998).

As an example, I will present the situation in ornamental, medicinal and forage. Among the ornamental ones, seven or eight species of petunias have been pointed out, from which all the hybrid petunias cultivated in England, Continental Europe and Japan come. About fourteen species of *Glandularia* (verbenas) from which hybrid verbenas spread all over the world derive and, in addition, the ornamental destination of almost all the native cacti, introduced in the United States, Europe and Japan (Marchesi, 1969).

A very wide range of species for domestic medicinal use has been described in their taxonomy and popular use. (González and others,s\f; Lombardo, 1968-1980). Some of them have greater local demand, such as: marcela (*Achyrocline saturaoides*); congorosa (*Maytenus ilicifolia*); giant horsetail (*Equisetum giganteum*); llantén (*Plantago tomentosa*, *P.myosurus*); carqueja (*Baccharis articulata*, *B.trimera*); yerba carnicera (*Coniza bonariensis*); pezuña de vaca (Bauhinia candicans); mburucuyá (*Passiflora coerulea*) and chamomile (*Matricaria chamonilla*) (Aguilera, 2005, pers. comm.). Some native aromatic species of interest are lemon beebrush (*Aloysia gratissima*) and peppercorn tree (*Schinus molle*). Several of these species are widely harvested and removed from the country, without any kind of control.

Natural grasslands, the main ecosystem of the country, covers almost 90% of its surface and their dominant component, native grasses, constitute the most valuable phytogenetic resource in Uruguay.

Among these native grasses, some of the following species have been highlighted: *Paspalum*, *Bromus*, *Coelorhachis*, *Poa*, *Axonopus*, *Eustachys*, *Setaria*, *Botriochloa*, *Calamagrostis*, *Ischaemum* and *Stipa* (Condón and others,1999). For decades, the Agronomy College has been collecting and conserving these native forage species and native varieties of horticultural species, despite having lapses of discontinuity in the conservation effort. On the other hand, the majority of highly cultivated species, such as forage, medicinal and aromatic ones, are conserved by INIA, in the Genetic Resources Unit created in 1993. Base collections of seed reproduction species are kept in La Estanzuela, and Las Brujas has *in vitro* collections.

Numerous papers, either published or forming part of theses and technical reports, support a detailed knowledge of taxonomy, genetics, cytogenetics, and of chemical and even medicinal properties of many native species. Commercial cosmetic and medicinal products have been obtained from some of them in the country.

Contributions of the Agronomy College to the taxonomy of native grasses and legumes for at least 70 years and the most recent research concerning genetics and cytogenetics in particular of the genera *Paspalum* and *Bromus*, are noteworthy in the set of scientific studies on native species. Work carried out by the Chemistry College is also very significant, particularly, in the identification of essential oils, polysaccharides, dyes, flavonoids and alkaloids, which covers a set of more than fifty native species (Moyna, 2005, pers. comm.); to which the research carried out by the Institute of Biological Research Clemente Estable, must be added.

As far as forage production is concerned, in 1970 it was already pointed out that: "It is shocking that in other countries *Paspalum dilatatum*, *P.notatum*, *P.urvillei*, *Axonopus compressus*, *Bromus* *unioloides*, *Cortaderia selloana* and other Uruguayan forage species are cultivated, whereas these are not cultivated here. It feels deeply shocking when we receive orders of native seeds from different African regions, Australia and the USA, etc."... "each species or taxonomic variety comprises very different strains in acceptance, productivity and other economic characteristics, and cultivars can be obtained without going through complex and expensive laboratory methods." (Rosengurtt and others, 1970). These reflections are more convincing and significant when they come from a researcher of widely recognized international value, who together with their pioneering observations on the natural field behavior and its components, publishes the nomination of several new species, described in rigorous Latin.

The same author had studied and presented, many years before, the behavior of hundreds of native grasses and legumes, in the field and cultivation plots. (Rosengurtt and others, 1946). Of the first, more than thirty species were awarded the double condition of productive and desired, pointing out at the same time the most evident limitations regarding the low production of seeds and the weak development in the first year.

