

# Organic yerba mate: an environmentally, socially and financially suitable agroforestry system

Florencia MONTAGNINI<sup>1</sup>  
Beatriz I. EIBL<sup>2</sup>  
Sara R. BARTH<sup>2,3</sup>

<sup>1</sup> Yale University  
School of Forestry  
and Environmental Studies  
370 Prospect Street  
New Haven, CT 06511  
USA

<sup>2</sup> Facultad de Ciencias Forestales  
Universidad Nacional de Misiones  
School of Forest Science  
(3380) Eldorado  
Misiones  
Argentina

<sup>3</sup> Instituto Nacional de Tecnología  
Agropecuaria, INTA  
EEA Montecarlo  
Misiones  
Argentina



**Photograph 1.**

A young yerba mate plant (*Ilex paraguariensis* Saint Hilaire, Aquifoliaceae) in Oberá, Misiones.  
Photograph F. Montagnini.

## RÉSUMÉ

### YERBA MATÉ BIOLOGIQUE : UN SYSTÈME AGROFORESTIER EN PHASE AVEC L'ENVIRONNEMENT ET L'ÉCONOMIE SOCIALE ET FINANCIÈRE

Le commerce de la yerba maté, *Ilex paraguariensis* Saint-Hilaire, est un négoce lucratif en Argentine, au Paraguay et au Brésil. Ses feuilles sont consommées comme du thé avec un marché en croissance aux États-Unis, en Europe et en Asie, car elles contiennent des antioxydants, sont énergisantes et constituent ainsi une alternative au café. Environ 5% de la superficie de la province de Misiones en Argentine sont consacrés à la production de la yerba maté. Beaucoup de paysans n'atteignent pas les rendements escomptés faute de techniques appropriées. La yerba maté en culture organique (sans intrants agrochimiques) peut atteindre un prix plus élevé pour les coopératives qui en font un de leurs produits. Traditionnellement gérée en monoculture, son exploitation peut entraîner l'érosion et l'épuisement des sols. Toutefois, la yerba maté pousse en forêt subtropicale et tolère l'ombrage ce qui permet de la cultiver dans des systèmes agroforestiers (SAF). Cette étude examine les SAF avec la yerba maté en culture organique à l'aide d'interviews semi-structurées auprès des paysans de la province de Misiones, y compris les fermes familiales, les grandes fermes, les compagnies privées et les réserves. Un grand nombre d'espèces naturelles poussant en association avec la yerba maté ont été identifiées. Le travail supplémentaire requis par les pratiques de la culture organique est compensé par un meilleur prix de vente. Les SAF, associant yerba mate et arbres, améliorent la fertilité des sols sans recourir aux fertilisants tout en procurant des revenus supplémentaires. Pour cette association l'étude recommande les espèces locales suivantes: *Balfourodendron riedelianum*, *Cordia trichotoma*, *Nectandra lanceolata*, *Bastardiopsis densiflora*, *Cedrela fissillis*, *Jacaranda micrantha*, *Araucaria angustifolia*, et *Ocotea puberula*, du fait de leur développement monopodial et de leur capacité d'auto-élagage; ainsi que *Tabebuia heptaphylla*, *Enterolobium contortisiliquum*, *Peltophorum dubium*, *Parapiptadenia rigida* et *Anadenanthera macrocarpa* avec une couronne plus large; toutes ont une bonne croissance et un bois de qualité. Il est aussi suggéré d'introduire d'autres espèces arborées, herbacées et arbustives de valeur fruitière, médicinale ou ornementale, diversifiant les produits fermiers. Finalement, cette agroforesterie associant yerba maté et espèces locales va promouvoir la diffusion de cette plante en culture organique et diversifier les revenus en Argentine et ailleurs.

**Mots-clés :** forêt atlantique, certification, espèces locales, aménagement des sols, ombrage, durabilité.

## ABSTRACT

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

Trade in yerba mate, *Ilex paraguariensis* Saint Hilaire, is a lucrative business in Argentina, Paraguay, and Brazil. The leaves of yerba mate are consumed as a tea, with a market expanding to the USA, Europe and Asia, as it contains antioxidants and is energizing, making it an alternative to coffee. Approximately 5 percent of the area of Misiones province, Argentina, is in yerba mate production. Many farmers do not reach expected yields due to lack of adequate technology. Organic yerba mate (grown without the use of agrochemicals) can get higher price with most cooperatives having it as one of their products. Typically grown in monocultures, its management can cause erosion and soil exhaustion; however, yerba mate grows in subtropical forest and is shade tolerant so it can be grown in agroforestry systems (AFS). The study examined organic AFS of yerba mate by conducting semi-structured interviews with farmers in Misiones, including family farms as well as larger farms, private companies, and reserves. This review recorded a large number of native species growing in combination with yerba mate. The extra work involved in organic practices is compensated by higher prices. Yerba mate AFS with native trees improve soil fertility without relying on fertilizers, while providing additional income. The following native tree species are recommended for growing in combination with yerba mate: *Balfourodendron riedelianum*, *Cordia trichotoma*, *Nectandra lanceolata*, *Bastardiopsis densiflora*, *Cedrela fissillis*, *Jacaranda micrantha*, *Araucaria angustifolia*, *Ocotea puberula*, due to their monopodial development and self pruning ability; as well as *Tabebuia heptaphylla*, *Enterolobium contortisiliquum*, *Peltophorum dubium*, *Parapiptadenia rigida* and *Anadenanthera macrocarpa* of broader crown, all with good growth and high quality timber. Other tree, herb or shrub species of fruit, medicinal or ornamental value can be also added to increase farm diversification. Finally the study concludes that agroforestry systems combining yerba mate with indigenous trees can promote the spread of organic yerba mate production and diversify income in Argentina and elsewhere.

