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Traditional Management of Agrobiodiversity in Brazil: A Case Study of Manioc

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Introduction

Manioc (*Manihot esculenta* Crantz), a plant originally from neotropical lowlands, can be considered a model for the study of the biological and cultural construction of agrobiodiversity managed by traditional communities in Brazil. Firstly, the plant is a staple in both Northern and Southern Brazil, which allows for comparisons along various ecological and sociocultural dimensions. Secondly, despite its vegetative multiplication, there is an immense diversity of manioc varieties, both at the regional and local levels, which makes possible analysis of the relations between diversity and its cultural basis. The issue we address here is a comparative study of manioc management in two traditional contexts of slash-and-burn agriculture, one in the Atlantic forest region and the other in the Amazon.

The heavy loss of diversity of crops now under way raises questions about the future of traditional agriculture (Thrupp 2000). Since the fourth technical FAO conference held in Leipzig in 1996, local *in situ* and on-farm conservation activities have been fostered in order to complement *ex situ* conservation. Nevertheless, all these activities, be they *in situ*, on-farm or *ex situ*, focused more on conservation of finalized biological objects, species or varieties grown, than on processes of local construction and perception of these objects. Agrobiodiversity, however, results from sociocultural criteria which involve norms of selection, circulation and denomination and productive characteristics. These criteria must be further explored to implement conservation and valorization models compatible with the local construction of agrobiodiversity. These aspects will be briefly discussed next.

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Methodology

Two programs, carried out independently, are responsible for the results presented here. In the Atlantic forest, the study was centered on genetic and ecological implications of space-time management of manioc varieties resulting from slash-and-burn agriculture. In the Amazon, the objective of the program was identification of local management strategies for manioc diversity in several cultural and ecological contexts also characterized by slash-and-burn agriculture centered on manioc. In both cases, despite an early difference in focus, a comparative approach was adopted *a posteriori* with the goal of identifying key elements of local diversity construction.

Study Sites

In the Atlantic Forest (Fig. 1), the study was carried out in *Caiçara* mestizo populations. Descendants of Portuguese, Amerindians and Africans, the *Caiçaras* live along the

