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RSG- Technical Report

Atlantic Forest restoration in the buffer area of Iguazú National Park (Misiones, Argentina)

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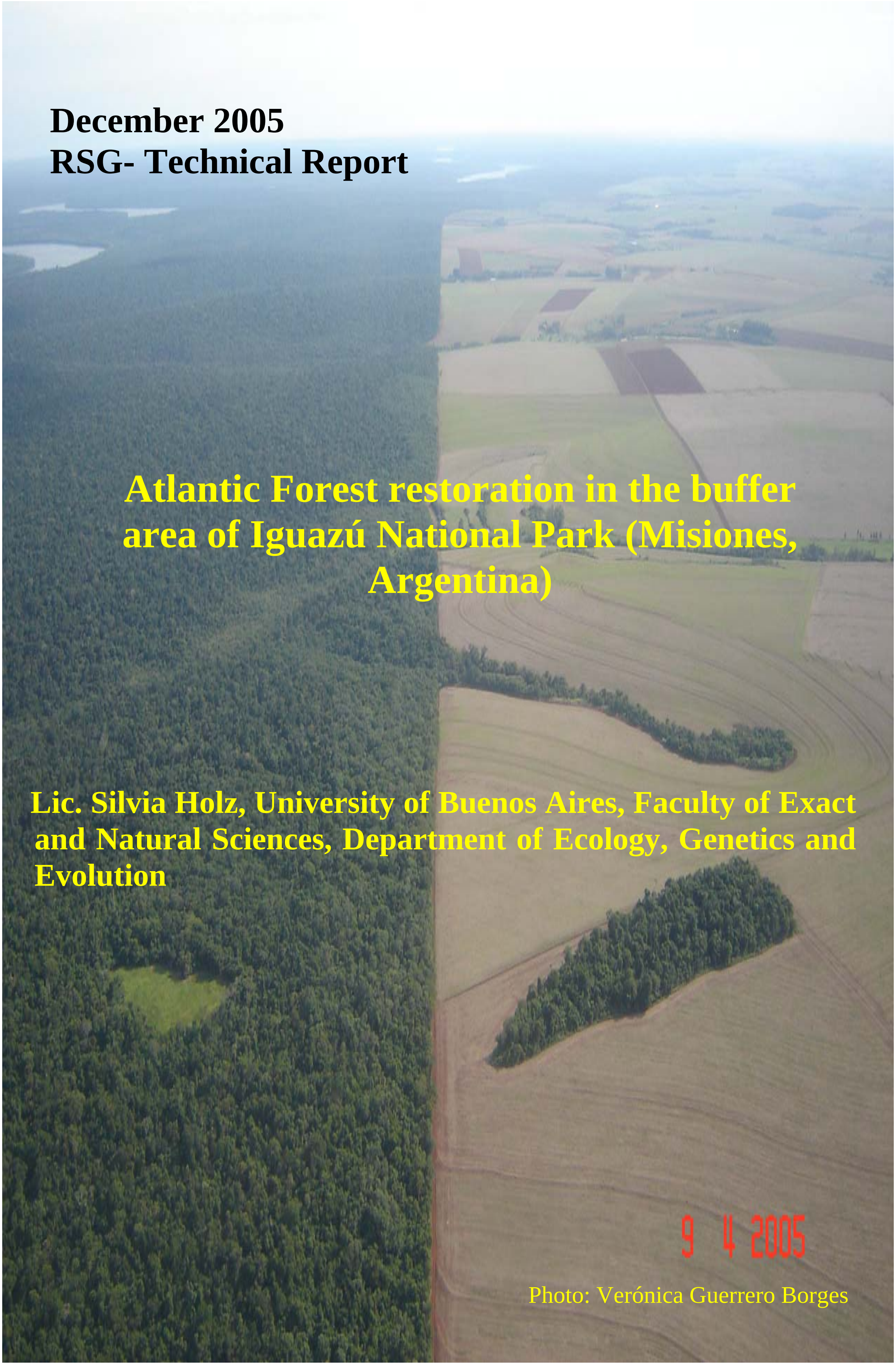


Photo: Verónica Guerrero Borges

Introduction

Recovering forest cover will be one of the biggest challenges to ensure biodiversity conservation and the maintenance of ecological services in the Atlantic Forest. This is one of the most biologically diverse and endangered rainforests on earth. A high human activity has determined that only 7% of the original forest-cover remains in a highly fragmented landscape. The south-western portion of the Atlantic Forest constitutes the Upper Parana Atlantic Forest ecoregion extending along south-west Brazil to eastern Paraguay and the Misiones Province in north-east Argentina (Figures 1 and 2). This ecoregion has the largest remaining forest blocks, still containing top predators such as harpy eagles and jaguars.