**Keywords:** atlantic forest, certification, native species, shade, soil management, sustainability.

## RESUMEN

### YERBA MATE ORGÁNICA: UN SISTEMA AGROFORESTAL AMBIENTAL, SOCIAL Y FINANCIERAMENTE ADECUADO

El comercio de la yerba mate, *Ilex paraguariensis* Saint Hilaire, resulta ser un negocio lucrativo en Argentina, Paraguay y Brasil. Las hojas de yerba mate se consumen como té, con mercado expandiéndose a USA, Europa y Asia, ya que contiene antioxidantes y es energizante, siendo una alternativa al café. Aproximadamente 5 por ciento de la superficie de la provincia de Misiones en Argentina está dedicada a la producción de yerba mate. Muchos agricultores no obtienen los rendimientos esperados debido a la falta de tecnología adecuada. La yerba mate orgánica (producida sin el uso de agroquímicos) puede obtener precios más altos siendo uno de los productos de la mayoría de las cooperativas. Típicamente plantada en monocultivo, su manejo puede causar erosión y agotamiento del suelo, sin embargo la yerba mate crece en bosque subtropical y es tolerante a sombra es decir que puede cultivarse en sistemas agroforestales (SAF). Se estudió los SAF de yerba mate orgánica conduciendo entrevistas semi-estructuradas con agricultores en Misiones, incluyendo chacras familiares así como establecimientos más grandes, compañías privadas y reservas. Se identificó gran cantidad de especies nativas creciendo en asociación con yerba mate. El trabajo extra requerido por las prácticas orgánicas se compensa con los mayores precios. Los SAF de yerba mate con árboles nativos mejoran la fertilidad del suelo sin necesidad de fertilizantes y proveen ingresos adicionales. Se recomienda las siguientes especies arbóreas nativas para asociación con yerba mate en SAF: *Balfourodendron riedelianum*, *Cordia trichotoma*, *Nectandra lanceolata*, *Bastardiopsis densiflora*, *Cedrela fissillis*, *Jacaranda micrantha*, *Araucaria angustifolia*, *Ocotea puberula*, de desarrollo monopódico y poda natural, así como *Tabebuia heptaphylla*, *Enterolobium contortisiliquum*, *Peltophorum dubium*, *Parapiptadenia rigida* y *Anadenanthera macrocarpa* de copa amplia, todas de buen crecimiento y madera de alta calidad. Asimismo se recomienda incluir otras especies arbóreas, herbáceas o arbustivas frutíferas o con valor medicinal u ornamental para aumentar la diversificación. Finalmente este estudio concluye que los sistemas agroforestales que combinan yerba mate con árboles nativos pueden promover la difusión de yerba mate orgánica y diversificar los ingresos en Argentina y otras regiones.

**Palabras clave:** bosque atlántico, certificación, especies nativas, manejo del suelo, sombra, sostenibilidad.

## Introduction

Trade in yerba mate *Ilex paraguariensis*, (South American holly), is a very lucrative business in Argentina, Paraguay, and Brazil (DAY *et al.*, 2011). Yerba mate leaves are processed into a tea that is traditionally consumed in Argentina, Uruguay, Brazil and Paraguay, with an increasingly large market expanding to the USA, Europe and Asia. The infused drink made from yerba mate contains nearly twice the antioxidant levels of green tea and is nutritious and energizing, making it a good alternative to the consumption of coffee (HECK, MEJÍA, 2007). In South America yerba mate has largely remained a drink of habit and culture, typically prepared in a traditional gourd. However, in recent years it has grown increasingly popular in the USA, where it is attractive due to its high antioxidant content and effect as a stimulant, equivalent to about half the caffeine of coffee but with fewer “jitters”. It is sold in a variety of forms, including loose-leaf mate, tea bags, ready-to-drink bottled mate, and energy products (COELI, 2009).

Argentina is the most important producer, with a total of 203,803 hectares (ha), of which about 75% are in Misiones with the rest in the neighboring province of Corrientes ([www.inym.org.ar](http://www.inym.org.ar)). Approximately 5% of the Misiones province is currently in yerba mate production (INYM<sup>1</sup>, 2006). Yerba mate 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.

### Yerba mate cultivation in Argentina: history and current trends

Yerba mate, *Ilex paraguariensis* Saint Hilaire, Aquifoliaceae (photograph 1) is a medium size tree species native to a relatively large region encompassing eastern Paraguay, northeastern Argentina, and southern Brazil. When the Spanish colonists arrived in the 15<sup>th</sup> century, they observed the Guarani indigenous people consuming it as an infusion made with dry and ground leaves. The Jesuit priests who established their religious missions in Misiones, which gave the Province its name, observed that the Guarani people who drank mate stayed awake for longer and could work harder than those who did not. The Spanish people adopted its use relatively quickly. Domestication of the species started during the 18<sup>th</sup> century, and the first successful plantations were established in the early 1900s in San Ignacio, Misiones. By 1935, there were a total of 66,000 ha in cultivation; and by the late 1980s, there were already about 165,000 ha planted with yerba mate in Misiones (BURTIK, 2006).

In order to maintain quality and pricing levels for small and medium farmers, rigid quotas dominated yerba mate production until the 1950s (LAWSON, 2009). The relaxation of these rules and the subsequent surge in plantings and production led to an oversupply and a return of the quota system until 1989 (SCHAMBER, 2000). Yerba mate cultivation expanded following consumers' demand until an over production crisis in 1995. Since the creation of the INYM in 2002, prices have improved and increasing the productivity of existing yerba mate plantations became important to the sector.

<sup>1</sup> Instituto Nacional de la Yerba Mate, National Institute for Yerba Mate, [www.inym.org.ar](http://www.inym.org.ar).



**Photograph 2.**  
Soil erosion and degradation due to soil cultivation practices in a conventional yerba mate plantation in Montecarlo, Misiones.  
Photograph N. Pahr.

As seen in table I, the majority of producers grows less than 10 ha of yerba mate in their farms, but represent almost one third of the total area under cultivation. However, they also have the lowest yields per hectare. This trend is because they are the poorest and most vulnerable sector, resulting in challenges incorporating technologies to maintain the productive capacity of the plantations and the soils. According to INYM, adoption of new management practices is the lowest in plantations less than 20 ha in size. In Misiones about 15% of producers have high density plantations, higher than 1,800 plants per hectare (pl/ha), about 48% have medium density (1,000-1,800 pl/ha), and the remaining 30-35% are low density (table I). In addition, low density plantations are generally on soils that have been degraded after over 80 years of continuous monoculture (INYM, 2006). In the past decade, the smaller producers with densities of fewer than 1,000 plants per hectare and low technology suffered the greatest impacts from the low price of yerba mate, as a result of production volumes that exceeded demand.

In response to the increasing marginalization of small farmers through the market conditions created by neo-liberal policies, small and medium-sized yerba mate farmers initiated a series of social movements in order to revitalize declining livelihoods in the 1990s. With the ten largest companies controlling 80% of yerba mate production in Misiones, small and medium-sized farmers began to organize into cooperatives. As cooperatives promoted an ethic of solidarity, integrity, and equality, combined with an institutional structure and economic power within the yerba mate market, cooperatives began to find their voice within the political economy of yerba mate (LAWSON, 2009).

**Table I.**  
Composition of the productive sector of yerba mate in Argentina.

Size of yerba mate plantation	Number of farmers	Area (ha)	Yields (green leaves, kg/ha)
0-10 ha	13,191	73,535	4,250
10-50 ha	3,882	78,224	5,310
50-100 ha	246	16,945	6,110
100-200 ha	79	10,914	6,120
Larger than 200 ha	46	23,665	7,472
Total	17,444	203,283	5,323

Source: INYM, 2010.



