



Bromeliad ornamental species: conservation issues and challenges related to commercialization

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ABSTRACT. Bromeliads grow almost exclusively in the New World tropics and subtropics, mainly in South America in the Brazilian Atlantic Forest (ca. 1200 species). Within the last few decades, their beautiful shapes and colors, low maintenance and easy adaptability to small gardens have brought bromeliads into worldwide use as ornamental plants. While the ornamental bromeliad trade could make significant contributions to household economies in rural areas, the trade may represent a significant threat in some of the bromeliad biodiversity hotspot countries such as Brazil, Bolivia and Colombia. This paper presents an overview of production volumes, analysis of the Brazilian bromeliads trade chain – at the state, national and international levels – and recommendations to address development and conservation challenges.

Keywords: fair trade, floriculture, non wood forest products, ornamental plants, production chain.

Espécies ornamentais de bromélias: conservação e desafios relacionados a sua comercialização

RESUMO. Bromélias crescem quase que exclusivamente nas regiões tropicais e subtropicais do Novo Mundo, ocorrendo principalmente na Floresta Atlântica brasileira na América do Sul. (ca. 1200 espécies). Nas últimas décadas, pelas suas belas formas e cores, baixa demanda de manutenção e fácil adaptabilidade a pequenos jardins, as bromélias tem sido mundialmente utilizadas como plantas ornamentais. O comércio de bromélias ornamentais pode promover significativo acréscimo de renda em áreas rurais, mas por outro lado pode também significar uma ameaça à manutenção da diversidade destes recursos biológicos, especialmente em países como Brasil, Bolívia e Colômbia. Este trabalho apresenta uma caracterização geral dos volumes de produção e da cadeia brasileira de comercialização de bromélias – em nível estadual, nacional e internacional assim como recomendações para promover o desenvolvimento deste setor e superar desafios relacionados ao uso sustentável deste recurso.

Palavras-chave: comércio justo, floricultura, produtos florestais não-madeiráveis, plantas ornamentais, cadeia produtiva.

Introduction

Bromeliads entered recorded history some 500 years ago when Columbus introduced the pineapple (*Ananas comosus* (L.) Merr.) to Spain upon return from his second voyage to the New World in 1493. On that voyage he found it being cultivated by the Caribbean Indians in the West Indies. Within 50 years this tropical fruit was being cultivated in India and other Old World countries; not until 1776 was another bromeliad (*Guzmania lingulata* (L.) Mez) brought to Europe. *Aechmea fasciata* (Lindl.) Baker followed in 1828 and *Vriesea splendens* (Brongn.) Lem. in 1840 (BENZIG, 2000; BSI, 2009).

Nine, non exclusive categories of plant use apply to Bromeliaceae including fiber, food, forage, medicine, ornamental and spiritual (BENNETT, 2000). These categories mainly reflect indigenous applications and perceptions, and do not always

coincide with modern notions of utility (BENZIG, 2000). The pineapple – the only member of the family cultivated for food – has served as both a food and a symbol throughout the human history of the Americas (LEVINS, 2009). Several other bromeliad species have been used as sources of fiber for aboriginal peoples since before the arrival of Columbus in the New World, including *Aechmea magdalenae* (André) André ex Baker (TICKTIN; NANTTEL, 2004; TICKTIN et al., 2003); *Ananas comosus* (L.) Merr. (BENNETT, 1992; BRUCHER, 1989); *Tillandsia usneoides* (L.) L. (BENNETT, 1986); and *Neoglaziovia variegata* (Arruda) Mez (BENZIG, 2000; BSI, 2009). Bromelain, an enzyme produced by *Ananas comosus* fruits in defense against insect larvae, is becoming important in the chemical and pharmaceutical industries. A second enzyme, hemisphericin, produced by *Bromelia* also has the

potentiality to be used in the same industries (CATHCART, 1995). Within the last few decades, bromeliads have become more widely used as ornamental plants. Originally only found in botanical gardens or the private greenhouses of wealthy Europeans, their popularity in gardening and landscaping has spread to a wider market because of their beautiful shapes and colors, low maintenance and easy adaptability to small gardens (BENZIG, 2000). Today, bromeliads are considered the new “ornamental fashion hit”, contributing to luxurious gardens around the world (BRANDIES, 2004; STEENS, 2003).

Although much of the ornamental bromeliad trade involves artificially propagated plants, there are still hundreds of wild plants traded internationally each year, including a specialist trade in rare species (ROE et al., 2002). While the ornamental bromeliad trade could make significant contributions to household economies in rural areas, the trade may represent a significant threat in some of the bromeliad biodiversity hotspot countries such as Brazil, Bolivia and Colombia.

Especially in the case of Brazilian bromeliads, several species are already under risk due to over-exploitation (ARRABAL et al., 2002; DROSTE et al., 2005; RECH FILHO et al., 2005) as well as habitat degradation (COFFANI-NUNES, 1997). Among the 107 plant species officially listed as extinct or endangered in Brazil, 15 are bromeliads (IBAMA, 1992).

This paper focuses on commercially traded Brazilian bromeliads, in order to enhance the scientific basis for the conservation and sustainable use of ornamental bromeliad species. The authors first describe the ecology and distribution of the bromeliad family, and then provide an overview of production volumes and commercialization at both international and national levels. The next section of the paper characterizes the agricultural community and other levels of the trade chain in Paraná State (Southern Brazil). The authors conclude with a discussion of the conservation challenges related to the use of this non timber forest resource and provide some recommendations to address development and conservation challenges.