An ecoregional planning process (biodiversity vision) developed by WWF indicates that protecting and ensuring connectivity among the larger forest remnants will enable the conservation of biodiversity and the ecological services to rural communities (DiBitetti *et al*., 2003). But these fragments are today not effectively connected.

Figure 1: Forest remnants along the Iguazú River coast of Andresito (Photo: Silvia Holz)

The Andresito area in the north of Misiones is critical for maintaining the connectivity of forest cover among four key parks - Iguaçu National Park in Brazil, Iguazu National Park in Argentina (both Heritage Sites that protects the world famous Iguazu Falls), and the Urugua-í and Foerster Provincial parks in Argentina.

The challenge in Andresito is to stop deforestation and forest degradation, and to increase connectivity among the protected areas while increasing the living standards of local people by providing them with new sustainable economic alternatives.

The implementation of forest landscapes restorations will require the adequate legal and political framework and also the development of inexpensive methods for forest restoration as well as viable forest-friendly economic activities and benefits that will make restoration and conservation more attractive to landowners. This project is aimed to:

a- evaluate ecological and economical efficiency of different forest restoration techniques.
b- develop a model of recovery of the forest productivity based on the sustainable use of palmito (*Euterpe edulis*) and the yerba mate (*Ilex paraguariensis*). These native species represent an important economic resource for local people.
c- through the implementation of objectives 1 and 2, to restore surface areas of forests in a key sector for conservation, contributing to re-establish the connectivity among patches.

The specific objectives are: 1) To analyze the capacity of different native tree species to be used in restoration works, 2) To train local people to work in different activities involved in restoration and rehabilitation of forests.

This project began to be developed at the end of 2001. During the first four years, a tree nursery was built and restoration experiments were set up in the buffer area of the Iguazú National Park (province of Misiones, Argentina). The information obtained through such experiments allows to adjust restoration techniques for forests of the area. In 2005 we were monitoring trails installed and carry out more restoration experiments using methods different from those used in the first stage, which will allow to answer key questions to implement the more efficient alternatives for the area.

Relevance of this study for conservation of protected areas of the Ecoregion

The information on natural regeneration and on the development of cheaper and more environmentally efficient restoration technique could be used for:

- ***Forest restoration*****:** In the Andresito area, it is necessary to create biological corridors to favor the interconnection among the large forest patches. The information provided by this study will allow to answer some questions, such as: **a-** How are the influence of different factors on the forest regeneration?, **b-** Which are the most appropriate groups of species to use in restorations?, **c-** Which is the growth velocity of each species and its response to different factors?, **d-** Is it necessary to eliminate grasses and soil compaction to plant native trees in the area to be restored? Or, in same situations, the influence of grasses is not so important as to invest in their removal?, **e-** According to the history of use of the area to be restored, which is the most adequate restoration strategy to be used?, etc.

- ***Management of secondary forests:*** When forests with productive purposes are generated (in this case, plantations of native trees), it is very important to know the time the system takes to reach a determined structure and production of wood (standing biomass) and the rhythm of growth of the different species.

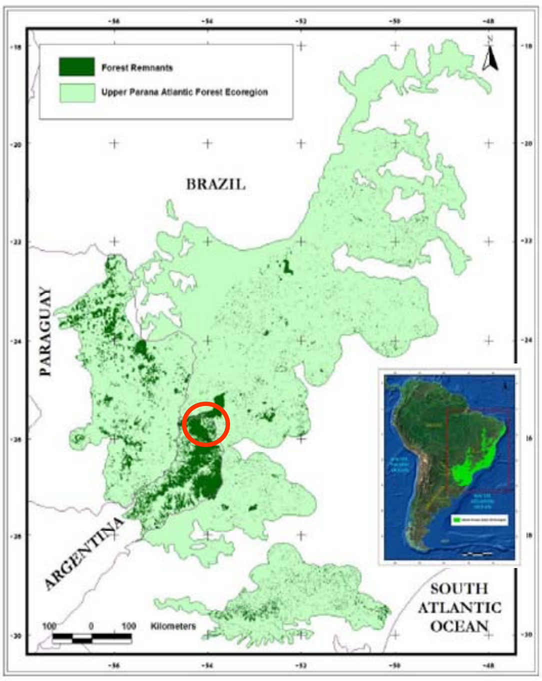


Figure 2: Original cover of Upper Paraná Atlantic Forest, current remnants and study area (Map: Verónica Guerrero Borges).