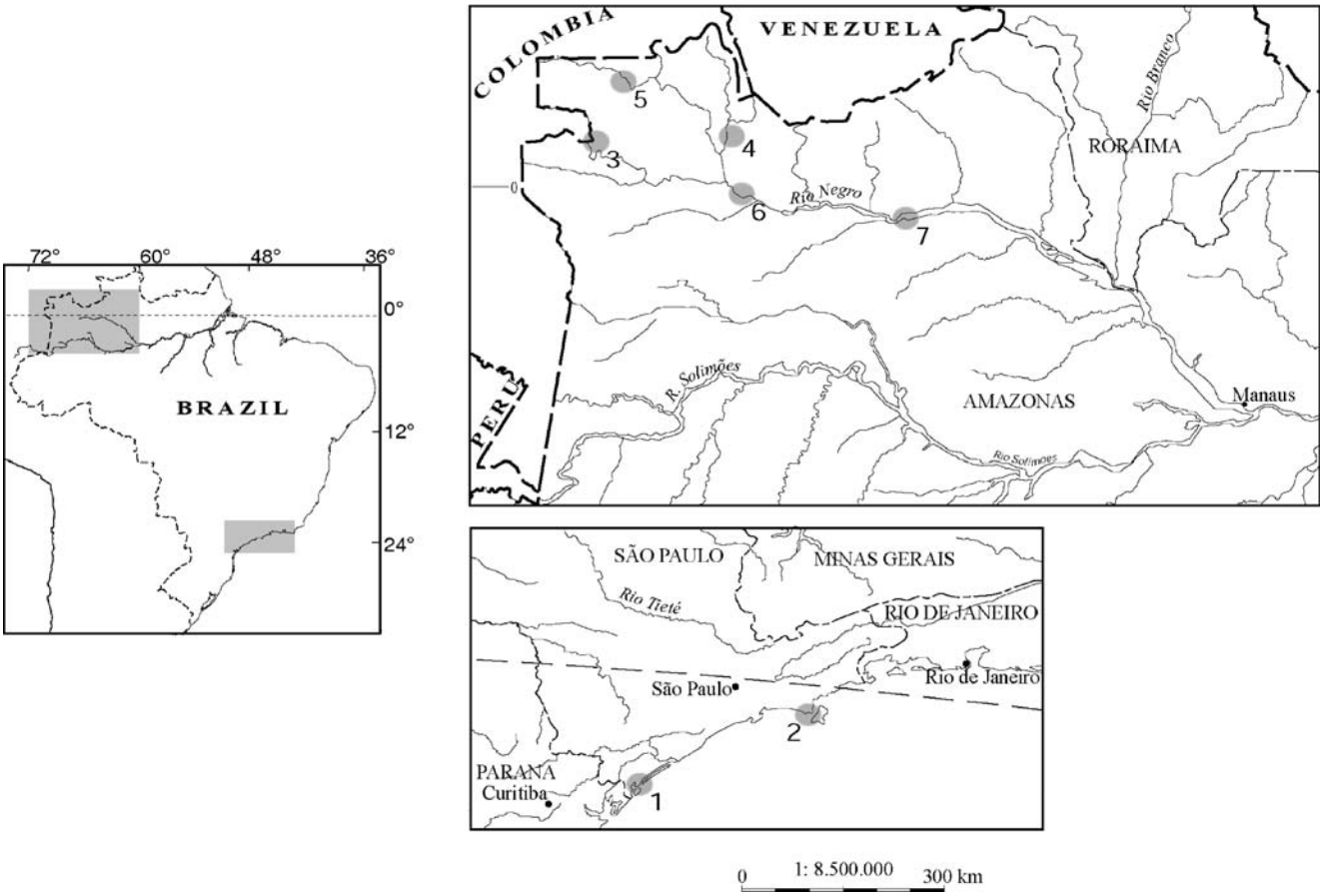

Fig. 1 Location of study areas (map source, LCA/IRD, Bondy-FR).

coastline of São Paulo state in regions where forests still stand (Mussolini 1953; Begossi 1998; Diegues 1983). Isolated for a long period of time from the rest of the country by the mountain ranges surrounding that part of the coast, they have low spatial mobility and are concentrated mostly in communities. Their knowledge and their production system are largely based on local indigenous knowledge. Slash-and-burn agriculture was the main farming activity until the first half of the twentieth century (Schmidt 1958; Dean 1995; Peroni and Hanazaki 2002), although there are currently several configurations. Monetary income in the southern part of the state is generated mainly from fishing and tourism, with farming activities being limited mostly to subsistence. Current agricultural systems are based on bitter or sweet[1] manioc, yams (*Dioscorea* spp.) and sweet potatoes (*Ipomoea batatas* Poir.), making up a multispecific and polyvarietal agricultural system. In northern São Paulo state, production systems are characterized by the combination of agricultural activities and wild plant collection. Manioc and banana (*Musa* spp.) planting for self-consumption and marketing are predominant, the former being sold as flour. Both to the north and south, and despite proximity to the largest urban center in South America, São Paulo, production systems maintain traditional characteristics, with limited use of input and essentially family-based labor. The study was carried out in the municipalities of Iguape, Ilha Comprida and Cananéia to the south (24°40′–25°10′S and 47°20′–48°05′W) and São Sebastião and Ubatuba to the north (23°27′–23°47′ S and 45°19′–45°00′W).

The Rio Negro region (Fig. 1) is characterized by the presence of almost unaltered forest cover and large cultural diversity. Twenty-three ethnic groups belonging to three linguistic families (Maku, Eastern Tukano and Arawak) inhabit this region, which is part of the cultural area of the Northwestern Amazon, covering parts of Brazil, Colombia and Venezuela (Calbazar and Ricardo 1998). As Vidal (1999) points out, before colonization, the region was probably included in a very large set of multiethnic confederacies from the Orinoco to the Solimões region, modifying its configuration during contact period until the actual situation (Andrello 2006).

