

AGROFORESTRY: A PROFITABLE LAND USE

Proceedings of the 12th North American Agroforestry Conference

June 4-9, 2011

Athens, GA

ORGANIC YERBA MATE: AN ENVIRONMENTALLY, SOCIALLY AND FINANCIALLY SUITABLE AGROFORESTRY SYSTEM

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Abstract: Trade in yerba mate (YM) (*Ilex paraguariensis*) is a lucrative business in Argentina, Paraguay, and Brazil. YM leaves are locally consumed as a tea with a market expanding to the USA, Europe and Asia, as it contains nearly twice the antioxidant levels of green tea and is energizing, making it an alternative to coffee. Approximately 5 percent of Misiones province, Argentina is in YM production. Many small farmers do not reach acceptable production levels due to lack of adequate technology. Organic YM producers can get up to 20% price surplus and most YM cooperatives have organic YM as one of their products. Typically grown in monocultures, its management can cause erosion and soil exhaustion, however YM naturally grows in subtropical forest and is shade tolerant thus it is adequate for agroforestry systems (AFS). We examined organic AFS of YM with other native trees by conducting semi-structured interviews with farmers in Misiones, including smaller, family-operated farms as well as larger farms, private companies, and private reserves. We recorded a substantial number of individuals of native species. Many farmers have their own nurseries to produce seedlings to use with YM and to sell for additional income. The extra work involved in using the organic practices and planting and tending for the native species is compensated by higher YM prices. YM AFS with native trees improve soil fertility of degraded areas without relying on fertilizers, while providing additional income from the timber of native trees. We conclude that AFS that combine YM with indigenous trees can favor the spread of organic YM production and diversify income in Argentina and elsewhere.

Keywords: Atlantic forest, certification, native species, shade, soil management, sustainability

INTRODUCTION

Trade in yerba mate (YM) (South American holly, *Ilex paraguariensis* Saint Hilaire, Aquifoliaceae) is a lucrative business in Argentina, Paraguay, and Brazil (Day et al. 2011), with an increasingly large market expanding to the USA, Europe and Asia, where it is attractive due to its high antioxidant content and effect as a stimulant (Heck and Mejía 2007). Approximately 5% of Misiones province, Argentina (Fig. 1) is currently in YM production (INYM, Instituto Nacional de la Yerba Mate, National Institute for Yerba Mate, www.inym.org.ar). YM is grown by small or medium to large farmers in Misiones, as a family business, a farmers' cooperative, or large-scale enterprise, both for local consumption and for export. YM (Fig. 2) is native to E Paraguay, NE Argentina, and

S Brazil. Argentina is the most important producer, currently with a total of 203,803 ha. The majority of producers grow <10 ha of yerba mate in their farms, with almost 1/3 of the total area under cultivation but also with the lowest yields per hectare. This is because they are the poorest sector, with challenges incorporating technologies to maintain the productive capacity of the plantations and the soils (INYM 2006).

In Misiones YM is grown on red soils of Ultisol and Alfisol orders with good physical conditions, slightly to strongly acid and of medium to good fertility. In its natural habitat YM occupies a medium stratum and can reach 16 m high. It is tolerant to shade which makes it adapted for agroforestry systems (AFS) (INYM 2006). In small farms, YM is planted in pure plots at 3 or 3.5 m x 1.5 m (1,900 to 2,220 pl/ha). Weeds are controlled manually or with herbicides within the YM lines, while mechanical control is performed in the alleys between the lines. The Program for Assistance to YM Producers (Programa de Asistencia al Sector Yerbatero, PRACY) of INYM, encourages farmers to grow green winter and summer covers to improve soils and help control weeds and pests. Harvesting is done in April-September (fall to winter), and summer (December-February). A major factor in productivity decline of conventional monoculture YM is the gradual decrease of the productive capacity of soils driven by inadequate soil management practices (Fig. 3).

Although due to price instabilities YM production may not be very attractive, organic YM producers can get substantial price surplus. The trend towards organic YM production can be encouraged when it is grown in combination with native trees. In this article we examine the use of organic AFS of YM grown in combination with other native tree species, their ecological and economic benefits, and provide recommendations for improving and expanding these practices.