Material and methods

This exploratory and descriptive research was carried out through a broad literature review, as well as semi-structured interviews with different representatives of the bromeliad trade chain including harvesters, producers, traders as well as technicians from the State Environmental Institute

(IAP), State Agency for Technical Assistance and Rural Extension (EMATER - PR) and State Secretary of Agriculture (SEAB - PR). Additionally, the State Catalog of Forestry Business (SERFLOR) and the Catalog of the “Paraná 12 Meses” Program from Emater - PR were consulted. Information at the national level was obtained from a literature review and from the Agricultural Census of the Brazilian Institute for Geography and Statistics (IBGE) as well as the IBRAFLOR and SECEX-MDIC databases. Technicians from the Brazilian Environmental and Renewable Resources Institute (IBAMA) were approached by email about the Brazilian bromeliad market, but no response was received to these inquiries. At the international level, the United Nations Statistics Division - Commodity Trade Statistics Database (UN - Comtrade) was consulted in addition to sources noted above.

Results and discussion

Bromeliads ecology and distribution

Bromeliaceae constitute a large family (56 genera and 2880 species) composed mainly of epiphytes (BENZIG, 2000). Most bromeliads belong to the phytotelm type with rosulate ramets (spiny rosette-forming plants) where enough leaf litter and rainwater accumulate to support a varied fauna, including small amphibians, arachnids and insects (DEJEAN; OLMSTED, 1997; DIAS; BRESCOVIT, 2004; LAESSLE, 1961; WHEELER, 1921, 1942; WITTMAN, 2000). Some amphibian species use bromeliads strictly for shelter, while others use them during the entire life cycle, reproducing and feeding inside the plant axils (OLIVEIRA et al., 1994; PEIXOTO, 1995; SILVA et al., 2000; TEIXEIRA et al., 2002). They are also an important food source for some small monkeys that eat bromeliads leaves, fruits and flowers, as well as drink the water stored in the rosette “tank” (CARVALHO, 2000; BENZIG, 2000). Probably no other family exceeds Bromeliaceae in the variety of services provided to dependent biota, ranging from detritivores to pollinators, nor does any comparably sized clade (organisms with common ancestor) employ a more novel array of contrivances to acquire and utilize water and mineral nutrients (BENZIG, 2000).

Bromeliads are a neotropical family, meaning they grow almost exclusively in the New World tropics (and subtropics). Most come from South America, with the greatest number of species found in the Brazilian Atlantic Forest (ca. 1200 species) (BENZIG, 2000; LEME, 1998). They range from Chile and Argentina in South America through Central America and the

Caribbean, reaching their northern limit around Virginia in the southeastern United States. A single species (*Pitcairnia felciana* (A. Chev.) Harms and Mildbraed) is found in western Africa.

Bromeliads grow at altitudes ranging from sea level to over 4,000 meters. They can be found in a wide variety of habitats from hot, dry deserts to moist rainforests to cool mountainous regions (BENZIG, 2000; BSI, 2009). Small body size, rhizomatous habit, phytotelm shoot, foliar absorptive trichomes and specific adaptations in their metabolism (CAM metabolism), succulence and other xeromorphic features are characteristics that account for the inordinate success of Bromeliaceae in diverse, often demanding, habitats (BENZIG, 2000). Bromeliads are found in a variety of growing situations; they are found as regular terrestrial species as well as saxicolous species (growing on rocks). Epiphytic species are also found growing on other plants – usually trees, shrubs or cactus – but can sometimes be found on telephone poles or even on the telephone lines themselves. This capability to take their nutrition and moisture from the atmosphere has earned these bromeliads the name "Air Plants" (BSI, 2009).

Global trade in bromeliads

Excluding pineapple and a few other species used for fiber, almost all bromeliad trade is registered under the commodity code HS 06 (live trees and other plants) in the international market. All the sub-categories of this code recognized as "floriculture sector", could include bromeliads as trade products (Codes 0601; 0602; 0603 and 0604). The 2008 import statistics reported to the United Nations from more than 95 countries show world trade value in dollars of floriculture was US\$ 13,273,794,014. Of this amount, US\$ 1,057,865,584 was attributed to bulbs, rhizomes, tubers and crowns (this last one is a category that suits bromeliads) (code 0601); US\$ 5,472,903,666 to live plants (Code 0602); US\$ 5,839,177,043 to fresh cut flowers (Code 0603); and US\$ 760,498,418 to fresh cut foliage (Code 0604) (COMTRADE, 2009).

The main floriculture exporters for the period of 2005–2008 were the Netherlands, Colombia, Italy, Belgium and Germany. The main importers were Germany, the United Kingdom, USA, France and the Netherlands. Since there are no details on taxonomic level related to HS code, it is not possible to define the percentage of bromeliads in those totals. Also, there are no available recent data on global bromeliad commerce.

According to Cathcart (1995), Europe was the most important center for bromeliad production. The largest bromeliad nursery in the world, at that time, was the

Netherlands; this nursery funneled millions of seedlings and finished plants annually into the world market. Other important bromeliad exporting centers were Belgium and the USA (Florida, California and Hawaii). In the United States, ornamental bromeliads became a commercial crop worth an estimated US\$ 20 million per year to Florida agriculture. Several micro propagation laboratories in Florida began production of bromeliad varieties, but most bromeliad nurseries in Florida and, indeed, the entire USA depend on imported meristems, seedlings or cuttings for their growing-on stock. Millions of seedlings and tens of thousands of finished plants were imported annually into the USA from Belgium and Holland alone. The majority of all imported bromeliads in the USA were from cultivated stock. Plants of wild origin were also imported, although to a much more limited degree. Wild plants were used primarily as propagation stock, and hybrid parent stock, for limited sales to collectors, and as herbarium material. Unfortunately, there is no updated information since Cathcart (1995). But, considering the global increase in plant commerce, it is expected that the USA ornamental bromeliad market followed the same increasing pattern reported in 1995.