The information on such aspects provided by this project could be used: **a)** to design afforestation plans with native species, to commercialize wood (only exotic species are currently planted in the province of Misiones), **b)** for firewood, a resource that is getting scarcer in the study area, **c)** for managing secondary forests with the objective of preserving them.

Once different methodologies of restoration have been tested and adjusted, it will be possible to apply them to larger areas. On the other hand, if the production and commercialization of palms is successful it will become a commercial alternative for a greater number of local families. This will encourage them to settle in one place permanently, avoiding migration and the purchasing of land by large timber companies, one of the main threats of the region.

Methods

Study area

The area where the project is developed, Andresito Peninsula (Figure 3), is located in the north of the province of Misiones (Argentina) and has been identified as a key area for conservation. The work was carried out in farms located in Andresito Peninsula, belonging to different families of producers, to whom we opportunely had asked for permission to do experimental trials in lands of their own. The sites to restore have been selected with the objective to contribute to restoration of connectivity or conservation of patches of key forests to maintain already existing corridors.

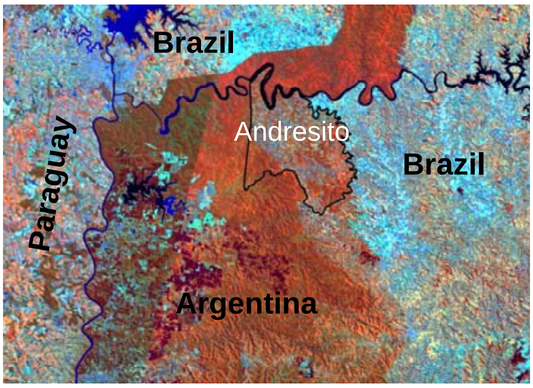


Figure 3: Satellite image of study area (Map: Verónica Guerrero Borges)

Already done activities

Below there is a description of the activities carried out in previous years, which have been kept up this year, and a detailed report of the tasks undertaken in 2005 and their results.

2001

1) *Construction of a tree nursery*

A tree nursery, where we was producing saplings of native species used in restoration treatments, was built in a farm located in the bottleneck area of the Iguazú National Park (See details in RSG-Technical report 2003).

Figure 4- Native species saplings in the tree nursery (Photo: A. Izquierdo).

2002-2005

2) Set up of restoration treatments

Although restoration works have begun years ago in the ecoregion (Kageyama y Gándara, 2000), there are still many questions to answer about factors and processes involved in restoration and rehabilitation of forests.

Restoration treatments are based on manipulation of factors which difficult or facilitate the regeneration of the system. In farming systems, the presence of pastures, soil compaction, herbivory and the lack of seed dispersion have been identified as the more important barriers for tree establishment (Guevara *et al*., 1986; Purata, 1986; Holl, 1999; Peterson and Haines, 2000; Zimmerman *et al*., 2000).

On the other hand, certain factors, as the presence of sources attracting fauna, which favour the use of the area by seed dispersing animals, facilitate sapling establishment (Peterson and Haines, 2000; Slocum, 2000; Wunderle, 1998; Holl, 2002). The manipulation of these factors will allow to accelerate the process of natural regeneration of the system and growth of transplanted saplings.

Treatments in monocultures of "yerba mate" ("yerbales"), cattle-raising lands and degraded forests, located in the bottleneck area of the Iguazú National Park, have been carried out to obtain information on the factors and processes which influence restoration and rehabilitation of the forest. Until the moment, experimental trials have been carried out in three types of systems:

1) Abandoned grazing lands.
2) Forest edges invaded by native invasive species (bamboos and other species).
3) "Yerba mate" plantations.

In 2005 we were monitoring this treatments and we are producing saplings of native species in the tree nursery. This sapling will be used in the new restoration treatments, that will be establishment in the next month (See section d).

a) Restoration of forests in abandoned grazing lands (Since 2002)

We are testing restoration designs in which we eliminated "barriers" for regeneration (compaction and pastures). In the treated parcels we have planted native species saplings (see details in RSG-Technical report 2003) (Figures 5 and 6).