**Photograph 3.**  
Yerba mate AFS with exotic species: kiri (*Paulownia* spp.), in Campo Ramón, Misiones.  
Photograph F. Montagnini.

## Ecology and cultivation of yerba mate

As a tropical or subtropical tree species, yerba mate requires high temperatures, high soil and ambient humidity, and deep and well-drained soils. In Misiones yerba mate is grown on red soils locally known as “tierra colorada” of the Ultisol and Alfisol orders, with good physical conditions, slightly to strongly acid and of medium to good fertility. These soils are low in organic matter, nitrogen, and phosphorus (FERNÁNDEZ *et al.*, 1997). In its natural habitat yerba mate forms part of the subtropical forest, occupying a medium stratum and reaching up to 16 meters in height. This characteristic means that it is tolerant to certain amount of shade and it is capable of growing in association with other trees, which makes it adapted for use in agroforestry systems (INYM, 2006).

In small farms, yerba mate is planted in pure plots from nursery seedlings at 3 or 3.5 m x 1.5 m distance (1,900 to 2,220 pl/ha). Older plantations are found at 3 m x 3 m or 3.5 m x 3.5 m and even broader planting distances. Weeds are controlled manually or with herbicides within the yerba mate lines, while mechanical control with disk plows or weeding tools is performed in the alleys between the yerba mate lines. In Misiones, the Program for Assistance to Yerba Mate Producers (Programa de Asistencia al Sector Yerbatero, PRACY) of INYM, encourages farmers to grow green winter covers with rye grass, *Lolium* spp., or black oats, *Avena strigosa*, and summer green covers with cowpea, *Vigna unguiculata*, dwarf Mucuna, *Stylobium* spp., or poroto sable, *Canavalia ensiformis*. The green covers improve soil physical and biological conditions, decreasing soil temperatures and helping control weeds and pests.

To prepare the plants for future harvests, during the early years pruning is done to favor sprouting of multiple and vigorous stems, encouraging the formation of a broad crown. Harvesting is done between April and September (fall to winter), and there is also a summer harvest from December to February. Harvesting by completely defoliating the tree is not recommended, as it leads to low yields (BURTNIK, 2006).

One of the principal reasons for the decline in productivity is longevity, i.e., farmers keep older yerbales (yerba mate plantations) in production. A major factor in productivity decline of yerbales over time is the gradual decline of the productive capacity of soils driven by inadequate soil management practices (DE BERNARDI, PRAT KRICUN, 2001). High annual precipitation and temperatures and sloping hills lead to soil erosion and degradation once the original forest cover is removed; while rates of mineralization of soil organic matter are accelerated due to inadequate soil management practices (photograph 2). Many farmers do not attain expected production levels due to weather abnormalities (drought, storms) or lack of adequate technology (improved genetic material, adequate planting density, correct and timely pruning practices, height and timing of leaf harvest, and use of sustainable soil management practices).

## Growing yerba mate in agroforestry systems

Agroforestry (growing crops in combination with trees) can be a useful tool to rehabilitate land degraded by intensive agriculture. Agroforestry systems (AFS) can minimize erosion, reduce or eliminate the use of fertilizers due to increased nutrient cycling or the use of nitrogen fixing trees, reduce or eliminate the use of agrochemicals due to weed suppression and/or pest management, and provide additional income to the farmer through diversification of products (MONTAGNINI *et al.*, 2005, 2006). AFS can also contribute to environmental services such as biodiversity conservation and carbon sequestration (MONTAGNINI *et al.*, 2005).

Experiences involving other perennial crop-tree combinations such as those of cacao, *Theobroma cacao*, coffee, *Coffea* spp., and tea, *Camellia sinensis*, provide baseline insight into how intermediate sub-canopy tree species can function in AFS. Several studies of shaded coffee and cacao report the beneficial effects of shade on production and on shade tree selection for optimum productivity, quality, and pest management (SOMARRIBA *et al.*, 2001). In Misiones, the most widespread AFS of trees associated with perennial crops are hedges of grevillea, *Grevillea robusta*, in tea plantations. There are also yerba mate AFS with native trees such as pino Paraná or araucaria, *Araucaria angustifolia*, peteribí or loro negro, *Cordia trichotoma*, among others, as well as with exotic species such as kiri, *Paulownia* spp., paraíso, *Melia azedarach*, and pines, *Pinus elliotti* and *P. taeda* (photograph 3).



**Photograph 4.**

Some farms that sell their product to Guayakí control weeds using a roller made of wood which is dragged by a small tractor between the yerba mate lines. The roller creates a layer of organic material that protects against soil erosion. Photograph S. Barth.

## Organic farming: an increasing trend contributing added-value to yerba mate

Although due to price instabilities yerba mate production may not be very attractive, organic yerba mate producers can get substantial price surplus on their product. The current increasing trend towards organic yerba mate production, *id est*, not using any agrochemicals, can be encouraged when the yerba mate is grown in combination with native trees. For example, some private companies that certify organic farming in Argentina, require the use of buffer strips with native trees to prevent wind-carried agrochemicals from nearby farms from reaching the organic yerba mate fields. Other organic buyers require farmers to have a minimum number of native species in the yerba mate fields. Thus, farmers today need to learn what native tree species are best to grow in combination with their organic yerba mate.

Currently, most yerba mate cooperatives have organic yerba mate as one of their leading products (LAWSON, 2009). Since Misiones has favorable ecological and soil conditions for yerba mate, it is important to take advantage of the opportunity presented by the implementation of novel production technologies, along with innovative strategies of commercialization such as developing new organic yerba mate-based teas and drinks.

In this article we examine the use of organic AFS of yerba mate grown in combination with other native tree

species in Misiones, their ecological and economic benefits, and provide recommendations for improving and expanding these practices. Three objectives of this research were to:

- Determine the current land use practices of organic yerba mate farmers, focusing on their agricultural techniques and the possibility of expanding organic AFS;
- Find out what are the best native tree species to combine with yerba mate in organic AFS;
- Determine the potential for increasing organic yerba mate AFS using native trees with economic (timber, fuelwood) and environmental (carbon sequestration, biodiversity) values.