Many potted plants produced in Europe, North America and Japan are based on imported plant material (cuttings, seed, bulbs or small plants to be grown to marketable size); most "potted plant species" originate in less developed countries (CHRISTENSEN; FRIIS, 1987; JØRGENSEN, 2004). The value of the import of ornamental plants, including partly grown plants to the European Union alone was US\$ 2,364 million in 1990 (HEINRICHS; SIGMUND, 1992) and up to US\$ 3,549 million in 2008 (COMTRADE 2009).

Production costs in the more developed countries of the north are high and new production methods that may cut production time (and thus costs) are, therefore, of great interest to northern producers of potted plants. One way to reduce the production time for potted plants is to import partly grown plants from countries with lower production costs, a more favorable climate, or both (RINDUM, 2002). Some ornamental plants for the local market are produced in virtually all developing countries, but production aimed particularly for export is concentrated mostly in the following developing or low-income countries: Brazil, Columbia, Costa Rica, Côte d'Ivoire, Ecuador, India, Indonesia, Kenya, Korea, Malaysia, Mexico, South Africa, Sri Lanka, Tanzania, Thailand, Togo, Uganda, Vietnam, Zambia and Zimbabwe (JØRGENSEN, 2004).

As Cathcart (1995) observes, bromeliad cuttings can be grown more quickly and cheaply in nurseries abroad than in the USA. Many such facilities exist in

Puerto Rico, Guatemala, Costa Rica, and Colombia and, to a lesser extent, in several other Latin American countries. Plants of the genus *Tillandsia* are grown in large overseas operations where a combination of favorable climatic conditions and lower production costs make production there more lucrative. These plants often incorporated into novelty uses, are not sent to the USA as finished products for direct sale. U.S. nurseries, at the least, house them for a time, pending sales. However, these plants are usually brought in as cuttings or pre-finished products, and grown out for an extended period to produce a superior, unblemished, finished product.

The bromeliad market is extremely competitive, with high demand for quality and uniformity, as is the case with other main products in the ornamental sector (JØRGENSEN, 2004). The biggest companies vie for market share with a steady stream of beautiful newly-patented varieties. Hybridizers are working constantly to produce ever more spectacular and hardy varieties for the marketplace. Researchers and scientists from many countries are investigating the taxonomy and physiology of bromeliads. Importation of fresh research material from the wild is essential to the survival of these research programs, and hence to the industry (CATHCART, 1995). What are the implications of this large, lucrative and widespread industry for the sustainability of bromeliad populations and for the economic and social well being of local peoples in countries where these plants originate? As Coetzee (2002) and Jørgensen (2004) emphasize, respect for intellectual property rights related to native plant species, and sharing of the benefits arising from the commercial utilization of the gene pool found in the developing countries, are still of relatively little concern in the industry.

The Brazilian scenario

In Brazil, the main source of information related to plant species production and trade is the Agricultural Census of the Brazilian Institute for Geography and Statistics (IBGE), which includes a questionnaire section about plant harvesting. A critical issue is the validity of the IBGE data. There are structural biases in the agricultural census that cause an undervaluation of wild harvesting relative to agricultural production. As noted by Wunder (1999), the main problems are: 1- the focus, duration, frequency and level of detail of the census interviews do not allow for a full appreciation of minor but multiple uses of forests and other natural ecosystems; 2- the census coverage is probably more restricted in agricultural frontier settings adjacent to

forested areas; 3- as commercial forest harvesting is generally illegal, this results in deliberate omission and understatement in some regions; 4- landless producers (who are not proper “agricultural establishments”) are excluded; and 5- using municipal *averages* of extraction values may be too broad to capture the important subgroup of forest-dwelling people for whom wild harvesting is a substantial source of income.

As a result of these shortcomings, the census is generally more representative of “formal” (legal, commercial) than of ‘informal’ (illegal and/or subsistence) production, but the census is still a valuable tool, which contributes to a general overview of the agricultural sector.

Specifically for the floriculture sector, the Ibraflor reports and the SECEX-MDIC database are the main sources of information related to floriculture trade in Brazil. But, similarly to IBGE data, the information provided by Ibrafor and Secex are also incomplete, especially regarding details on species level and informal production or wild harvesting activities. All these reports and databases also group the production and trade information under the international commodity codes (HS 06 = live trees and other plants – and its sub-divisions 0601; 0602; 0603 and 0604).

According to the above-mentioned sources, the floriculture market in Brazil is around US\$ 2 billion a year, representing almost 2% of the global market. Almost all of Brazilian floriculture production goes to the domestic market; however, paradoxically, the *per capita* spending on flowers is low, mainly because of low income of the population and the absence of a culture that values decorative plants and flowers. To compensate for the limitations of domestic markets, some producers are always seeking alternatives in the international market.

Brazilian floriculture activity is concentrated in São Paulo State, where almost 66% of the floriculture producers and more than 81% of the area cultivated for floriculture are located. The biggest Brazilian floriculture wholesalers - Ceagesp, Ceasa - Campinas and Veiling- Holambra - are also in São Paulo State. The second production hub is found in the states of the southern region (Paraná, Santa Catarina and Rio Grande do Sul). Most output is from small production areas (average = 3.5 ha; max. = 6.3 ha; min. = 0.5 ha) (ANEFALOS; GUILHOTO, 2003; IBRAFLOR, 2005a; SEBRAE, 2005).