The ***objectives*** of these treatments are 1) To analyze how much the presence of pastures and soil compaction influence forest regeneration and to evaluate if it is really convenient (at an economic and ecological level) to eliminate them before planting, 2) To analyze the mechanisms through which these "barriers" act to limit the system regeneration.

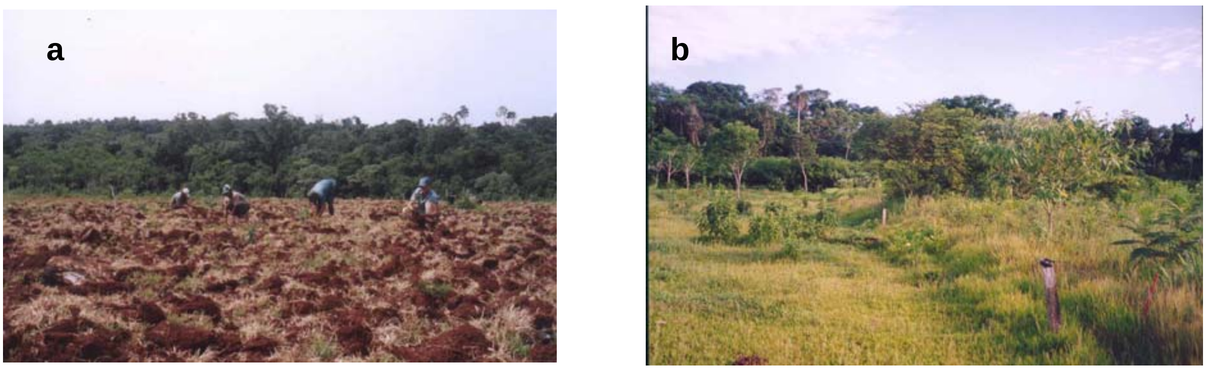


Figure 5- a) Sapling plantation in 2002 (Photo: Sergio Casertano), **b)** The same site three years after plantation (rigth) and cattle pasture (left) (Photo: Silvia Holz).

Monitoring- 2005

Two kinds of monitoring have been employed:

<u>Intensive Monitoring:</u> in which each individual was measured and soil samples were obtained. In each plot, growth of saplings of planted and naturally established native species was measured (diameter at base: DAB, and height). Besides, soil samples were taken to determine moist, apparent density and nutrient content.

There have been 4 intensive monitoring rounds up to date: in 2002 when treatments were set up, the height of all planted saplings was measured, in 2003 there were 2 re-measurement instances (See details in RSG-Technical report 2003) and in 2005 there was a fourth one. In the future, this type of monitoring will take place every 3 years.

<u>Quick Monitoring:</u> in which we went round every treatment, taking photographs and writing down general facts on the evolution of each plot. These rounds have occurred about every couple of months and will be continued with the same regularity.

Resultados

<u>Survival and growth of planted saplings</u>
To identify groups of species that survived better to different field situations a saplings' survival analysis was done, and we be able to identify groups of species that survived better to different field situations. Most species showed a high survival (between 75% and 100%) and a mid survival (between 25 and 50 %), and a lower number of species showed a low survival (between 25 and 50 %). Only *Euterpe edulis* showed a very low survival (lower than 25%). According to data, 35 native species used in these treatments were classified under 3 groups (Table 1).

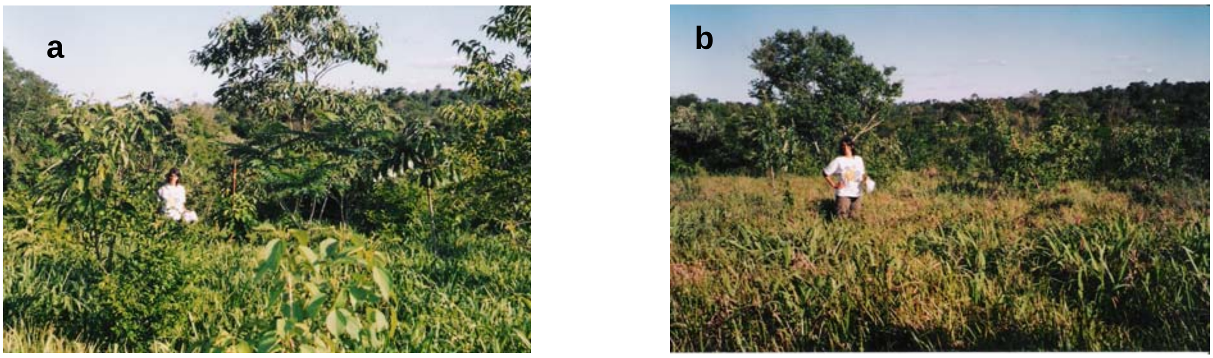


Figure 6- Plots with different treatments, 2005: a) Plot with saplings planted in 2002, b) Plot without saplings planted (Photos: Silvia Holz).