However, to date, of all this set of valuable native species, including ornamental, medicinal and forage, we have domesticated only one, the*Bromus auleticus*, of which three cultivars were launched (Millot, 2001).

I believe that this observation should be the focus of serious reflection and a reorientation of many scientific and technical efforts. As an example, the excellent Final Report on phytogenetic resources reads: “In the particular case of natives, basic studies (taxonomic, genetic, reproductive, etc.) are primarily required before starting improvement programs.” (National Committee on Phytogenetic Resources, 2003). At first reading, the statement is strictly logical, however, it can exert a crippling operational effect. In general, these studies are carried out by researchers unrelated to the production systems and end up becoming an end in themselves or being abandoned due to lack of project continuity. In my opinion, a dynamic articulation between the design of productive systems and basic research must be generated from the beginning, so that both processes grow simultaneously, in such a way that the first interrogates and demands the second.

SOME FINAL REFLECTIONS

“The decision to be reached on a country's genetic resource conservation is not purely technical or economic. It is fundamentally political" (Valls, 1987). This statement applies to the entire management process of phytogenetic resources, from harvesting to productive use. As mentioned before, productive systems should be the engine that guides and accelerates the entire process, through specific demands formulated to solve specific problems or to design new options. To rethink priorities and reorient productive systems, it is necessary to define and implement a set of strategies, within the framework of integrated rural development, with a regional Latin American and long-term perspective.

These strategies would cover, at least, the following aspects:

- Diversify production by establishing, together with export agriculture, new production systems with intelligent use of native genetic wealth and rescuing, where appropriate, traditional practices.
- Support and stimulate small-scale production, associated with food security and genetic conservation.
- Integrate conservation with production because: “Diversity can only be preserved as long as it is part of the production logic, otherwise both will be condemned, diversity first and production later.” (Gómez,1997).
- Devote thought, research, efforts and direct stimuli to the construction of the path that has been called "the transition to sustainable development", which means in the first place: "The development, rescue or mixing of technologies that maintain or improve the diversity of production options." (Morello, 1993).
- Articulate, in rural areas, agriculture with a set of services and productive activities, from ecotourism to local industries, which present positive synergies for regional development.
- Directly linked to the above, recompose the land use planning and restore the balance, in terms of population and development, between urban environment- rural environment or capital –countryside.
- Involve, throughout the process, local communities and producers trained and stimulated for a strong dynamics of participation.

- Commit the indispensable and firm support of public institutions and the presence of their technical agents in the field, where the events occur.

- Develop committed research to solve the accumulation of problems arising from very complex processes; associated interdisciplinary science and practice, which requires creativity, scientific level, fieldwork and a holistic perspective of the problems.

- Finally, all this requires both a vertical integration of scientific activities, as well as horizontal integration of academic and technical activities with the productive sector, and institutional consolidation of these efforts, in each country, in National Phytogenetic Resource Systems and at the regional level through reciprocal cooperation, strengthening the existing networks.

Undoubtedly, the proper conservation, domestication and subsequent productive use of our phytogenetic wealth demand more resources. But even before that, as already expressed in another area, cultural change is required: "To begin the construction of new utopias, oriented towards more equitable and democratic societies, within the paradigm of sustainable and socially inclusive development, we need a kind of *switch*, a cultural change that illuminates other values and returns confidence in ourselves. A profound change, with ethical, political-social and institutional implications, from which we can recompose the economic parameters and the relationship between society and nature" (Díaz, 2004.).

As can be seen, in short, a powerful challenge to our technical-political creativity.