National export trade in flowers and ornamental plants showed a significant increase from less than US\$ 15 million in 2002 to approximately US\$ 24 million in 2004. Despite

substantial growth in recent years, Brazilian exports are small in comparison to other countries - such as Colombia, for example - that export approximately US\$ 500 million annually. The main export products of the Brazilian floriculture sector are seedlings of various ornamental plants (responsible for 40% of the value exported); bulbs, tubers and similar (22%) and cut flowers and flower buds (20%). The main exporting states are São Paulo, Rio Grande do Sul and Minas Gerais, which are responsible for 77, 8 and 6% of the value exported in 2004, respectively. Europe, Japan and United States are the main destinations for Brazilian floriculture exports (IBRAFLO, 2005b).

There is very little information available relating specifically to Brazilian bromeliad production and trade. There is no formal documentation about bromeliads on IBGE or SECEX-MDIC documents or databases. Ibraflor (2002) as a national floriculture report, shows only some generic information about bromeliad cultivation area under four categories: 1- cut flowers ("ananás" total cultivation área = 6.6 ha; 0.4% of the total cut flowers area); 2- potted flowers ("bromélia" = 19.9 ha; 3% of the total cut flowers area), 3- potted foliage ("gravatá" = 0.3 ha; 0.2% of the total potted foliage area); and 4- crowns, shrubs and climbers ("bromélia" = 12.9 ha; 1.4% of the total crown, shrub and climber area).

According to Ibraflor (2005a), the total bromeliad production area in Brazil was around 25.7 ha, representing 0.6% of the total floriculture area in 2004. Total bromeliad output in that year was 1,130 thousand units, mainly from São Paulo, Alagoas and Paraná production areas (Figure 1). These figures represent a 35% decrease in production area based on 2001-2002 Ibraflor data.

These figures also suggest that bromeliads are only a minor part of the floriculture sector, despite strong evidence that bromeliads are as highly commercialized in Brazil for landscaping and gardening as they are in other parts of the world (DURAN; MONTEIRO, 2000; SBB, 2009). According to Brazilian environmental law, all producers or trader dealing with native species must be formally registered at IBAMA - Brazilian Environmental and Renewable Resources Institute - in order to be considered legal. However, few floriculture producers are formally registered as bromeliad producers, with most of these being located in São Paulo, Rio de Janeiro and Santa Catarina States. The average output of the country's largest commercial bromeliad grower ("Bromélias Rio", located in Campinas, São Paulo State) is

around 40,000 potted plants per month from micro-propagation production, including hybrids of different species of *Guzmania*, *Aechmea*, *Neoregelia*, *Vriesea* and *Ananas comosus*. Prices range from US\$ 2.50 to US\$ 12.00. The main Brazilian buyers of this production are in São Paulo, Rio de Janeiro, Minas Gerais and the southern region. The second largest producer ("Ecoflora", located in Holambra, São Paulo) has 3 million seedlings under cultivation, with an average output of 1,500 to 2,000 potted plants per week. Ninety percent of this production is hybrid varieties produced by micro-propagation in Holland, Belgium and USA laboratories. The company also produces native Atlantic Forest species from seeds. According to Mr. Wiejers - the owner of Ecoflora - these plants can produce abundant amounts of seed but take 8 to 10 years to reach commercial size. This long grow-out time is the main reason for intensive wild harvesting of native bromeliad species.

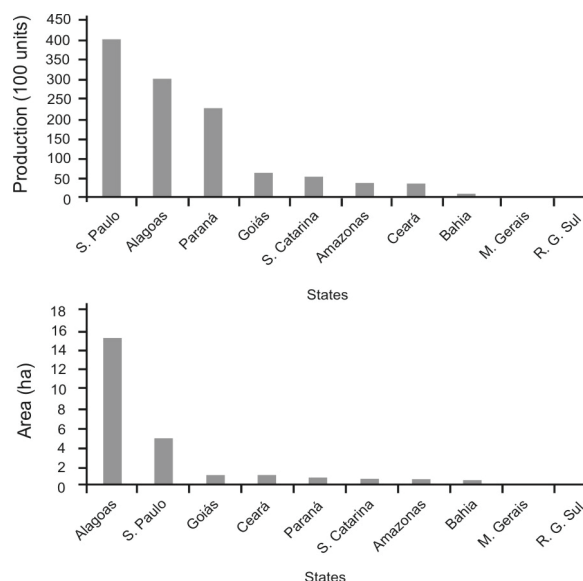


Figure 1. Brazilian bromeliad production in 2004 (Source: IBRAFLO, 2005a).

Domestic production and extraction from the wild

Implications for the resource: According to the SBB (2009), little investment has been made in establishing bromeliad production systems, because of the abundance of bromeliads and easy access to them in wild environments. Therefore, a great part of the Brazilian bromeliad trade is based on illegal wild harvesting; with increasing market demand, several ornamental bromeliad species are threatened with extinction due to over-harvesting (IBAMA, 2007; ROE et al., 2002). Several lists originated at state levels show analogous situations (e.g., SEMA, 2003; SEMA, 2004). Predatory harvesting practices, carried out without consideration of natural

regeneration or sustainability, promote severe environmental damage including loss of other co-existent bromeliad species (ANACLETO, 2001; LEME, 1998; NAHOUM, 1994). For example, a corollary to the illegal overexploitation of bromeliads is the serious impact on xaxim - *Dicksonia selowiana* - a primitive arborescent fern used to make vases or supports for both bromeliads and orchids. This native plant of the Brazilian Atlantic Forest is also on the national as well as international official lists of species under risk of extinction because of its intense commercial exploitation related to gardening and flower production (IBAMA, 1992).