Species better surviving plantations in the open and growing more rapidly fell under **Group 1,** those of intermediate characteristics were under **Group 2,** and those with a lower survival rate and growing more slowly were classified into **Group 3.**

This identification into species groups according to different ecological features is a useful tool in forest restoration. Species selection must be done bearing in mind not only their ecological features but also the environmental characteristics of each place and the restoration objectives.

Group 1	Group 2	Group 3
Solanum verbascifolium	*Jacaratia spinosa*	*Chorisia speciosa*
Trema micrantha	*Allophylus edulis*	*Diatenopteryx sorbifolia*
Alchornea iricurana	*Bahuinia candicans*	*Syagrus romanzoffiana*
Bastardiopsis densiflora	*Inga uruguensis*	*Nectandra megapotamica*
Cordia trichotoma	*Nectandra lanceolata*	*Ocotea diospyrifolia*
Luehea divaricata	*Ocotea puberula*	*Cabralea canjerana*
Peltophorum dubium	*Cedrela fissilis*	*Euterpe edulis*
Cecropia pachystachya	*Lonchocarpus leucanthus*	*Aspidosperma polyneuron*
Maclura tinctoria	*Machaerium stipitatum*	*Holocalyx balansae*
Enterolobium contortisiliquum		*Cupania vernalis*
Myrocarpus frondosus		*Lonchocarpus muehlbergianus*
Balfourodendron riedelianum		
Parapiptadenia rigida		
Patagonula americana		
Tabebuia heptaphylla		

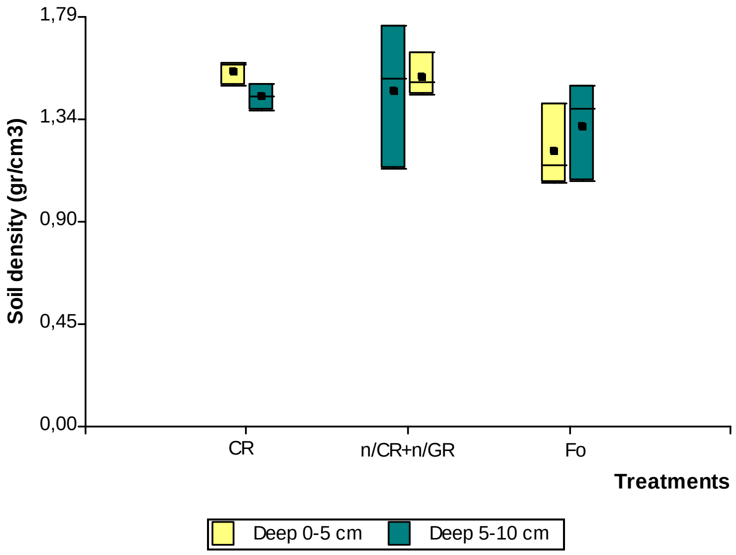
Table 1: Especies agrupadas teniendo en cuenta la supervivencia y crecimiento en plantaciones a cielo abierto (ver explicación en el texto).

Soil characteristics

We take sampling of soil of each treatment and in nearby forest, to analyze: soil density, C, N and organic matter (Figure 7). The objective of this analyses is to evaluate if there are differences in this variables between treatments. Six soil samples were collected per treatment (3 of them 0 to 0.5 cm deep and 3 others, 5 to 10 cm deep).