## Study site: Misiones, Argentina

The province of Misiones in NE Argentina is part of the Upper Paraná Atlantic Forest (figure 1). The Atlantic Forest extends throughout Brazil, Paraguay, and Argentina, and is one of the most endangered ecosystems in the world. Only 7% of the original Atlantic Forest exists, and Misiones contains the largest continuous expanse (HOLZ, PLACCI, 2003). Misiones with approximately 30,000 km<sup>2</sup>, is less than 1% of the country's area; however, it harbors almost 40% of the biodiversity and produces over 75% of the country's timber. The climate is classified as Cfa in the Köppen system, corresponding to a subtropical humid climate without a dry season, with mean annual precipitation of 2,020 millimeters, uniformly distributed throughout the year, and mean annual temperature of 20°C, with an absolute maximum of 40°C (January) and absolute minimum of -7°C (July) (SILVA *et al.*, 2008). The main agricultural crops in Misiones are yerba mate (167,722 ha), tobacco (26,380 ha), and tea (34,900 ha). Government subsidies also contribute to rapid increases in tree plantations (384,948 ha), which mainly include exotic species such as pine, *Pinus taeda* and *Pinus elliottii*, eucalyptus, *Eucalyptus* spp. and the native araucaria, *Araucaria angustifolia* (LANY *et al.*, 2010).

Figure 1.

Map showing the province of Misiones in Argentina, and localities mentioned in this article.

## Methods

An enquiry was conducted with semi-structured interviews with organic yerba mate farmers in Misiones, including smaller, family-operated farms as well as larger farms, private companies and private reserves and NGOs (table II). This enquiry covered a broad range of the yerba mate growing region of Misiones from Andresito in the northeast corner of the province bordering Brazil, to Santo Pipó, San Ignacio, and Oberá in the south, and San Vicente and Dos de Mayo in the central region (figure 1). During each visit, questions were used to evaluate land-use history and allocation, the agricultural techniques employed, and the political economy of yerba mate production. Interviews included a walk through the yerba mate fields and observations of the current yerba mate growing systems.

## Results and Discussion

### Guayakí

Guayakí is an organic, fair-trade yerba mate company started in 1996 by partners based in Buenos Aires, Argentina, and California, USA ([www.guayaki.com](http://www.guayaki.com)). They promote yerba mate products in the USA, while engaging in growing and harvesting yerba mate with participating farmers and indigenous groups in Paraguay, Argentina and Brazil. Guayakí yerba mate is a USDA<sup>2</sup> organic product certified by OIA<sup>3</sup>, an international certification body accredited by IFOAM<sup>4</sup>. In addition, in 2009 Guayakí became the first Fair Trade Certified yerba mate company in the world (COELI, 2009).

<sup>2</sup> United States Department of Agriculture.

<sup>3</sup> Organización Internacional Agropecuaria, [www.oia.com.ar](http://www.oia.com.ar).

<sup>4</sup> International Federation of Organic Agriculture Movements, [www.ifoam.org](http://www.ifoam.org).

Much of Guayakí's yerba mate leaves come from the COFAECO cooperative in San Mateo do Sul, Paraná, the center of yerba mate production in Brazil. This cooperative includes about 25 small farmers who produce 20 tons organic yerba mate annually mainly under the shade of older native araucaria trees that are forbidden to be cut by law. The Guayakí company originated in Paraguay, where Guayakí buys yerba mate from indigenous peoples who plant yerba mate in the forest understory, such as the Aché Guayakí who are compensated for the use of their name with a licensing fee paid to the tribe, an example of how sustainable development can empower indigenous populations as part of a successful commercial endeavor (COELI, 2009).

**Table II.**  
**Organic yerba mate farms visited in Misiones, Argentina, 2007-2010.**

Farm	Location	Farm size (ha)	Farmer's activities	Weed control	Cover crops	Native species recorded in yerba mate	Certification
Guayakí	Andresito and nearby locations	Varied, < 20 ha	Other outside employment, nurseries	Wood roller, machete, small tractor with weed cutter	Natural vegetation that remains after weeding	Cañafístola, fumo bravo, pindó, isapuy, timbó blanco, cacharana, caroba, palo rosa, palmito, laurel guaicá, laurel amarillo, laurel negro, timbó colorado, guayubira, anchico, loro negro (natural regeneration)	Organic, Fair Trade, Kosher, OIA, accredited by US Department of Agriculture
Kraus S.A.	Colonia Santo Domingo Savio, San Ignacio	400	Organic tea, beef cattle	Manually with machete, hoes, and use also a small tractor with disk plow	Natural vegetation that remains after weeding	Lapacho amarillo, lapacho negro, cañafístola, loro negro, cedro, anchico, araucaria (planted)	Organic, Fair Trade, Kosher certified by OIA
Roapipó	Santo Pipó, Department of San Ignacio	100	40 ha yerba, 15 ha silvopastoral systems, 20 ha pine, nursery plantations, 27 ha natural forest	Machete, disk plow and roller	Jesuit grass ( <i>Axonopus compressus</i> ) in trails and roads	Peteribí (planted), cedro, incienso, pindó, rabo molle, loro blanco, anchico, cancharana, timbó, grapia (in yerba under forest)	Yerbatera ROAPIPO certified by OIA
Barney Family	Oberá and Campo Ramón	Two farms of 75 ha each	13 ha of natural unexploited subtropical rainforest, tea	Machete and fuel-powered weed cutters	Kuratú ( <i>Coriandrum sativum</i> ), Avena Negra Criolla, <i>Vicia villosa</i> , mucuna enana and elephant grass	Acrocomia, pindó, anchico blanco, fumo bravo, araticu, cedro, guatambú, cancharana, laurel guaicá (natural regeneration), lapacho negro, lapacho amarillo (planted)	OIA
Ruiz de Montoya Cooperative	San Vicente, Dos de Mayo	Several small farms ~50 ha each	Tea, citrus trees, horticultural crops, fish farming	Sling blade, machete, small tractor with weed cutter, small tractor with disk plow	Natural vegetation	Cancharana, loro negro, caroba (natural regeneration), cañafístola (planted)	ARGENCERT



**Photograph 5.**

Yerba mate with native species (pindó and laurel guaicá) growing in the lines in the farm owned by Victor Jacinsky, who sells yerba mate to Guayakí in Andresito, Misiones. Photograph S. Barth.

Farmers we visited associated with the company in Andresito, Misiones had relatively small yerba mate plantations (< 20 ha), and its production was a supplement to their income. Use of agrochemicals or machinery or tools that could damage vegetation and soils is not allowed. To control weeds, some farmers use a roller made of wood which is dragged by a small tractor between the yerba mate lines that does not cut the weeds, but pushes them down and creates a layer of organic material and protects against soil erosion (photograph 4).

The participating farmers conduct an annual census of native species in their parcels. They are expected to have about 2,000 individuals belonging to at least about 30 native species per hectare of any size and life forms, not just trees. We recorded a variety of native species growing in the yerba mate lines, many originating from natural regeneration, which is favored by organic practices as well as by seed sources and other propagules from surrounding patches of natural forests (table II) (photograph 5). Guayakí has a nursery to produce native species, and farmers are encouraged to have their own nurseries to produce their own seedlings and to sell for additional income. The extra work involved in using the organic practices is compensated by higher prices paid by Guayakí, about 2-3 times the “normal” price.