Implications for local communities: Harvesting of bromeliads produces sporadic supplementary income for small farmers from rural and poor coastal communities that have no easy access to the market and no information about the real market value of their resources or about their legal rights (ANACLETO, 2001). Unaware of the real market value of the bromeliads, pickers sell them for less than US\$ 0.25 each to wholesalers. The same bromeliad can sell for up to US\$ 100.00 per unit in the domestic retail market, and up to US\$ 350.00 per unit internationally, with only a small amount of additional effort (to tidy and pot up the plants). Thus, it appears that outside intermediate buyers are able to realize very high profits by selling bromeliads purchased at a very low cost. Since there is no consistent information on the bromeliad trade, it is difficult to establish prices at each stage of the trade chain and hence, the profits realized by intermediate buyers relative to their investment and risks.

Also, some indigenous communities exploit these resources without knowing that they are supplying an illegal market (DURAN; MONTEIRO, 2000). According to Brazilian law, the indigenous community has legal rights to harvest and sell native species directly to retail customers without formal registration. However, it is illegal for intermediaries to purchase native species from indigenous peoples for subsequent resale.

The result of this illegal wild harvesting is visible even in the CEAGESP - the main official floriculture wholesale center in São Paulo State. According to Duran and Monteiro (2000), native wild bromeliads are mixed with those produced in formal greenhouses even at CEAGESP booths, although it is relatively easy to distinguish between wild and cultivated plants. Landscapers, who are the main costumers, usually buy up to 100 plants per lot, especially *Vriesea hieroglyphica* (Carrière) E. Morren ("tiger") and *Alcantarea imperialis* (Carrière)

Harms ("imperial") - a giant bromeliad that reaches up to 3 meters when blooming. This is an endemic species from Serra dos Órgãos (Rio de Janeiro State). Bromeliads specialists recognize that almost all imperial bromeliad sold at CEAGESP are wild harvested because of their large size. The cultivated ones are smaller, as few greenhouses wait for the necessary ten years to achieve the desired large size. According to Leme (1998), in the Bocaina National Park (São Paulo State), the illegal harvesting of *Vriesea hieroglyphica* is a daily activity. In 1994, 500,000 illegally harvested bromeliad crowns from different native species were discovered by the Forest Guard at a nursery in Petrópolis (Rio de Janeiro State).

According to Duran and Monteiro (2000), neither industry nor government agencies appear to fully recognize or take responsibility for the problems associated with illegal wild harvesting. They report that some interviewed landscaping and gardening professionals do not recognize uncontrolled illegal wild harvesting as a problem resulting from designs that create demand for bromeliads, but instead point to the problem as the responsibility of IBAMA (Brazilian Environmental and Renewable Resources Institute). Managers at CEAGESP state that they do not interfere with sales and purchases inside their facility, and they also point out that environmental monitoring is not their duty, but is IBAMA's responsibility. Conversely, IBAMA's representative in São Paulo states that although his agency is aware of the illegal harvesting of wild bromeliads, human resources are not sufficient to cover all the monitoring and enforcement required. According to IBAMA's representative, CEAGESP works with formal invoices, which are sometimes forged by the middlemen to disguise wild extraction. However, there is no feasible means to monitor this activity.

IBAMA also regulates all export of bromeliads and other native species, but since there is no distinction between illegally wild harvested and legally produced bromeliads at the very basic level of the trade chain, the only even modestly effective control or restriction seems to be over those species that are officially at risk for extinction.

Policy and regulation of bromeliads in Brazil: The exploitation or wild harvesting of bromeliads (and other native plants) is not absolutely forbidden by Brazilian environmental laws, but the process is subject to onerous regulatory requirements and depends on special licensing (Decree 750/93 - specific for Atlantic Forest and Brazilian Forestry Code - Law 4.771/65). To be able to get a license, the interested harvester or producer must present a

sustainable management plan based on technical and scientific information, and must either own or lease the land in question, or, alternatively, have access to legally established extractive reserves. Illegal bromeliad harvesting and trade, as well as the illegal harvesting and trade of any other native species, is an environmental crime (Article 46 - Federal Law 9.605/98 and Article 32 - Federal Decree 3.170/99). Penalties upon conviction are three months to a year detention and fines ranging from US\$ 20 up to US\$ 200 per bromeliad.

Development and conservation challenges: In several parts of Brazil, illegal harvesting provides periodic supplementary income for small farmers from rural and poor coastal communities that have no easy access to market and no information about the real market value of their resources or about their legal rights. As noted above, this situation enables outside intermediate buyers to realize very high profits by selling bromeliads, purchased at very low cost, to the domestic or international ornamental plant market.

As noted in the case of Paraná State, most harvesters neither own land nor are able to obtain legal access to public lands, since there are no extractive reserves established in the Atlantic Forest region. Further, scientific biological and ecological knowledge for most of the species is lacking, therefore there is very little or no possibility for prospective harvesters or producers to establish and submit management plans. Consequently, very few management plans have been approved. Lack of licensing does not deter wild harvesting; because monitoring is weak, illegal activity is common.