METHODS

The province of Misiones in NE Argentina is part of the Upper Paraná Atlantic Forest (Fig. 1). The climate is subtropical humid without a dry season, with mean annual precipitation of 2020 mm, uniformly distributed throughout the year, and mean annual temperature of 20°C. The main agricultural crops are YM, tobacco, and tea. Tree plantations include exotic species such as pine (*Pinus taeda* and *Pinus elliottii*), eucalyptus (*Eucalyptus* spp.) and the native araucaria (*Araucaria angustifolia*) (ILANY et al. 2010). We conducted semi-structured interviews with organic YM farmers including smaller, family-operated farms as well as larger farms, private companies, reserves and NGOs. We evaluated land-use history and allocation, the agricultural techniques employed, and the economy of YM production.

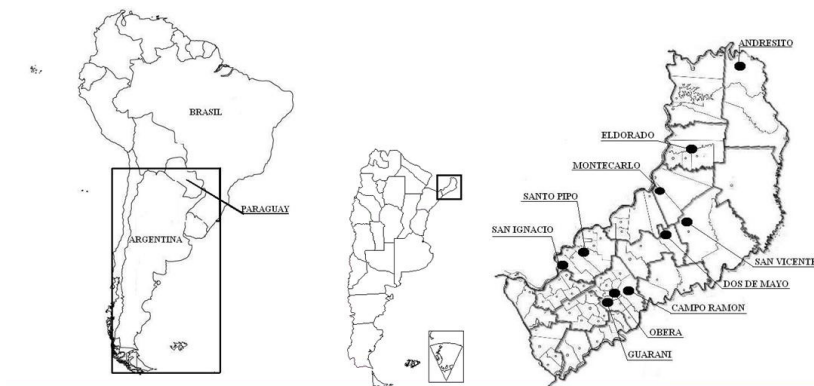


Figure 1. Misiones, Argentina, and localities visited (Map: Marcio López).



Figure 2. (left). Young YM plant, photo: F. Montagnini. **Figure 3.** (right). Soil erosion in conventional YM plantation in Montecarlo, Misiones, photo: N. Pahr.

RESULTS AND DISCUSSION

Guayakí

Guayakí was started in 1996 by partners from Buenos Aires, Argentina, and California, USA (www.guayaki.com). Their organic YM is certified by O.I.A. (Organización Internacional Agropecuaria, International Agriculture Organization), accredited by the USDA. Farmers we visited near Andresito (Fig. 1) had relatively small YM plantations (< 20 ha), and YM production was a supplement to their income. To control weeds, farmers use a roller made of wood which is dragged by a small tractor between the YM lines. The roller pushes the weeds down and creates a layer of organic material that protects against erosion. The participating farmers annually conduct a census of native species in their parcels. They are expected to have about 2,000 individuals of about 30

native species per hectare, of any size, including all life forms, not just trees. Seed sources were apparently available since farmers had patches of natural forests on their properties. Guayakí has a nursery to produce native species to plant with YM, and some farmers have their own nurseries. The extra work involved in using organic practices is compensated by higher prices of YM paid by Guayakí, ~ 2-3 times the “normal” price (Raúl Kolln, pers. comm., May 2009).

Kraus

Kraus, S.A. is a small family enterprise near San Ignacio Miní, one of the most prominent Jesuit-Guarani missions, a tourist attraction in Misiones (Fig. 1) (www.kraus.com.ar). They use a unique drying system that consists of flowing warm air produced by indirect heat that comes from a boiler and provides a smoke-free product which may be specially preferred in foreign markets. There are several patches of native forest within and around the periphery of their 400 hectare farm. Apart from YM (certified by O.I.A.), they grow organic tea, and beef cattle. They control weeds with machete and hoes and use a small tractor with a disk plow between the lines. There is no need for use of pesticides since their YM is healthy and incidence of pest is minimal (Milton Kraus, pers. comm., June 2007). They plant native tree seedlings at 3 m distance from each other, within the YM lines, in late winter after danger is frost has past. Their reforestation project is in collaboration with EcoTeas (www.ecoteas.com).