Recently Guayakí purchased land for a reserve managed by the Iguazú Agroecological Foundation (Fundación Agroecológica Iguazú) to serve for research on ecological restoration, dissemination and training, using the Guayakí experience on sustainable agriculture in the Atlantic Forest ecoregion of Argentina, Paraguay and Brazil.

## 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 (figure 1, table II). The Kraus family has maintained the pioneering spirit of their ancestors who started growing yerba mate in the early 1900s, and it was the first Argentine company to supply organic green tea to the domestic market and for export ([www.kraus.com.ar](http://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 (photograph 6).

There are several patches of native forest within and around the periphery of their 400 hectare farm (photograph 7). Apart from yerba mate (certified by OIA), 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 yerba mate is healthy and incidence of pest is minimal.

They plant native tree seedlings at 3 m distance from each other, within the yerba mate lines, in late winter after danger of frost has past. Their reforestation project is in collaboration with EcoTeas ([www.ecoteas.com](http://www.ecoteas.com)). The School of Forest Science of the University of Misiones in Eldorado, collaborates with them and provides advice on species choice, care and maintenance. Kraus buys seedlings of native trees from local nurseries that produce seedlings for reforestation of degraded land as part of ProSoBo, a social forestry project run by the Secretary of the Environment of Argentina ([www.ambiente.gov.ar](http://www.ambiente.gov.ar)). Several native trees growing from natural regeneration and from plantings in the lines of a 15 year old yerba mate plantation (Table II) were recorded. Yerba of this size effectively protects the young seedlings from excess insolation in summer and occasional frost in winter.



**Photograph 6.**

The drying system at Kraus' farm that enables them to provide a smoke-free product that may be preferred in foreign markets. Photograph B. Eibl.



## Roapipó

Roapipó is a 100 ha farm that a Swiss settler, Alberto Roth bought in 1925 in Santo Pipó, Department of San Ignacio (figure 1, table II). Mr. Roth designed a set of novel soil conservation methods maintaining good soil cover to avoid soil loss and increase nutrient recycling, and pioneered the planting of native trees, which was considered worthless at a time when Misiones maintained considerable forest cover ([www.fundaroth.org](http://www.fundaroth.org)). Roth introduced the art of composting and production of organic fertilizer using earthworms. He planted yerba mate following contour lines to avoid erosion. He practiced selective clearing without burning (“rozado sin quemar”), felling the tallest trees and keeping many young trees standing to allow the planted yerba mate seedlings to grow in a more natural setting.

The Fundación Alberto Roth (FAR) (Alberto Roth Foundation) is currently adapting Roth’s methods to include the use of machinery. The Roapipó yerbales use winter green covers of vicia, *Vicia villosa*, a leguminous herb which reseeds itself every year, germinates in early fall, and leaves a mat of dry material that lasts into early summer delaying weed germination. Roapipó currently has about 40 ha of yerba mate, 15 ha of silvopastoral systems, 20 ha of slash pine, *Pinus elliotii*, and 27 ha of natural forest. Animal husbandry is essential for the production of organic manure, which is composted with the use of Californian earthworms (“lombricompost” or “earthworm compost”). Yerba mate is processed in the mills and packing plant at the Roapipó farm, and it is marketed by the company “Yerbatera ROAPIPÓ”, certified by OIA (photograph 8).

They have a 4 ha, 20-30 year old yerba mate AFS which had been planted with pteribí, *Cordia trichotoma*, a native tree of valuable timber, with abundant natural regeneration in the understory (photograph 9). Initial site preparation was done with disk plow to improve water infiltration. Weeding was done with machete, disk plow and roller between the yerba mate lines. In another site with about 50 year old yerba mate planted in forest after selective logging there were several adult trees of valuable timber species (photograph 10, table II).

All trails and roads are planted with the native, shade-tolerant Jesuit grass, *Axonopus compressus*, to avoid erosion but have to be controlled because it can become invasive. They do not have disease or pest problems in these mixed systems. Management can also affect the presence of pests: for example, when harvest is done late, the new yerba mate sprouts are more prone to pest attacks because they are weaker than when the harvest is done earlier in the season. In these AFS, good populations of natural pest predators such as dragon flies and birds help to control pests such as grasshoppers and worms. The nearby forest likely contributes to maintaining a natural balance of pest-predator species.

Their native species nursery is well equipped with irrigation and shade as needed. They grow seedlings in tubes on a substrate of pine needles and organic compost. Seeds of native forest species are collected by local people, many of whom belong to the indigenous Takuapí village nearby.



**Photograph 7.**

Yerba mate field at Kraus’ farm near San Ignacio, Misiones showing soil cover and remnant forest in the background. Photograph F. Montagnini.



**Photograph 8.**

Packing plant located at Roapipó farm. Their yerba mate is marketed by ‘Yerbatera ROAPIPÓ’, certified by the OIA. Photograph F. Montagnini.

In the native forest, observations showed a great diversity of native trees and lianas that give their name to the 300 m long trail, *Tapé Ysyó* (in Guaraní: liana trail) (photograph 11). The forest trail is part of a Roapipó ecotourism project. They also have a 900 m long agricultural trail that serves to acquaint tourists with their organic yerba mate production system. Visits to the native species nursery, yerba mate processing plant, historic original house with lodging facilities, and a small museum complement the tours.



**Photograph 9.**  
Yerba mate AFS with planted native trees of *Cordia trichotoma* (peteribí), 20-30 years old, at Roapipó, Santo Pipó, Misiones.  
Photograph B. Eibl.



**Photograph 10.**  
AFS of 50 year-old yerba mate planted in a forest after selective logging, with several adult trees of valuable timber species at Roapipó, Santo Pipó, Misiones.  
Photograph F. Montagnini.

### Barney Family

This is a small family business with two farms of 75 ha each located near Oberá and Campo Ramón (figure 1). They own the Anna Park Biological Reserve with 13 ha of natural subtropical rainforest, which is part of the Misiones Green Corridor and has protected status from the Misiones' Ministry of Ecology and Natural Resources. Yerba mate cultivation is a productive alternative that generates sustainable income for the reserve (<http://yerbamateannapark.blogspot.com>). The Barney family uses green covers to keep the yerba 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 plants. They have a small nursery with native tree and fruit species. Their yerba mate is certified by OIA, sold locally and for export. They grow tea for additional income, bordered by natural forest and lines of *Grevillea robusta* trees.

Several native trees grow in the yerba mate lines, both planted and from natural regeneration in the yerba mate lines, including palms, fruit trees, and valuable timber species such as cedro, *Cedrela fissilis* (table II, photograph 12). Laurel guaicá, *Ocotea puberula*, was the only species that had been planted.