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ANEXO I

En efecto: "En la religión azteca, había meses señala- dos en los que se elaboraba con la harina de las semillas del huautli y con la miel de maguey una masa llamada *tzoalli* con la que se moldeaban, según la festividad mensual de que se tratara, diferentes figuras, desde pequeñas pirámides a imágenes de ciertas deidades de los montes. Estos ídolos se repartían en pedazos entre los asistentes y así eran consumidos. Este tipo de ceremonias pareció a los ojos de los colonizadores similar a la eucaristía cristiana, por lo que fue perseguido su cultivo y prohibido su consumo".(FAO, 1992.). Esto se refleja en sugerentes do- cumentos de la época: "...hacen unos ídolos de figura humana de tamaño de una cuarta de vara poco más o menos; para el día que los forman tienen preparado mucho de su vino y ya estando hechos los ídolos y cocidos los ponen en sus oratorios como si colocaran alguna imagen y poniéndole candela e incienso les ofrecen entre sus ramilletes del vino preparado para la dedicación(...) y sentados en rueda con mucho aplauso delante de sus ídolos empieza su honra y alabanza (...) y en señal de sacrificio derraman de aquel vino (...) o parte o todo delante de los idolillos del huautli y esta acción llaman Tlatotoyahua (...). Empero los dueños de los idolillos los guardan con cuidado para el día siguiente, en el cual todos juntos los de la fiesta en dicho oratorio, repartiendo los idolillos a pedazos como por reliquias se los comen todos (...). Este hecho prueba muy bien las grandísimas ansias y diligencias del demonio, en continuación de aquel su primer pecado, origen de soberbia de querer ser semejante a Dios nuestro Señor (...) pues en lo que acabo de referir se ve tan al vivo envidiado y imitado el singularísimo misterio del Santísimo Sacramento del Altar, en el cual recopilando nuestro Señor los beneficios de nuestra redención dispuso que verdaderísimamente le comiésemos y el demonio, enemigo de todo lo bueno, aliña como estos desventurados le coman, o se dejen apoderar de él comiéndole en aquellos idolillos." (Ruíz de Alarcón,1626; citado por FAO, 1992).

ANEXO II

El siguiente documento describe con dramatismo las penurias de los yerbateros: " Los montes de yerba están, Señor, más de ciento y treinta leguas de esta ciudad, por unos caminos tan difíciles como peligrosos a cada paso con los pantanos, esteros, bañados, lagunas y precipita- das montañas, que se encuentran y pasan precisamente: sin que el Obispo tenga indulto para este camino, que me fue preciso correr (para la visita de Curuguatí) a costa de indecibles trabajos, y no con pequeños costos, por la multitud de animales que se necesitan para este dilatado viaje: siendo precisa la provisión desde la sal, que no suele encontrarse en aquella villa, ni menos la carne.

Hácese el porte y trajín con mulas en esta forma. Para cada cien cargas de yerba se necesitan ciento mulas, por las que a cada paso se destruyen maltratan y fenecen, no haciendo más jornada que dos a tres leguas cada día; y por las estrechuras de caminos van en tropa de diez en diez mulas: cuidada y arriada cada partida por un peón; y si algunas se caen o se echan con la carga (que regular- mente es de catorce arrobas en dos tercios), para cuyo remedio vienen cinco peones de brío (que llaman retarguardieros) que van levantando y arreando las caídas y mudando las cargas a otras"(...) "...se demoran en aque llos desiertos por un año o más, mal alimentados con flaca carne, pagándola por muy gorda; teniendo por cama el duro suelo sin más abrigo que su poca ropa; durmiendo entre víboras y otras sabandijas ponzoñosas; y después de estas penosas incomodidades, tiene que madrugar a buscar los árboles de yerba, a veces a muchas leguas del rancho; fatigarse en cortar las ramas, formar haces y traer- los a lomo como si fuera jumento sin {contar con} los peligros de muchos tigres, que en aquellas partes hacen no pocos destrozos; y para descansar es preciso desde la primera noche comenzar la faena de secar y retostar la yer-ba con gran cuidado y prolijidad porque no se le pierdan las diarias fatigas; no pudiendo a veces trabajar por los malos temporales;" (De Torres, 1761; citado por Whigham,1991).