Roapipó

Roapipó is a 100 hectare farm in Santo Pipó, Department of San Ignacio (www.fundaroth.org) (Fig. 1). Roapipó has about 40 ha of YM, 15 ha of silvopastoral systems, 20 ha of slash pine, and 27 ha of natural forest. YM is processed for local consumption or export at their farm, and it is marketed by “Yerbatera ROAPIPÓ”, certified by O.I.A. We visited YM plantations, the YM processing plant, the native tree nursery, and the protected native forest. A 4 ha, 20-30 year old YM AFS had been planted with the native tree *Cordia trichotoma* (peteribí), with abundant natural regeneration of this species (Fig. 4). Weeding was done with machete, disk plow and roller between the YM lines. All trails and roads were planted with the native, shade-tolerant Jesuit grass (*Axonopus compressus*) to avoid erosion. They do not have disease or pest problems in these AFS, since natural pest predators such as dragon flies and birds help control pests. The nearby forest contributes to maintaining a balance of pest-predator species. FAR is planting new YM clones produced by INTA to renew their old YM (H. R. Würigler and G. Netter, pers. comm., March 2010).

Barney Family

This is a small family business with two farms of 75 has each located near Oberá and Campo Ramón (Fig. 1) (<http://yerbamateannapark.blogspot.com>). The Barney family uses green covers to keep the YM clean of weeds and to protect plants from summer weather. Additional weed control is done with machete and fuel-powered weed cutters around the individual YM plants (Eric Barney, pers. comm., March 2010). They have a small nursery with native tree and fruit species. Their YM is certified by O.I.A., sold locally and for export. They grow tea for additional income. Several native trees grow in the YM lines, both planted and from natural regeneration (Fig. 5).



Figure 4. (left). YM AFS with planted native trees of *Cordia trichotoma* (peteribí), 20-30 years old, at Roapipó. Fig. 5 (right) Cedro (*Cedrela fissilis*) from natural regeneration at the Barney family farm. Photos: B. Eibl.

Ruiz de Montoya Cooperative

The Ruiz de Montoya agricultural cooperative was founded in 1953 and has 230 members (Fig. 1). They have a drying and packing YM facility that processes their brands “Tucangúa” and “Oroyé”, sold locally and exported as certified organic by ARGENCERT. They process approximately 2,500,000 tons annually, of 14 different YM and tea products (www.yerbayetucangua.com.ar). Farms that sell their YM leaves to Ruiz de Montoya cooperative receive technical assistance from the local INTA extension agency. Generally, these producers obtain YM price about 30% higher than that paid by INYM, although at times the cooperative cannot buy the whole volume produced. However, YM can remain in the fields without deterioration so they can delay harvesting to wait for favorable prices (M. Fernández Corda, INTA, pers. comm., March 2010). They do not use herbicides. They weed once or twice a year and just before harvest time using mechanical methods. They allow certain amount of weeds among the YM lines, as they help maintain soil cover and avoid high levels of pests. They promote the natural regeneration of trees in the yerba mate lines and plant some additional native species (Table 1). The farms are inspected twice a year by ARGENCERT representatives at the Cooperative’s expense.

Ecological and economic advantages of organic YM AFS

Table 1 summarizes the species that we found associated with YM in our research and the main traits that make them desirable for combination with YM. Most individuals we found were from natural regeneration in the YM lines, while araucaria, palo rosa, guatambú, loro blanco, peteribí, anchico colorado, lapacho amarillo and lapacho negro had been planted from seedlings by the farmer (Table 1). Several of these species have demonstrated good growth and adaptability in experimental systems in Misiones (Eibl et al. 2000, Montagnini et al. 2006, Barth et al. 2008).

Table 1. Native tree species found growing in AFS of organic YM in this study. Recommended species are marked with an asterisk.