### Ruiz de Montoya Cooperative

The Ruiz de Montoya agricultural cooperative was founded in 1953 and has 230 members located around the town of the same name and others nearby (figure 1). They have a drying and packing facility that processes their brands "Tucanguá" and "Oroyé", sold locally and exported as certified organic by ARGENCERT. They process approximately 2,500,000 tons annually, of 14 different yerba mate and tea products ([www.yerbayetucangua.com.ar](http://www.yerbayetucangua.com.ar)). The farms located near the towns of San Vicente and Dos de Mayo (figure 1) sell their unprocessed yerba mate leaves to Ruiz de Montoya cooperative and receive technical assistance from the local INTA extension agency. Generally, these producers obtain prices about 30% higher than that paid by INYM, although at times the cooperative cannot buy the whole volume produced. However, yerba mate can remain in the fields without deterioration so they can delay harvesting to wait for favorable prices. The farms are inspected twice a year by ARGENCERT representatives at the Cooperative's expense.

Near the town of Dos de Mayo we visited a farmer who owns about 50 ha, of which 14 ha are in yerba, the rest are planted with tea, citrus trees, and horticultural crops for family consumption and extra cash. There are about 8 farmers with similar arrangements who have started organic production in the last 4-5 years, others are getting their certification, and others are making a decision. It is relatively easy for farmers to convert to organic production because as yerba mate has historically held relatively low prices, farmers use low-input production.

They do not apply herbicides, which is the main chemical used in yerba mate production. They weed once or twice a year and just before harvest time using a sling blade, machete, and a small tractor with a disk plow set high so it does not reach the soil. They allow certain amount of weeds among the yerba lines to maintain soil cover and avoid high levels of pests. They promote the natural regeneration of

**Photograph 11.**

A 300 m long trail, *Tapé Ysypó* (in Guarani: liana trail), at forest reserve at Alberto Roth Foundation. Patches of natural forests in farmer's properties serve as sources of seeds and other propagules that promote the natural regeneration of native species in yerba mate AFS. Photograph: F. Montagnini.

**Photograph 12.**

Cedro (*Cedrela fissilis*) from natural regeneration at the Barney family farm near Oberá, Misiones. Photograph: B. Eibl.

trees in the yerba mate lines and plant some additional native species. Fumo bravo, *Solanum granulosum-leprosum*, is one of the first species to appear from natural regeneration, attracting birds that contribute dispersal of more valuable species (table III). Cañafístola, *Peltophorum dubium*, is one of the preferred species in yerbales, as it can be planted from both seeds and stakes. They prefer native trees species instead of pines, because pine needles affect the flavor of yerba mate. Many of their seedlings are produced in a small nursery at a local elementary school.

## Selecting tree species for organic yerba mate AFS

It is important that species chosen for yerba mate AFS have a root structure that minimizes competition with yerba mate and crowns that are not too broad or dense so they do not provide too much shade for the yerba mate. Some species can have additional characteristics of interest such as attracting fauna that can contribute to pest control. It is also helpful when trees lose their leaves in autumn/winter, allowing greater light penetration during the seasons when there is less light available. Deciduous trees will also transpire less, thus reducing competition for water.

Table III summarizes the species that we found associated with yerba mate in our research and the main traits that make them desirable for combination with yerba mate. Several of these species have demonstrated good growth and adaptability in experimental systems in Misiones. For example, BARTH *et al.* (2008) searched productive alternatives for the recovery of degraded soils in Misiones and found that guatambú, *Balfourodendron riedelianum*, and lapacho negro, *Tabebuia heptaphylla*, showed the best adaptability and growth, timbó, *Enterolobium contortisiliquum*, urunday, *Astronium balansae*, and cañafístola, *Peltophorum dubium*, had good growth, while rabo molle, *Lonchocarpus muehlbergianum*, had low adaptability in the most degraded sites.

In a long-term experiment to test growth and productivity of yerba mate in AFS with native trees, EIBL *et al.* (2000) found that *I. paraguariensis* suffered no loss in yield when intercropped with *Enterolobium contortisiliquum* (a nitrogen fixing tree species) or *Balfourodendron riedelianum*, although on a per hectare basis it did not produce as much as in monoculture due to the lower number of yerba mate plants in the AFS. In the same experiment, DAY *et al.* (2011) examined soil nutrient content and plant health of the AFS and compared it to a yerba mate monoculture, mature secondary forest, and a nearby degraded agricultural field. Results indicated no competition for nutrients was occurring between the yerba mate plants and the trees, with some soil improvement occurring in the long term.

Considering all the visits to organic yerba mate farms and field experiences mentioned above, the following species could be recommended: guatambú, peteribí, laurel amarillo, loro blanco, cedro, caroba, araucaria, laurel guaicá, due to their monopodial development and self pruning ability; and a second group with lapacho negro, timbó, cañafístola, anchico colorado and curupay with broader crown. All these species have good growth and high quality timber (table III). Other species may also have good potential and deserve attention in future work. For example, fruit, medicinal, or ornamental species, including not only trees, but also herbs or shrubs would increase farm diversification.

**Table III.**  
**Native tree species found growing in AFS of organic yerba mate in this study.**  
**Recommended species are marked with an asterisk.**