[1] Two large groups of manioc varieties stand out: bitter manioc, which has a fresh weight concentration of cyanogenic glucosides above 80–100 ppm and must be detoxified before consumption, and sweet manioc, also referred to as *aipim* or *macaxeira*, which can be cooked without previous processing.

With the exception of the Maku groups, whose economy is largely based on hunting-gathering, these groups practice slash-and-burn farming centered on bitter manioc for subsistence. Manioc flour is marketed at a small scale in the regional urban centers. Some sweet varieties are grown despite their reduced role both in alimentary systems and management of agricultural diversity.

The study was carried out in the Upper and Middle Rio Negro (64°–69°30′W and 1°30′N–4°S). In the Rio Negro Indigenous Land, the Tucumã-Rupitá and Juivitera Baniwa villages (Arawak linguistic family) located in the Içana River were visited, as well as Tabocal dos Pereira and briefly Iábi, both Baré communities originally speakers of Arawak who now speak Nheengatu[2], on the bank of the Rio Negro. Lastly, visits were made to the multiethnic Iauareté urban nucleus (2,500 inhabitants) and Loiro Village, both located on the Uaupês River, with mainly households of the Eastern Tukano family. Outside the Indigenous area, visits were made to the city of São Gabriel da Cachoeira, whose 15,000 inhabitants are for the most part indigenous, and further down the river, in the Middle Rio Negro, to the Tapereira community, which is also pluriethnic. The rural dwelling pattern consists of dispersed communities, with approximately ten families each.

The general way of cultivating and planting manioc is the same in both regions. Yearly, a small area of forest or fallow is cleared and burned for planting. The manioc is propagated by stem cuttings which generally come from an older plot of the same farmer. The weeding occurs in the best cases once or twice a year. The manioc cycle lasts from 6 months to 2 years. So each farmer manages one to three plots in different stages of maturation.

In spite of differences between occupation pressures in the two regions under study, both have comparable general edaphoclimatic characteristics, with low fertility soils and subtropical or tropical climate with high precipitation (1,700 to 2,200 mm/year in the Atlantic Forest and between 2,500 and 3,000 mm/year in the Rio Negro).

Methods

Both programs adopted as starting point the local perception of the diversity of varieties. A variety is understood here as the smallest unit of perception and management of agricultural diversity, i.e. "a set of individuals considered sufficiently homogenous and sufficiently different from other groups of individuals to receive a specific name and be the object of a set of practices and knowledge throughout its cycle or a particular stage within it" (Emperaire 2005).

Names, origin and main characteristics of the varieties were collected on the fields under guidance of the farmer, being a man or a woman in the Atlantic Forest and a woman in the Rio Negro. Interviews or conversations with other members of the domestic unit enabled more detailed research on subjects such as networks for acquisition of varieties, its forms of management, farm cycles, selection criteria or other elements related to agriculture. Names assessed were in Portuguese, Tukano, Baniwa or Nheengatu, later translated into Portuguese by bilingual informants and checked in respective dictionaries.

In the case of farmers in the Atlantic Forest, only households residing in the region for more than one generation and who practiced slash-and-burn agriculture for at least five years were included. The snowball technique was used in the choice of farmers. The 51 households in 21 communities visited account for approximately 56% of farmers who practice this kind of agriculture. In Middle and Upper Rio Negro, the highest possible number of agricultural informants was used in each community in order to cover the diversity associated with each location. At the urban poles, the choice of informants was made according to local networks of acquaintances (Table I).

Qualitative data presented here result from analysis of the farmers' statements, in an attempt to identify how diversity is perceived, named and managed. Quantitative data were objects of a basic statistical analysis. Sample-based rarefaction curves were established using the EstimateS version 7.5 program to compare the richness of varieties in different locations (Colwell 2005). These curves represent the relation between expected number of varieties versus numbers of farmers in each place of study independently of the sampling order of the farmers.

Results

Amplitude of the Diversity

Quantitative data show, through an average number of varieties per farmer between 7 and 33, the important diversity found in both regions, albeit at a higher level in the Northwest Amazon. São Gabriel (6), despite the periurban character of its agriculture, is also characterized by maintenance of high diversity (Table I and Fig. 2).