| Scientific Name | Common Name | Botanical Family | Uses | Farm | Ecological characteristics |
|---|------------------------|------------------|-----------------------------|-----------------|--|
| <i>Acrocomia aculeata</i> (Jaq)Lodd ex Mart | acrocomia | Arecaceae | Oil, fuel, wildlife | Barney | Restoration, biological corridors |
| <i>Albizia hasslerii</i> (Chodat) Burkart | anchico blanco | Fabaceae | Fuelwood | Guayakí | N fixation |
| <i>Annona</i> spp. | Araticú | Annonaceae | Fruit | Barney | Restoration, wildlife |
| <i>Apuleia leiocarpa</i> (Vogel) J.F.Macbr. | Grapia | Fabaceae | Timber | Roapipó | Restoration, wildlife, N fixation, slow growth |
| <i>Araucaria angustifolia</i> * (Bertol) Kuntze | araucaria, pino paraná | Araucariaceae | Timber | Kraus | Good timber, monopodic, frost tolerant, sun loving |
| <i>Arecastrum romanzoffianum</i> | Pindó | Arecaceae | Wildlife, honey | All sites | Restoration, biological corridors |
| <i>Aspidosperma polyneuron</i> Mull.Arg. | palo rosa | Apocinaceae | Timber | Guayakí | Slow growing, monopodic growth, shade loving |
| <i>Ateleia glazioviana</i> Baill | Timbó blanco | Fabaceae | Fuelwood | Guayakí | N fixation |
| <i>Balfourodendron riedelianum</i> * (Engl) Engl | guatambú | Rutaceae | Timber | Kraus | Good timber, monopodic growth, slow growing |
| <i>Bastardiopsis densiflora</i> *(HooketArn.)Hassl. | loro blanco | Malvaceae | Timber, honey | Kraus | Improves soils, semi-deciduous, self pruning; sun loving |
| <i>Cabralea canjerana</i> (Vell) Mart | cancharana | Meliaceae | Timber, wildlife | All sites | Fast growing, shade |
| <i>Cecropia pachystachya</i> Trecul | ambay | Cecropiaceae | Wildlife, medicinal | All sites | Fast growing, pioneer, soil improvement, fauna. |
| <i>Cedrela fissilis</i> * Vell. | Cedro | Meliaceae | Timber | All sites | Good timber, monopodic, deciduous, sun loving |
| <i>Cordia trichotoma</i> * (Vell.) Johnst. | peteribí | Boraginaceae | Timber, honey | Roa Pipó, Kraus | Good timber, monopodic, deciduous, soil improver, sun loving |
| <i>Enterolobium contortisiliquum</i> * (Vell.) | Timbó | Fabaceae | Timber | | N fixation, degraded lands, deciduous, sun |
| <i>Euterpe edulis</i> Mart. | palmito | Arecaceae | Palm heart, wildlife, honey | Guayakí | Grows under shade |
| <i>Holocalyx balansae</i> | alecrin | Fabaceae | Timber | Guayakí | Restoration, wildlife |
| <i>Jacaranda semiserrata</i> *, <i>J. micrantha</i> * Cham. | caroba | Bignoniaceae | Timber | All sites | Fast growing, monopodic, deciduous |
| <i>Lonchocarpus muehlbergianus</i> Hassl. | rabo molle | Fabaceae | Timber | Barney | N fixation, slow growing |
| <i>Machaerium</i> spp. | Isapuy | Fabaceae | Timber, fuelwood | | Fast growth, degraded lands |
| <i>Myrocarpus frondosus</i> Allemao | inciense | Fabaceae | Timber, honey | Roa Pipó | Good timber, shade loving |
| <i>Nectandra lanceolata</i> * Nees et Mart. ex Nees | laurel amarillo | Lauraceae | Timber fruit | Guayakí | Grows well in degraded land, self pruning |
| <i>Nectandra megapotamica</i> (Spreng) | laurel negro | Lauraceae | Timber, fruit | | Grows in degraded land |
| <i>Ocotea puberula</i> (Rich) | laurel guaicá | Lauraceae | Timber | Guayakí | Restoration, wildlife |
| <i>Parapiptadenia rígida</i> * (Benth.) Brenan | anchico colorado | Fabaceae | Fuelwood, Timber | | N fixation, open crown, deciduous, sun loving |
| <i>Patagonula americana</i> * L. | guayubira | Boraginaceae | Timber | Guayakí | Monopodic, frost tolerant, sun loving |
| <i>Peltophorum dubium</i> * (Sprengel) Taub. | cañafistola | Fabaceae | Timber, fuel, honey | Kraus | Good timber. Fast growth, degraded lands, deciduous |
| <i>Solanum granulosum-leprosum</i> Dunal | fumo bravo | Solanaceae | Honey, wildlife | All sites | Fast growing, pioneer tree, soil improvement, fauna. |
| <i>Tabebuia</i> spp.* | lapacho amarillo | Bignoniaceae | Timber, fuel, honey | Kraus Barney | Good timber. Deciduous, fast growth, needs pruning |
| <i>Tabebuia heptaphylla</i> * (Vell.) Toledo | lapacho negro | Bignoniaceae | Timber, fuelwood, honey | Kraus Barney | Good timber. Fast growth, deciduous, degraded sites, needs pruning |
| <i>Trema micrantha</i> (L.) Blume | Palo pólvora | | Fuelwood, honey | All sites | Small tree, semideciduous, good soil improvement. |