SCIENTIFIC NAME	COMMON NAME	BOTANICAL FAMILY	USES	FARM/SITE WHERE IT WAS FOUND	PLANTED OR FROM NATURAL REGENERATION	OTHER CHARACTERISTICS
<i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.	Acrocomia	Arecaceae	Oil, fuel, wildlife, ornamental	Barney	Nat regen	Restoration, biological corridors
<i>Albizia hasslerii</i> (Chodat.) Burkart	Anchico blanco	Fabaceae	Fuelwood	Guayakí	Nat regen	Nitrogen fixation
<i>Anadenantera macrocarpa</i> (Benth.) Brenan	Curupay	Fabaceae	Fuelwood, Timber	Guarani	Planted	Nitrogen fixation, open crown, deciduous, sun loving
<i>Annona</i> spp.	Araticú	Annonaceae	Fruit	Barney	Nat regen	Restoration, wildlife
<i>Apuleia leiocarpa</i> (Vogel.) J. F. Macbr.	Grapia	Fabaceae	Timber	Roapipó	Nat regen	Restoration, wildlife, N fixation, slow growth
<i>Araucaria angustifolia</i> * (Bertol.) Kuntze	Araucaria, pino paraná	Araucariaceae	Timber	Kraus	Planted	Excellent timber. Monopodic growth. Tolerant to frost. Sun loving
<i>Arecastrum romanzoffianum</i> (Cham.) Becc.	Pindó	Arecaceae	Ornamental, wildlife, honey	All sites	Nat regen	Restoration, biological corridors
<i>Aspidosperma polyneuron</i> Mull. Arg.	Palo rosa	Apocynaceae	Timber	Guayakí	Planted	Slow growing, monopodic growth, shade loving
<i>Ateleia glazioviana</i> Baill.	Timbó blanco	Fabaceae	Fuelwood	Guayakí	Nat regen	Nitrogen fixation
<i>Balfourodendron riedelianum</i> * (Engl.) Engl.	Guatambú	Rutaceae	Timber	Kraus	Planted	Excellent timber, monopodic growth, slow growing
<i>Bastardiopsis densiflora</i> * (Hook. et Arn.) Hassl.	Loro blanco	Malvaceae	Timber, honey	Kraus	Planted	Increases soil pH, cations; semi-deciduous, self pruning; sun loving
<i>Cabralea canjerana</i> (Vell.) Mart.	Cancharana	Meliaceae	Timber, fruit for wildlife	Barney, Ruiz de Montoya	Nat regen	Fast growing. Shade loving
<i>Cecropia pachystachya</i> Trécul	Ambay	Cecropiaceae	Fruit for wildlife	All sites	Nat regen	Fast growing, pioneer tree, good for soil improvement, attracts fauna
<i>Cedrela fissilis</i> * Vell.	Cedro	Meliaceae	Timber	All sites	Nat regen	Excellent timber, monopodic, easy to reproduce, difficult to grow in open due to shoot borer attacks, deciduous, sun loving
<i>Cordia trichotoma</i> * (Vell.) Johnst.	Peteribí	Boraginaceae	Timber, honey	Roa Pipó, Kraus	Planted and nat regen	Excellent timber, monopodic, good soil improver, deciduous, sun loving
<i>Enterolobium contortisiliquum</i> * (Vell.) Morong.	Timbó	Fabaceae	Timber	Guayakí, Barney	Nat regen	Nitrogen fixation, grows well in degraded lands, deciduous, sun loving
<i>Euterpe edulis</i> Mart.	Palmito	Arecaceae	Palm heart, wildlife, honey, ornamental	Guayakí	Nat regen	Grows under shade
<i>Holocalyx balansae</i> Micheli	Alecrin	Fabaceae	Ornamental, timber	Guayakí	Nat regen	Restoration, wildlife
<i>Jacaranda semiserrata</i> *, <i>J. micrantha</i> * Cham.	Caroba	Bignoniaceae	Ornamental, timber	Ruiz de Montoya, Guayakí	Nat regen	Fast growing, monopodic growth, deciduous, sun loving
<i>Lonchocarpus muehlbergianus</i> Hassl.	Rabo molle	Fabaceae	Timber, ornamental	Barney	Nat regen	Nitrogen fixation, slow growing, root sprouts
<i>Machaerium</i> spp.	Isapuy	Fabaceae	Timber, fuelwood	Guayakí, Barney	Nat regen	Fast growth, grows well in degraded lands
<i>Myrocarpus frondosus</i> Allemão	Incienso	Fabaceae	Timber, ornamental, honey	Roa Pipó	Nat regen	Excellent timber, shade loving
<i>Nectandra lanceolata</i> * Nees. et Mart. ex Nees	Laurel amarillo	Lauraceae	Timber, fruit	Guayakí	Nat regen	Grows well in degraded land, self pruning
<i>Nectandra megapotamica</i> (Spreng.) Mez.	Laurel negro	Lauraceae	Timber, fruit	Guayakí, Barney	Nat regen	Grows well in degraded land

Table III (suite).

SCIENTIFIC NAME	COMMON NAME	BOTANICAL FAMILY	USES	FARM/SITE WHERE IT WAS FOUND	PLANTED OR FROM NATURAL REGENERATION	OTHER CHARACTERISTICS
<i>Ocotea puberula</i> (Rich.) Ness	Laurel guaicá	Lauraceae	Timber	Guayakí	Nat regen	Restoration, wildlife
<i>Parapiptadenia rígida</i> * (Benth.) Brenan	Anchico colorado	Fabaceae	Fuelwood, Timber	Guayakí, Kraus	Nat regen and planted	Nitrogen fixation, open crown, deciduous, sun loving
<i>Patagonula americana</i> * L.	Guayubira	Boraginaceae	Timber	Guayakí	Nat regen	Monopodic, tolerant to frost, sun loving
<i>Peltophorum dubium</i> * (Sprengel.) Taub.	Cañafístola	Fabaceae	Timber, fuelwood, honey	Kraus	Nat regen	Excellent timber. Fast growing, adapted to degraded lands, deciduous, sun loving
<i>Solanum granulolum-leprosum</i> Dunal	Fumo bravo	Solanaceae	Honey, wildlife	All sites	Nat regen	Fast growing, pioneer tree good for soil improvement, attracts fauna
<i>Tabebuia</i> spp.*	Lapacho amarillo	Bignoniaceae	Timber, fuelwood, honey	Kraus, Barney	Planted	Excellent timber. Deciduous, relatively fast growing, needs pruning, sun loving
<i>Tabebuia heptaphylla</i> * (Vell.) Toledo	Lapacho negro	Bignoniaceae	Timber, fuelwood, ornamental, honey	Kraus, Barney	Planted	Excellent timber. Relatively fast growing, deciduous, adapted to degraded sites, needs pruning, sun loving
<i>Trema micrantha</i> (L.) Blume	Palo pólvora	Ulmaceae	Fuelwood, charcoal; good animal fodder, honey	All sites	Nat regen	Small tree, semideciduous, excellent for soil improvement, potential for P mobilization through mycorrhizae, attracts fauna

## Soil improvement in yerba mate AFS

Yerba mate AFS incorporating native trees can improve soil fertility without relying on fertilizers. In a study of 20 yerba mate plantations of two ages (30 and 50 years old) both in monoculture and intercropped with the native tree *Araucaria angustifolia*, it was found that when comparing the young plantations, soils in the monocultures had higher nutrient content than in the AFS; however, the monocultures were more susceptible than the AFS to a decline in soil nutrients over time, particularly with respect to Ca, N and C (ILANY *et al.*, 2010).

In previous research in Misiones, native tree species prized for their timber, such as *Balfourodendron riedelianum*, *Bastardiopsis densiflora*, *Cordia trichotoma*, *Enterolobium contortisiliquum*, and *Ocotea puberula*, were found to increase soil macronutrient levels down to 15 centimeters in depth, with an effect detected at a distance of up to 1 m away from the trunk (FERNÁNDEZ *et al.*, 1997). In other research on AFS of yerba mate with native tree species, at 0-10 cm soil depth yerba in combination with the N-fixing *Enterolobium contortisiliquum* (timbó) had higher phosphorus levels than yerba + *Tabebuia heptaphylla* (lapacho negro). In addition, yerba + timbó, and yerba + timbó and lapacho contained significantly more magnesium than the other treatments (DAY *et al.*, 2011).