By contrast, licensing for an agricultural production system for ornamental plants is much easier, although, in practice, a production system is not easily implemented due to the lack of ecological, biological and agricultural knowledge. The combined result of these factors is that a few ornamental bromeliad species are cultivated in a few places, while a large amount of wild harvesting takes place under cover of this small legal production. In effect, wild bromeliads are 'laundered' through agricultural production. Additionally, it is very difficult for small and medium sized enterprises based in developing countries to enter the export market for floriculture products. High transportation costs and the market demand for high quality and uniformity were cited as the main limitation for exportation. At the same time, due to its relatively stable economy, good water supply, and appropriate climate, cheap land and easy bank credit, Brazil has been attracting a great number of foreign floriculture producers with superior purchasing

power (RINDUM, 2002), reducing the opportunities for local communities to benefit from the biodiversity at their own doorsteps. As a result, Brazil plays a secondary and passive role in the trade, being only a "conduit" for the floriculture industry. In this system, the producer establishes a much stronger connection with the "outside world", and almost no relation with the "inside world", considering export as the main focus of activity (CREVOISIER, 1996; CREVOISIER; MAILLAT, 1989; MAILLAT, 2002).

At the national level, a major barrier is the great lack of scientific and technical knowledge related to native species. Such knowledge as exists is largely held by a few large private corporations and is not made available to either public organizations or local communities. A national and state ornamental policy was developed only very recently. Before that time, there was no specific government support for production activities or other activities along the trade chain. There continues to be very little support for research activities, technical assistance or rural extension. Additionally, quality standards or production rules for the majority of the ornamental species have not yet been developed.

Ornamental horticulture is an industry with excellent employment opportunities and a great potential for generating much needed export income (IBRAFLOR, 2002). It is also widely acknowledged that there is an increased demand for greater variety of natural/exotic products in several market sectors, especially in the floriculture sector at both the domestic and international levels. Brazil, due to its high biodiversity, has an enormous opportunity to expand that frontier and to use native resources to improve quality of life in low-income rural communities. In addition, floriculture is an activity that can be carried out on small holdings and can employ a female work force, thus promoting gender equity and assisting communities in slowing the exodus from rural areas. However, this potential will be achieved only after some important barriers are overcome, including the diminution of environmental degradation, which reduces biodiversity, and abundance of native ornamental plants.

As this paper has demonstrated, sustainable development of Brazil's native bromeliad resource is a complex and difficult challenge, and is intertwined with many issues related to the conservation of ecosystems and biodiversity, rural economic diversification, and poverty reduction. Globalization of bromeliad supply and demand represents both threats and opportunities. Measures to help harvesting, production and sale of bromeliads to

become more competitive and more sustainable would be beneficial whether the eventual destination of the product is local, national or international. Many of the problems and needs of bromeliad harvesters and small producers are likely to be those experienced by micro, small and medium forest resource enterprises more generally, as described by MacQueen (2009). These include: complexity of small enterprises in remote locations establishing links with the value chain; Informal or insecure access to resources; lack of managerial capacity and bargaining power; inadequate market information, design capability and technology; problems matching supply with demand due to small sales volume; little collateral to attract investors or offset risks themselves (enterprise development), and policy changes.

These challenges are more pronounced for enterprises attempting to deal in distant (global) markets. Increasingly, approaches to rural development emphasize both conservation and socio-economic objectives. Product certification schemes, for example, attempt to create incentives for consumers to purchase goods from value chains that incorporate environmental or social goals or both (KLOOSTER, 2006). Organic certification and forest certification are two examples that could be applied to bromeliad production (wild harvested or cultivated). A third approach, which places relatively greater emphasis on social rather than environmental goals, is 'fair trade' certification. "Fair trade" is a trading partnership that aims at sustainable development for disadvantaged producers. As described by Jørgensen (2004), fair trade is well established within a range of edible horticultural products (coffee, tea and cocoa) and has been adapted to a range of other products. Fair trade certification of flowers and ornamental plants is an emerging trend. Fair Trade Labeling Organization International (FLO)¹ states that the first flower producers were certified in Kenya in early 2004. Other organizations certifying, or selling, flowers, floral greens, and, in some cases, plants, under a fair trade system include the Rainforest Alliance², the German Flower Label Program³, Ecoflora⁴ and Sierra Eco⁵. These initiatives have concentrated on cut flowers, but, at the time of writing, standards for ornamental plants are under development by the FLO and the initiatives such as the MSP Fair Flowers Fair Plants program (focused

on European produced flowers and plants) have recently been established. Fair trade, if extended to ornamental horticulture, would not only create a whole new product line but may also create a new niche in the global plant market. To develop fair trade of ornamental plants as a viable and sustainable business on a longer term will require training and education and increased research into the practical aspects of plant production and export as discussed above.

A final, fundamental, difficulty in the development of a bromeliad industry that is both environmentally sustainable and socially equitable is the current national and international data recording system related to wild harvesting and production of native ornamental plants. This problem is ubiquitous in the natural products or "non-timber forest products" sector (VAN TOMME et al., 2002). A good first step in this direction would be the consideration of the species scientific name instead of generic trade categories when registering the trade information of biological resources.

Conclusion

Bromeliads grow almost exclusively in the New World tropics and subtropics, mainly in South America in the Brazilian Atlantic Forest (ca. 1200 species). Within the last few decades, their beautiful shapes and colors, low maintenance and easy adaptability to small gardens have brought bromeliads into worldwide use as ornamental plants. While the ornamental bromeliad trade could make significant contributions to household economies in rural areas, the trade may represent a significant threat in some of the bromeliad biodiversity hotspot countries such as Brazil, Bolivia and Colombia. Sustainable development of Brazil's native bromeliad resource is a complex and difficult challenge, and is intertwined with many issues related to the conservation of ecosystems and biodiversity, rural economic diversification, and poverty reduction. Globalization of bromeliad supply and demand represents both threats and opportunities. Measures to help harvesting, production and sale of bromeliads to become more competitive and more sustainable would be beneficial whether the eventual destination of the product is local, national or international.

References

ANACLETO, A. **Cultivo de bromélias e plantas ornamentais**. Guaratuba: Emater-Paraná, 2001. (Relatório técnico, n. 74).