YM AFS incorporating native trees can improve soil fertility without relying on fertilizers. In a comparison of YM plantations in monoculture and intercropped with the native tree *Araucaria angustifolia*, it was found that soils in the monocultures had higher nutrient content than in the AFS but they were more susceptible to a decline in soil nutrients over time (Ilany et al. 2010). In other research on AFS of YM with native tree species, YM in combination with the N-fixing *Enterolobium contortisiliquum* (timbó) had higher soil P than yerba + *Tabebuia heptaphylla* (lapacho negro). In addition, yerba + timbó, and yerba + timbó and lapacho contained more soil Mg than the other treatments (Day et al. 2011). We have observed better growth and greener YM leaves in plants growing close to timbó trees than in plants growing close to eucalypts (Fig. 6).

Organic certification plays an important role in securing a premium price for an agricultural product. Organic certification has allowed companies to charge double the price for conventional YM export products (Table 2).



Figure 6. Advantages of growing YM associated with the proper trees: YM growing under timbó (*Enterolobium contortisiliquum*, a native, nitrogen fixing tree of good timber) is greener than when growing under eucalypt trees (held by hand for comparison); José Zubczuk's farm in Guaraní, Misiones. Photo: B. Eibl.

Table 2. Prices of YM products in stores in Connecticut, USA, October 2010.

| Product brand | Type | Price in USA dollars | Store |
|------------------------|------------------------------------|----------------------------|---|
| Guayakí | Organic Traditional mate loose tea | 9.99 for a 454 gram pack | Thyme and Seasons Natural Food Store, Hamden, Connecticut |
| The Maté Factor | Organic mate loose tea | 9.45 for a 340 grampack | Thyme and Seasons Natural Food Store, Hamden, Connecticut |
| Wisdom of the Ancients | Organic mate loose tea | 10.99 for a 79.9 gram can | Thyme and Seasons Natural Food Store, Hamden, Connecticut |
| Rosamonte | Loose tea, conventional | 3.99 for a 1000 gram pack | CTown super market, Fair Haven, Connecticut |
| La Hoja | Loose tea, conventional | 3.49 for a 1000 gram pack | CTown super market, Fair Haven, Connecticut |
| Eco-Teas | Organic tea bags | 5.39 for 24 bags, 48 grams | Thyme and Seasons Natural Food Store, Hamden, Connecticut |
| The Maté Factor | Organic tea bags | 6.25 for 24 bags, 84 grams | Thyme and Seasons Natural Food Store, Hamden, Connecticut |
| Wisdom of the Ancients | Organic tea bags | 6.99 for 25 bags, 50 grams | Thyme and Seasons Natural Food Store, Hamden, Connecticut |

CONCLUSIONS

Interest in organic YM cultivation under shade is rapidly increasing. Thus, there is a demand for appropriate knowledge to obtain better YM prices and other income from the trees, along with improved livelihoods and environmental quality. We recommend the following tree species for organic YM AFS: guatambú, peteribí, laurel amarillo, loro blanco, cedro, caroba, araucaria, laurel guaicá, due to their monopodic growth and self pruning ability; as well as lapacho negro, timbó, cañafístola, anchico colorado and curupay of broader crown, with good growth and high quality timber (Table 1). We also recommend other tree, herb or shrub species with fruit, medicinal or ornamental value to increase farm diversification.

ACKNOWLEDGEMENTS

We are grateful to the farmers, technical personnel, business partners and other people involved in YM production in Misiones for sharing their experiences and ideas. This research was supported by the Program in Tropical Forestry of Yale University.

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