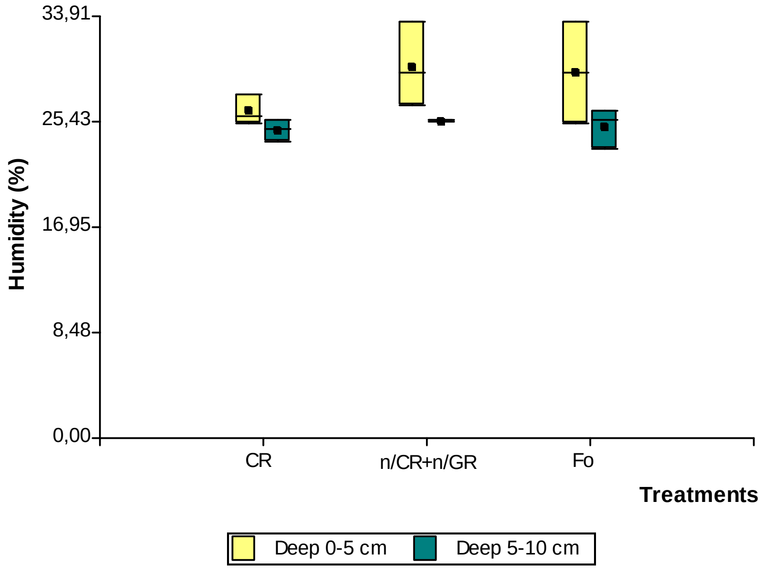
The soils in the Study area are Kanduidultes (Soil Taxonomy). Density for soil samples in the treatments where compression was removed (CR) and in treatments with non-removal of compression (n/CR) was higher than for hose samples obtained in nearby forests (Graph 1). However such differences are not statistically significant for samples 0-0.5 cm deep (Kruskal Wallis, $H= 3.47$, $p= 0.17$) or 5-10 cm deep (Kruskal Wallis, $H= 3.47$, $p= 0.19$).

Figure 7: Sampling of soil a) in the forest, b) in the plantation (Photo: Silvia Holz).



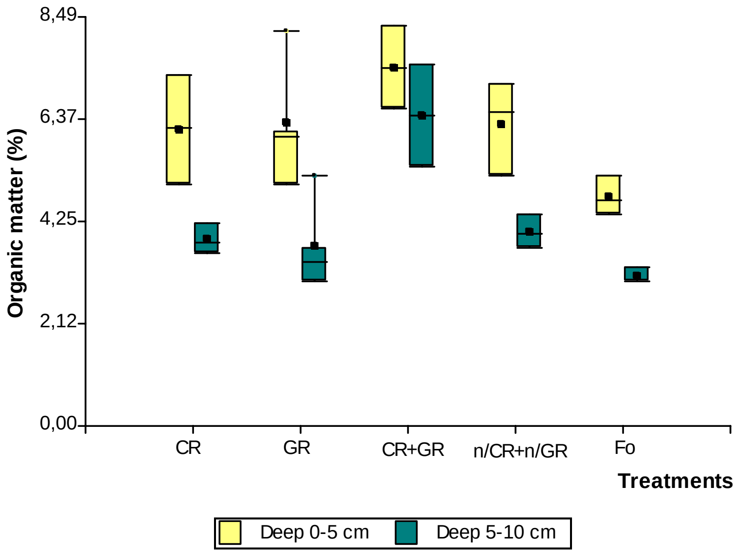
Graph 1: Soil density for each treatment. References: GR= grass removal, CR= compaction removal, n/ GR= no grass removal, n/ CR= no compaction removal, Fo= forest.

As for soil moist, no statistically significant differences were recorded among treatments neither 0-0.5 cm deep (Kruskal Wallis, H= 2.07, p= 0.4) nor 5-10 cm deep (Kruskal Wallis, H= 0.62, p= 0.77) (Graph 2).