¹<http://www.fairtrade.net/sites/products/others/partners.html>.

²<http://www.rainforest-alliance.org>

³<http://www.flower-label-programme.org>

⁴<http://www.ecoflora.ca>

⁵<http://www.sierraeco.com>

- ANEFALOS, L. C.; GUILHOTO, J. J. M. The Brazilian market structure on flowers and ornamental plants in 2000. **Agricultura em São Paulo**, v. 50, n. 2, p. 41-63, 2003.
- ARRABAL, R.; AMANCIO, F.; CARNEIRO, L. A.; NEVES, L. J.; MANSUR, E. Micropropagation of endangered endemic Brazilian bromeliad *Cryptanthus sinuosus* (L.B. Smith) for *in vitro* preservation. **Biodiversity and Conservation**, v. 11, n. 6, p. 1081-1089, 2002.
- BENNETT, B. C. The Florida bromeliads: *Tillandsia usneoides*. **Journal of the Bromeliad Society**, v. 36, n. 4, p. 149-160, 1986.
- BENNETT, B. C. Plants and people of the Amazonian rainforests: the role of ethnobotany in sustainable development. **BioScience**, v. 42, n. 8, p. 599-607, 1992.
- BENNETT, B. C. Ethnobotany of Bromeliaceae. In: BENZING, D. H. (Ed.). **Bromeliaceae: Profile of an adaptive radiation**. London: Cambridge University Press, 2000.
- BENZIG, D. H. **Bromeliaceae: profile of an adaptive radiation**. Cambridge: Cambridge University Press, 2000.
- BRANDIES, M. M. **Landscaping with tropical plants**. Menlo Park: Sunset, 2004.
- BSI - Bromeliad Society International. **What are bromeliads?** California: BSI, 2009.
- BRUCHER, H. **Useful plants of neotropical origin and their relatives**. Berlin: Springer-Verlag, 1989.
- CARVALHO, R. B. Bromélias da Serra do Brigadeiro. **Ciência Hoje**, v. 27, n. 158, p. 47-48, 2000.
- CATHCART, D. J. C. The importance of maintaining bromeliad imports. **Florida Entomologist**, v. 78, n. 1, p. 6-21, 1995.
- CHRISTENSEN, O. V.; FRIIS, K. Research and development of unknown new pot plants. **Acta Horticulturae**, v. 205, p. 33-38, 1987.
- COETZEE, J. H. Benefit sharing from flowering bulb - is it still possible? **Acta Horticulturae**, v. 570, p. 21-27, 2002.
- COFFANI-NUNES, J. V. **Estudos florísticos e fenomorfológicos de Tillandsioideae (Bromeliaceae) na Serra do Cipó, Minas Gerais**. São Paulo: USP, 1997.
- COMTRADE-United Nations Commodity Trade Statistics Database. New York: UN, 2009.
- CREVOISIER, O. Développement économique régional et management territorial: grille d'analyse. In: DECOUTERE, S.; RUEGG, J.; JOYE, D. (Ed.). **Le management territorial**. Lausanne: Presses Polytechniques et Universitaires Romandes, 1996.
- CREVOISIER, O.; MAILLAT, D. **Milieu, organisation et système de production territorial: vers une nouvelle théorie du développement spatial**. Neuchâtel: IRER, 1989.
- DEJEAN, A.; OLMSTED, I. Ecological studies on *Aechmea bracteata* (Swartz) (Bromeliaceae). **Journal of Natural History**, v. 31, n. 9, p. 1313-1334, 1997.
- DIAS, S. C.; BRESOVIT, A. D. Microhabitat selection and co-occurrence of *Pachistopelma rufonigrum* Pocock (Araneae, Theraphosidae) and *Nothoctenus fuxico* sp. nov. (Araneae, Ctenidae) in tank bromeliads from Serra de Itabaiana, Sergipe, Brazil. **Revista Brasileira de Zoologia**, v. 21, n. 4, p. 789-796, 2004.
- DROSTE, A.; SILVA, A. M.; MATOS, A. V.; ALMEIDA, J. W. *In vitro* culture of *Vriesea gigantea* and *Vriesea philippocoburgii*: two vulnerable bromeliads native to Southern Brazil. **Brazilian Archives of Biology and Technology**, v. 48, n. 5, p. 717-722, 2005.
- DURAN, S.; MONTEIRO, K. Jardim de luxo sustenta tráfico de plantas. Biodiversity Reporting Award. **Folha de S. Paulo**, São Paulo, 17 setembro. 2000.
- HEINRICHS, F.; SIGMUND, I. **Jahrbuch der internationalen gartenbaustatistik band 40**. Germany: Institut für Gartenbauökonomie der Universität Hannover, 1992.
- IBAMA-Instituto Brasileiro de Meio Ambiente. Portaria n. 37-N, de 3 de abril de 1992. **Lista Oficial de Espécies da Flora Brasileira Ameaçada de Extinção**. Brasília: Ibama, 1992.
- IBAMA-Instituto Brasileiro de Meio Ambiente. **Exportação necessita anuência prévia do IBAMA**. Brasília: Ibama, 2007.
- IBRAFLO- Instituto Brasileiro de Floricultura. **A produção brasileira de flores**. São Paulo: Ibraflor, 2002.
- IBRAFLO- Instituto Brasileiro de Floricultura. **Relatório do diagnóstico da produção de flores e plantas ornamentais brasileira**. São Paulo: Ibraflor, 2005a.
- IBRAFLO- Instituto Brasileiro de Floricultura. **Mercado internacional de flores e plantas ornamentais: características de mercado e do exportador brasileiro**. São Paulo: Ibraflor, 2005b.
- JØRGENSEN, B. Sustainable trade in ornamental horticulture. **Acta Horticulturae**, v. 630, p. 119-123, 2004.
- KLOOSTER, D. Environmental certification of forests in Mexico: the political ecology of a nongovernmental market intervention. **Annals of the Association of the American Geographers**, v. 96, n. 3, p. 541-565, 2006.
- LAESSLE, A. M. A microlimnological studies of Jamaican bromeliads. **Ecology**, v. 42, n. 3, p. 499-517, 1961.
- LEME, E. M. C. **Canistrum Bromélias da Mata Atlântica**. Rio de Janeiro: Salamandra, 1998.
- LEVINS, H. **Symbolism of the pineapple**. New Jersey: Levins, 2009.
- MACQUEEN, D. **Working together: forest-based associations and social justice**. London: IIED, 2009.
- MAILLAT, D. Globalization, innovative milieu and territorial systems of production. **Revista Internacional de Desenvolvimento Local**, v. 3, n. 4, p. 9-16, 2002.
- NAHOUM, P. Bromélia. **Revista Bromélia**, v. 1, n. 1, p. 1- 40, 1994.
- OLIVEIRA, M. G. N.; ROCHA, C. F. D.; BAGNALL, T. The animal community associated with the tank bromeliad *Neoregelia cruenta* (R. Graham) L. B. Smith. **Revista Bromélia**, v. 1, n. 1, p. 22-29, 1994.
- PEIXOTO, O. L. Associação de anuros e bromeliáceas na mata Atlântica. **Revista da Universidade Rural, Série Ciências da Vida**, v. 17, n. 2, p. 75-83, 1995.