Rarefaction curves point mainly in the case of the Amazon locations to the importance of the individual dimension of management of diversity: each farmer brings his own varieties to the local stock. In fact, frequencies in which varieties were mentioned show that in the Rio Negro

[2] Nheengatu, or general language, is a *língua franca* of Tupi origin. It was forged by the missionaries in the seventeenth and eighteenth centuries. In the Rio Negro, it appeared in the 1740s and is still spoken today as a *língua franca* in Upper and Mid Rio Negro (Grenand and Ferreira 1989).

Table I Amplitude of the Diversity of Varieties in the Seven Groups Studied (adapted from Pinton and Emperaire 2001 and Peroni 2004)

Biome	Atlantic Forest		Amazon Forest				
State	São Paulo		Amazonas				
Region	Southern Coastline	Northern Coastline	Northwestern Amazon				
Location (Fig. 1)	1	2	3	4	5	6	7
(River) Locality	Cananéia, Iguape, Ilha Comprida	Ubatuba, São Sebastião	(Uaupés) Iauareté, Loiro	(Rio Negro) Tabocal dos Pereira, Iábi	(Içana) Tucumã-Rupitá, Juivitera	(Rio Negro) São Gabriel da Cachoeira	(Rio Negro) Tapereira
Origin	Mes.	Mes.	Amd. (urb.)	Amd.	Amd.	Amd. (urb.)	Mes., Amd.
Ethnic/cultural group	Caiçara	Caiçara	Tukano	Baré	Baniwa	Pluri-ethnic	Pluri-ethnic
N informants	34	17	12	9	6	7	5
N varieties	58	53	89	60	74	69	66
Average	7	6.8	19	21	26	16	33
Variance	7.5	19.4	100	93.8	64.6	33.6	44.8
Median	7	6	18	17	24	14	30
Min/max	02 / 13	01 / 16	09 / 48	10 / 37	18 / 39	11 / 26	28 / 44
Number of varieties cultivated by only one informant (%)	22 (37.9%)	28 (52.8%)	48 (53.9%)	24 (40.0%)	39 (52.7%)	45 (65.2%)	20 (30.3%)
Number of varieties cultivated by all informants (%)	0 (0%)	0 (0%)	1 (1.1%)	0 (0%)	4 (5.4%)	0 (0%)	6 (9.1%)

Amd. Amerindians; *Mes.* Mestizos; *(Urb)* Urban context

30 to 65% of varieties are kept in each location by a sole farmer and equivalent, between 37 and 53%, in the case of the *Caiçaras*. On the other hand, the number of varieties common to all informants in a location varies respectively from 0 to 10 and 0%, thus reinforcing the importance of individual choice criteria.

Processes at the Base of Diversity

Two sets of mechanisms operate in the management of this diversity. One set is based on social networks and the other on agricultural knowledge and practices which allow for continuous incorporation of new morphotypes arising from