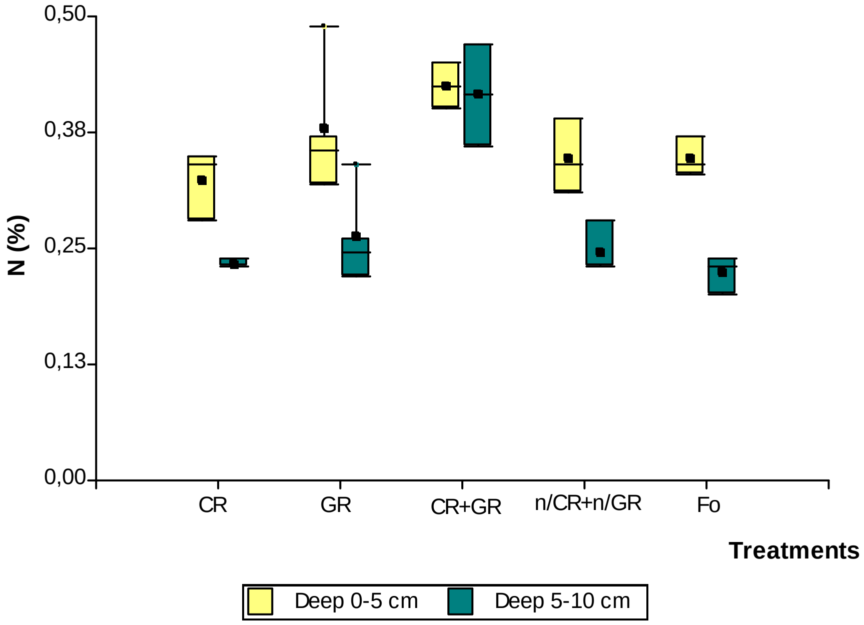
Graph 2: Percentage of soil humidity for each treatment. References: GR= grass removal, CR= compaction removal, n/ GR= no grass removal, n/ CR= no compaction removal, Fo= forest.

Content of organic matter was higher in the first soil centimeters in all treatments as well as in the forest (Graph 3). Values recorded for each treatment showed ample variation. No statistically significant differences were recorded among treatments neither 0-0.5 cm deep (Kruskal Wallis, H= 6.75, p= 0.14) nor 5-10 cm deep ((Kruskal Wallis, H= 8.92, p= 0.06).



Graph 3: Percentage of organic matter for each treatment. References: GR= grass removal, CR= compaction removal, n/ GR= no grass removal, n/ CR= no compaction removal, Fo= forest.

Content of organic nitrogen was also higher in the first soil centimeters in all treatments and in the forest. No statistically significant differences were recorded among treatments neither 0-0.5 cm deep (Kruskal Wallis, H= 4.43, p= 0.34) nor 5-10 cm deep (Kruskal Wallis, H= 5.52, p= 0.207).



Graph 4: Percentage of organic nitrogen for each treatment. References: GR= grass removal, CR= compaction removal, n/ GR= no grass removal, n/ CR= no compaction removal, Fo= forest.

Possibly we have been unable to detect differences among treatments on any analyzed variable due to the high variation recorded between samples of a same treatment. Most probably it will be necessary to increase the number of samples so as to find differences between treatments.

Cost analysis

Based on the set up tests, costs were worked out for native tree plantations in deforested areas. The sums worked out correspond to the ones a local producer would have to afford if they wanted to set up these kind of plantations on their own land.

Even if the weeding method used in the treatments (hand weeding by machete and hoeing around each sapling) was effective, it was also very expensive. Therefore we must keep on developing weeding techniques at lower costs (such as using quick-growing species for shadowing), a key point when it comes to restorations in these systems, mainly if we consider larger scale plantations.

Activity	Detail	Cost (U$S)
Plantation cost (Ha/ year)	1660 stem/ Ha	424.83
Weeding* (Ha/ year)		241.61

Table 2: Description of the costs of native tree plantations in Northern Misiones, with a 1660 stem/ha density, under similar conditions as those experiments set up on grazing land. *Weeding must be carried out throughout the first 2 or 3 years after planting, until saplings are higher than the grass.

Treatment Upkeep

In treatments with grass removal, weeding was done by hand with machete in all the plot and by hoeing around each sapling (within a radius of 30 cm around each individual). Clean-ups were carried out periodically as demanded by grass growth.

These clean-ups have been brought to an end since most saplings are over 1 m tall. Grass will only be removed in paths around treatments so as to have easier access to these experiments.

c) Plantations of native tree species in monocultures of "yerba mate" (Since 2003)

The "yerba mate" is currently cultivated as a monoculture. Formerly, this tree species formed dense patches within the jungle, which disappeared due to their overexploitation (Devoto y Rotkugel, 1936). Therefore, this is a species that can develop under the shade of other species.

Since yerba mate is one of the most important activities in the region, native trees plantations on yerba mate fields would allow:

- an increase in the profits of yerba mate fields, since yerba mate production is complemented with wood and firewood production;
- a larger native forest cover.

We carried out plantations with native species plantations inside yerba mate fields (See details in RSG- Technical report 2003), with the **objectives** of 1) evaluating native species growth and survival in these systems; 2) assessing the effect of these plantations on yerba mate production; 3) identifying and evaluating cost and benefits regarding the application of this model.