All of these species were present in the organic yerba mate farms we visited, generally growing from natural regeneration in the yerba mate lines, with farmers appreciating their role and tending to them. Few native tree species were

planted, in Kraus, Roaipipó and Barney (tables II and III). However, since farmers have their own nurseries (Guayakí, Barney, Roaipipó) or have access to nurseries that grow native species (Kraus, farmers who sell to Ruiz de Montoya), it's expected that, given sufficient ecological and economic incentives, farmers will increasingly plant native tree species in their organic yerba mate AFS.

## Microenvironment amelioration favoring yerba mate growth and quality in AFS

In Misiones, a bare soil at noon can reach temperatures of up to 55°C, while soil temperatures never exceed 32°C in yerbales that have green covers and/or trees (REUTEMANN, 2009). In addition, in areas with mist, the trees can act as condensation points and catch water droplets, producing "horizontal precipitation", which can be an important water input in times of drought (BAGGIO, 2008; SILVA *et al.*, 2008). The presence of trees also moderates the effects of wind (REUTEMANN, 2009).

Excessive insolation during the summer can damage plants in monocultures, as mentioned by producers who sell to Guayakí (V. Yasinsky, personal communication, May 2009), and also by researchers from EMBRAPA<sup>5</sup> Forestal. In addition there appears to be a consumer preference for yerba mate grown under shade due to its better quality (BAGGIO *et al.*, 2008).

<sup>5</sup> Empresa Brasileira de Pesquisa Agropecuária, Brazilian Agency for Agricultural Research, Forestry Division.

## Establishment and management of organic yerba mate AFS

Tree density and spatial arrangement must be suited to a yerba mate-native tree multistrata system. A final density of approximately 100 planted trees per hectare (tr/ha) would be expected, however, tree density could increase with trees that grow from natural regeneration. Between 171 and 226 trees per hectare were found in natural yerba mate forest in Paraná state, Brazil (BORGES *et al.*, 2003). An initial density of 200-400 tr/ha may be needed to reach the desired number of mature individuals. A higher tree density achieves faster results in terms of soil protection and shade and also allows for the selection of the best trees.

It would be preferred for the trees to be mixed with the largest possible number of the recommended yerba mate species mentioned above. Adequate shade and protection, positive impacts on soils, and desired products stress the importance of choosing the correct tree species for shade of yerba mate, ideally selecting among those that combine several of the desired characteristics (table III) (photograph 13). Trees should be planted within the yerba mate lines to leave free space between the lines to facilitate weeding and harvest operations. This spacing also stimulates growth in height of native trees, improving their form, and protects young seedlings from frost and excess sun.

## Economic advantages of organic yerba mate: marketing and pricing

Organic certification plays an important role in securing a premium price for an agricultural product. Among yerba mate companies marketing products in the U.S.A., there is a significant difference between pricing levels for conventional and organic yerba mate. Organic certification has allowed companies to charge double or more the price for conventional export products.

While any level of product branding (MONTAGNINI *et al.*, 2011) represents the opportunity to secure a significant premium, just creating an identity for a product can lead to significant variations from one product to another. As described above, these companies have structured their operations and practices as part of what is often referred to as a values-based agricultural supply chain. This concept is based on several principles, including strategic partnerships based on values. Under these practices, companies that control significant volumes of high-quality, differentiated food products, create and distribute responsibilities and rewards across the supply chain, and operate effectively at regional levels. In this setting, consumers may move from merely recognizing a brand or feeling good about it to a sense of connection to the product. Companies that follow the practices they champion have a competitive advantage in the marketplace. These companies have an important role as business leaders and have the capacity to offer the consumer a chance to learn about social and environmental issues beyond the realm of their daily lives and to contribute to sustainable and fair trade farming in often remote, rural areas of the world.



**Photograph 13.**

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

Photograph B. Eibl.

## Conclusions and recommendations

Interest in organic farming and in yerba mate cultivation under shade is rapidly increasing in recent years. Thus, there is a growing demand for appropriate knowledge for these systems, to obtain better yerba mate prices and other income from the trees, along with improved livelihoods and environmental quality. This need requires continued research to incorporate additional species beyond those recommended here (photographs 14), as well as to improve management and other aspects of the yerba mate within agroforestry systems. The many experiences discussed in this article contribute to advancing the knowledge needed to promote these systems. From this study it is recommended to combine yerba mate with the following species: *Balfourodendron riedelianum*, *Cordia trichotoma*, *Nectandra lanceolata*, *Bastardiopsis densiflora*, *Cedrela fissillis*, *Jacaranda micrantha*, *Araucaria angustifolia*, *Ocotea puberula*, due to their monopodial development and self pruning ability; as well as *Tabebuia heptaphylla*, *Enterolobium contortisiliquum*, *Peltophorum dubium*, *Parapiptadenia rigida* and *Anadenanthera macrocarpa* of broader crown, with good growth and high quality timber. Other tree, herb or shrub species with fruit, medicinal or ornamental value should be also added to increase farm diversification.

The emphasis on diversification of yerba mate growing systems is increasing in Misiones and elsewhere, with farmers and institutions devoting time and resources in pursuing the best system for each situation (photograph 15). For example, the Ministerio del Agro y la Producción of the province of Misiones has a program focused on soil recovery and diversification in yerba mate, related to the Instituto Nacional de la Yerba Mate. The School of Forest Sciences of the National University of Misiones in Eldorado and the National Institute of Agricultural Technology of Montecarlo, Misiones are conducting research on domestication of native tree species in experimental settings and in farmers' fields to record their adaptability for combination with yerba mate; silvicultural treatments needed; and provision of environmental services such as pest management, impacts on soil conservation and recovery, carbon sequestration, wildlife, and biodiversity conservation.

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**Photograph 14a.**

A young seedling of the native tree species timbó, *Enterolobium contortisiliquum*, planted in a 10 hectare experimental trial conducted by INTA of Montecarlo, Misiones, to test the suitability of yerba mate combinations with about 14 tree species of interest. Photograph F. Montagnini.



**Photograph 14b.**

A young seedling of the native tree species peteribí, *Cordia trichotoma*, planted in a 10 hectare experimental trial conducted by INTA of Montecarlo, Misiones, to test the suitability of yerba mate combinations with about 14 tree species of interest. Photograph F. Montagnini.



**Photograph 15.**

The Guayakí company conducts experiments to test growth of yerba mate associated with native species in different settings at their Iguazu Agroecological Reserve: yerba mate has just been planted in natural forest that has been under cleared to allow plants at 3x1 and 2x1 meters spacing. Photograph F. Montagnini.

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