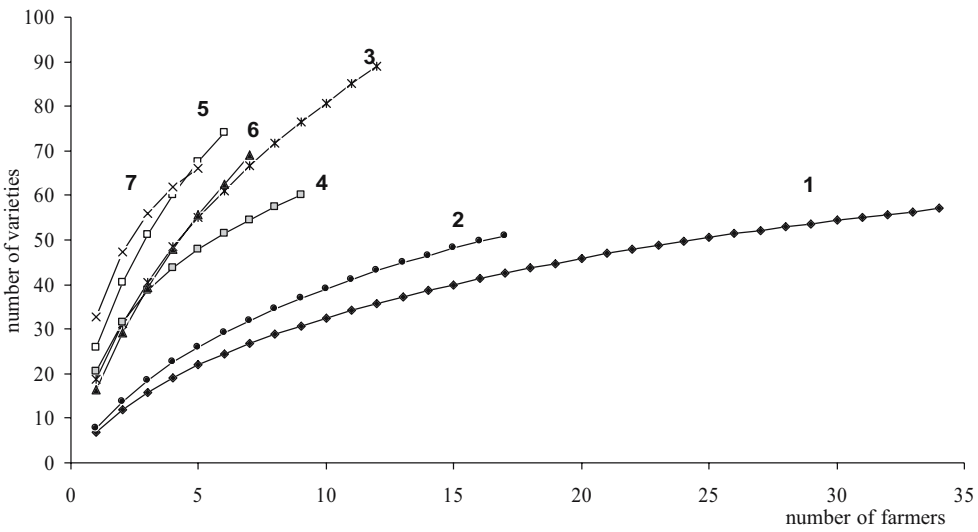

Fig. 2 Rarefaction curves for the diversity of varieties for the different study areas (numbers from Table I).

sexual multiplication into the collection of varieties. Both processes characterize dynamic diversity management.

Exchange Networks

Circulation of varieties is based on social networks of varying size and composition. In the Eastern Tukano groups, sophisticated keepers of knowledge about manioc, it is supported by rules for constitution of lineages which rest on linguistic exogamy, virilocality and patrilinearity. Newlywed women receive from their mothers-in-law a stock of varieties to be expanded with varieties from their own mothers, i.e., varieties from their villages of origin. This stock will be adjusted throughout these women's lives, according to their mobility. Chernela (1986) and ourselves show that varieties circulate in a radius of several hundred kilometers in Brazil, Colombia and Venezuela. In the Baniwa language groups, also holders of deep knowledge about agricultural diversity, rules are of clan exogamy, but the arrangement remains the same, with wide circulation of varieties.

The role of women is essential in this circulation which, allied to great curiosity about agricultural novelty, is the reason for the high number of varieties. Any novelty attracts attention and can be rapidly diffused over an immense territory through exchange networks. The extremely active variety circulation system is specific to the Upper Rio Negro region. Studies undertaken in mestizo or settler groups in the Amazon (Pinton and Emperaire 2001) or in São Paulo state (Peroni 2004), with more restricted diversity, found a different circulation system. In these situations, exchanges are limited to the close family or neighbors. The search for propagation material to mobilize the circulation of germplasm in these situations is more important than novelty.

In both regions of the state of São Paulo, the bitter varieties circulate in a restricted area, and are moved by exchange networks related to geographic proximity and family relations. In the south, *aipim* circulation is also subject to a different logic which forces consideration of the historic dimension of regional population in order to understand the local configuration of the diversity. Despite low spatial mobility by the *Caiçaras*, the Southern São Paulo coastline, due to the fact that it is an estuary region with large availability of fishing resources, was a destination for migration, especially of fisher/farmer families coming from Paraná and Santa Catarina states. Indigenous families in the Guarani group, mainly the Mbyá, moved more intensely in the past and continue to move over a vast geographic expanse in southern Brazil, northern Argentina, Paraguay and Uruguay (Scatamacchia 1995; Ladeira 2001). These families carried, and still do, fast growth sweet varieties, to be consumed without need for detoxification. This significant advantage of *aipins* over bitter varieties allows families to establish themselves in their places of arrival in less than a year, with their own food ready for consumption without the need for specific equipment for processing of manioc. In this case, the use of sweet varieties fits short-term or mid-term subsistence strategies.

Renewal of Diversity

Despite predominant multiplication of manioc through use of stakes, this cultivated species has maintained its capacity to flower and produce fertile seeds. During the cultivation cycle, seeds originating from cross-breeding are produced, fall to the ground and are incorporated to the seed bank, where they enter a stage of dormancy (Martins 1994; Elias *et al.* 2001). Dormancy is broken when clearing a new field after a fallow period of up to ten years on average. All farmers know the phenomenon well, although the destination given to the seedlings varies. In the Northwestern Amazon (Emperaire *et al.* 1998) and in the state of São Paulo (Peroni 2004), these morphotypes are viewed as a source of diversity. Once the plant is well grown, its characteristics are evaluated and it is discarded or incorporated to the existing variety stock. Later, the plants are multiplied with use of stakes as is done for any other variety and will enter the variety circulation network with a new name or, as is often the case, borrowing the name of the variety closest in morphology. In the Amazon and Atlantic contexts, a local variety is thus made up of several clones which are generally close (Peroni 1998; Emperaire *et al.* 1998; Colombo 1997).