- RECH FILHO, A.; DAL VESCO, L. L.; NODARI, R. O.; LISCHKA, R. W.; MULLER, C. V.; GUERRA, M. P. Tissue culture for the conservation and mass propagation of *Vriesea reitzii* Leme and Costa, a bromeliad threatened of extinction from the Brazilian Atlantic Forest. **Biodiversity and Conservation**, v. 14, n. 8, p. 1799-1808, 2005.
- RINDUM, P. Tropisk produktion. **Gartnertidende**, v. 118, n. 8, p. 57-60, 2002.
- ROE, D.; MULLIKEN, T.; MILLEDGE, S.; MREMI, J.; MOSHA, S.; GREIG-GRAN, M. **Making a killing or making a living**: wildlife trade, trade controls, and rural livelihoods. London: IIED, 2002.
- SBB-Sociedade Brasileira de Bromélias. **Bromélias**. Rio de Janeiro: SBB, 2009.
- SEBRAE-Agência de Apoio ao Empreendedor e Pequeno Empresário. **Perfil setorial - Floricultura**. Belo Horizonte: Sebrae, 2005.
- SEMA-Secretaria de Estado de Meio Ambiente. Decreto estadual n. 42.099, publicado em 1/1/2003. **Lista final das espécies da flora ameaçadas**. Rio Grande do Sul, 2003.
- SEMA-Secretaria de Estado de Meio Ambiente. Resolução SMA 48/2004. **Lista oficial das espécies da flora do Estado de São Paulo ameaçadas de extinção**. São Paulo, 2004.
- SILVA, S. P. C.; IZECKSOHN, E.; SILVA, A. M. P. T. C. Diversidade e ecologia de anfíbios em restingas do Sudeste brasileiro. In: ESTEVES, F. A.; LACERDA, L. D. (Ed.). **Ecologia de restingas e lagoas costeiras**. Macaé: Nupem/UFRJ, 2000. p. 89-97.
- STEENS, A. **Bromeliads for the contemporary gardens**. Portland: Timber, 2003.
- TEIXEIRA, R. L.; SCHINEIDER, J. A. P.; ALMEIDA, G. I. The occurrence of amphibians in bromeliads from a Southeastern Brazilian restinga habitat, with special reference to *Aparasphenodon bruno* (Anura, Hylidae). **Brazilian Journal of Biology**, v. 62, n. 2, p. 263-268, 2002.
- TICKTIN, T.; JOHNS, T.; CHAPOL, X. V. Patterns of growth in *Aechmea magdalenae* (Bromeliaceae) and its potential as a forest crop and conservation strategy. **Agriculture, Ecosystems and Environment**, v. 94, n. 2, p. 123-139, 2003.
- TICKTIN, T.; NANTEL, P. Dynamics of harvested populations of the tropical understory herb *Aechmea magdalenae* in old-growth versus secondary forests. **Biological Conservation**, v. 120, n. 4, p. 461-470, 2004.
- VAN TOMME, P.; MARKKULA, A.; LESLIE, R. N. **Non wood forest products in 15 countries of tropical Asia**: an overview. Rome: FAO, 2002.
- WHEELER, W. M. A new case of parabiosis and the "ant gardens" of British Guiana. **Ecology**, v. 2, n. 2, p. 89-103, 1921.
- WHEELER, W. M. Studies on neo-tropical ant-plants and their ants. **Bulletin of the Museum of Comparative Zoology**, v. 90, n. 1, p. 1-262, 1942.
- WITTMAN, P. K. The animal community associated with canopy bromeliads of the Lowland Peruvian Amazon Rain Forest. **Selbyana**, v. 21, n. 1/2, p. 48-51, 2000.
- WUNDER, S. **Value determinants of plant extractivism in Brazil**: an analysis of the data from the IBGE agricultural census. Rio de Janeiro: Institute for Applied Economic Research, 1999. (IPEA Working Paper, n. 682).

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