The Meaning of Diversity

A Collectively Owned but Individually Managed Asset

These statements about manioc circulation and about the dynamic characteristic of its management raise questions about a more general meaning for the diversity held by farmers. Interest in a polyvarietal system is frequently interpreted in terms of the stability of production systems. In addition to providing varied food resources or fulfilling market demands, high crop diversity accounts for heterogeneity of microenvironments in cleared fields, both to present differentiated resistance to predator and pest attacks and to guarantee harvesting throughout the year or over longer periods. All of these arguments, widely debated by authors such as Altieri (1999), are applicable in our study sites.

However, the relationship between agriculture and the varieties produced by it cannot merely be interpreted in terms of production. The choice of varieties is based on considerations of productivity and quality, but also on

heritage: a manioc collection is property handed down through generations, and its history, in the Rio Negro region, is anchored in myths of origin of mankind and agriculture. The Desana myth of manioc origin, the *food's stick*, quotes explicitly nineteen names of varieties, the most part always in use (Galvão and Galvão 2004). The version of the Tukano myth reported by Azevedo and Azevedo (2003) underlines an ancestral diversity of varieties, however without naming them. These references point out that the diversity of varieties, or crops in more general way, and their circulation, are an intrinsic element of the mythical origin of cultivated plants. Diversity has a collective dimension despite its individual management and must be considered as a cultural and biological patrimony.

A Human Relation With Varieties

The choice of location for a new manioc field and its preparation are usually activities for men, although management of the diversity, from the choice of varieties to harvesting, is for women. Fields are private areas managed by the women. Just as Heckler (2004) writes about the Piaroa, fields in the Rio Negro are spaces in which women express their profound knowledge of the plant diversity surrounding them, while men's relationships with their plant environment is best described as expeditions for collecting forest products, hunting or fishing. A well-maintained field "where the manioc is well-groomed," an expression used by a woman farmer in Tapereira, is a source of prestige. There is a humanized relationship between the woman farmer and the plants grown in her land, surrounded by a feeling of "well-being" of the plants. Diversity of varieties and care of the land come together as a source of pride for the woman farmer. This excellence in agriculture is extended to the careful preparation of the different manioc derivatives, such as flour, *beijus* and *tucupi*, among others (Hugh-Jones 1979; Ribeiro 1995).

Names, A Central Attribute of Diversity

Analysis of denominations used for different varieties enables formulation of several hypotheses about construction and perception of diversity. In the Rio Negro, 351 bitter manioc denominations were assessed—nearly all of which (348) made up solely of base names. Sweet maniocs are not taken into account here, since they were probably introduced during contact with Whites and include only five denominations. The names of bitter maniocs are classified into two groups: those indicating introduction (13 to 30% of assessed denominations) and those referring to varieties considered local. Introduced bitter manioc varieties generally receive names referring to their origin (*dos brancos*, *do Pará*, *do Solimões*–White Men's, Pará, Solimões) or a particular characteristic like size, fast growth or color (*baixinha*, *seis meses*, *vermelha*—short, 6-month, red). Furthermore, the latter denominations are frequently expressed in Portuguese rather than indigenous idioms, reinforcing their non-local characteristics.

The referential for denominations in the local manioc group, or considered as such, is biologic diversity in the surroundings. This reference accounts for 40 to 75% of the varieties, according to study sites. It includes names of fish, palm trees or other crops grown in the fields, denoting a strong positive connotation, synonyms of plentiful resources.

A new universe in biological diversity, in a virtual sense, thus arises in the farms from the manioc names. This statement points to a global dimension of perception of diversity of manioc varieties: the units recognized and managed by the farmers are not made up of varieties taken separately, but rather a collection, a set bearing meaning, made up of independent elements.

Boster (1984), in his study of varieties grown by the Aguaruna in Peru, also indicates the importance of a plant and animal referential in the local manioc denominations. These denominations are justified by morphologic similarities in the stem, the tuber or other parts. They are obvious in some cases, but barely recognizable in others. In the Rio Negro, likewise, attribution of a name is often justified by a morphologic resemblance between the variety and a plant or animal. But a global logic for denomination can also be identified, creating relations between a group of varieties and a referential based on biologic diversity.

Caiçaras predominantly use descriptive names for the varieties, both on the northern and the southern coastline, 46 and 50%, respectively, followed by denominations connected to origin, accounting for 36 and 13.8%, respectively. Descriptive denominations make references to morphologic or agronomic characteristics, such as precocity and also ease of cooking and softness (*amarela*, *manteiga*—Yellow, Butter). There is no denomination making reference to toxicity of the manioc, thus demonstrating that bitter and sweet varieties belong to different cultural registries, with no ambiguity or overlap.

As for *aipins*, the importance of culinary registration is relevant in denominations, such as time of cooking, or texture and color of the finished dish. However, depending on the category of manioc, bitter or sweet, certain denominations bear a different meaning: the adjective Yellow may refer to the finished product in the case of *aipins*, i.e., its softness and color. Bitter maniocs, in turn, carry the adjective as a function of the root previous to its processing (yellow manioc), its bitter (toxic) trait being implicit. Characteristics related to technical aspects of production refer exclusively to the bitter varieties. Therefore, the *saco-nas-costas* (Sack on the back) and *mata negro* (Negro killer) and *mata negrinho* (Little negro killer)

are highly productive and hard to pull. The explanations for these names are "always yields enough to fill a sack to be carried on one's back" and "can kill even a strong negro when being pulled."

The forms of denomination of the varieties are thus inserted into various referentials, showing in the case of the *Caiçaras* a more agrotechnical view of the varietal diversity, explicitly considering the characteristics of each variety. *Farinha seca* (dry flour) is made from a collection of varieties, but all are white or creamy in color, determining the light color of meal in that region. Not only a few varieties, but the whole set of them have a common characteristic which is favored in selection and use. A new variety may successfully become part of a manioc flour recipe, being therefore incorporated, according to existing characteristics in the set of varieties already present, in this case white or creamy color. Conservation of the previously existing set determines the success of future insertions, and diversity is managed as a collection, rather than randomly.

Conclusion

Both studies show the importance of the cultural dimension of manioc varieties in both contexts. They bear evidence as well of the existence and efficacy of local genetic resource conservation systems. These, consciously or unconsciously managed, allow for minimized risks of loss of diversity, leading to the idea that phytogenetic resource adaptability to the most varied conditions rather than choosing strict adaptation maybe more efficient in terms of production but also more vulnerable in terms of resource conservation.

The local elements which permit minimization of the loss of diversity are many. Emphasis will be given to the local notion of variety which by itself, under a single name, gathers several genotypes into a continuous flow supported by a wide genetic base. Variety is not a static entity but rather in continuous renewal.

Circulation of varieties is made up of another efficient key element of local diversity of varieties conservation systems. It allows on the one hand for varieties to be tested under different ecologic conditions, and on the other for local loss, be it voluntary or accidental, of a variety to be quickly made up for by arrival of other varieties, maintaining the stock of diversity, thus investing the system with a large capacity for resilience. Circulation of varieties operates at the regional level, although it is based on individual or domestic group dynamics showing more interest in activation of these networks. Diversity is made up of an individually managed asset, tried and improved by each farmer, albeit with no individual appropriation. Construction of agricultural diversity results from gathering of knowledge and practices at the individual and collective levels. Cultural factors subtend these forms of management. There is thus global interest in diversity and management of varieties as a collection of varieties with their own meaning rather than a juxtaposition of varieties.

The approach used shows how cultural and biological aspects of this management are inseparable, causing varieties to be seen as more than just phytogenetic resources but as cultural heritage as well. However, the issue at present is the continuity of such systems. The current challenge is not so much conservation of varieties, local agrotechnical knowledge or symbolic referentials as it is to create new meaning for diversity in new generations. Conservation of phytogenetic resources must be regarded as an element in global strategies for sociocultural and environmental diversity to survive, no longer an objective in and of itself.

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