Figure 8- Monitoring on yerba mate plantations, 2004 a) *Maclura tinctoria* is 1.10 m in height, 1 year after it was planted (Photo: Silvia Holz), b) *Parapiptadenia rigida* is 1.50 m, 1 year after it was planted (Foto: Omar Holz).

Monitoring-2005

Two kinds of monitoring have been employed:

<u>Intensive Monitoring:</u> In each plot, growth of saplings of planted and naturally established native species was measured (diameter at base: DAB, and height). There have been 2 intensive monitoring rounds up to date: in 2003 when treatments were set up, the height of all planted saplings was measured and in 2004 when saplings were planted anew (See Results section). In the future, this type of monitoring will take place every 3 years.

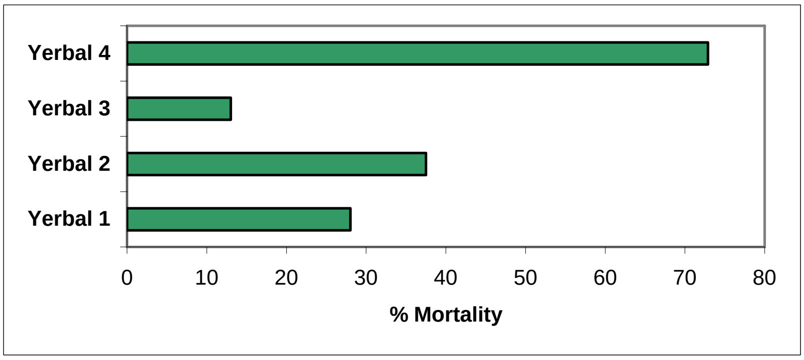
<u>Quick Monitoring:</u> in which we went round every treatment, taking photographs and writing down general facts on the evolution of each plot. These rounds have occurred about every couple of months and will be continued with the same regularity.

Results

Quick monitoring rounds from January to August 2004 showed that even if there had been considerably mortality during the summer, sapling mortality had mainly occurred during yerba mate harvesting and by weeding. See Graphic 5, where mortality rates are presented. In "yerbal 4" almost all planted saplings died.

In 2004 all treatments were planted anew, to make up for dead saplings thus maintaining the initial density of the treatments.

As in the grazing land plantation, saplings that were smaller in size when planted, died in larger quantities. Some saplings deemed dead during quick monitoring, later sprouted new shoots and continued growing.



Graphic 5: Mortality rates of native species sapling in different sites, 1 after it was planted.

Natural regeneration

Those yerba mate plantations which were not weeded over long periods, showed considerable natural regeneration in yerba rows. During quick monitoring rounds several saplings of native species were seen to grow among yerba mate plants. It is worth mentioning that moisture and lower temperatures are better kept in yerba rows than in the rest of the yerba mate plantation. This fact added to lower trampling and weeding impact on the site, could aid natural regeneration. That is to say, yerba plants would be working as "regeneration nuclei" within these systems.

Cost analysis

Based on the set up tests, costs were worked out for native tree plantations in yerbales (Table 3). The sums worked out correspond to the ones a local producer would have to afford if they wanted to set up these kind of plantations on their own land.

Activity	Details	Cost (U$S)
Plantation cost (Ha/ year)	400 stem/ Ha	171.14
Weeding (Ha/ year)		241.61

Tabla 3- Description of the costs of native tree plantations in yerbales in Northern Misiones, with a 400 stem/ha density, under similar conditions as those experiments set up.

c) Rehabilitation of degraded forest edges

The borders of forest fragments are generally invaded by native invasive species, as "tala" (*Celtis sp)*, or bamboos, which difficult regeneration, stressing "the border effect", mainly the tree felling. When restoration models are posed it is important to manage the borders, not only to decrease the border effect in the same patch, but also to decrease the "tala" effect on the "matrix".

Taking into account that the surface of forest edges is very important in Andresito, and that edges are considered to be unproductive, clearing invading species may be an interesting method to increase profitability at the edges:

- since this improves natural regeneration (mainly palmetto regeneration, a species marketed by local farmers)
- and different crops which allow for a certain shadow percentage (such as yerba mate or pineapple) may be grown.

c.1) Plantations of "yerba mate" (*Ilex paraguariensis*) in degraded forest edges (since 2003)

Trials were settled at forest edges, where "tala" were cleared and yerba mate crops planted (See details in RSG Technical report 2003) (Figure 9).

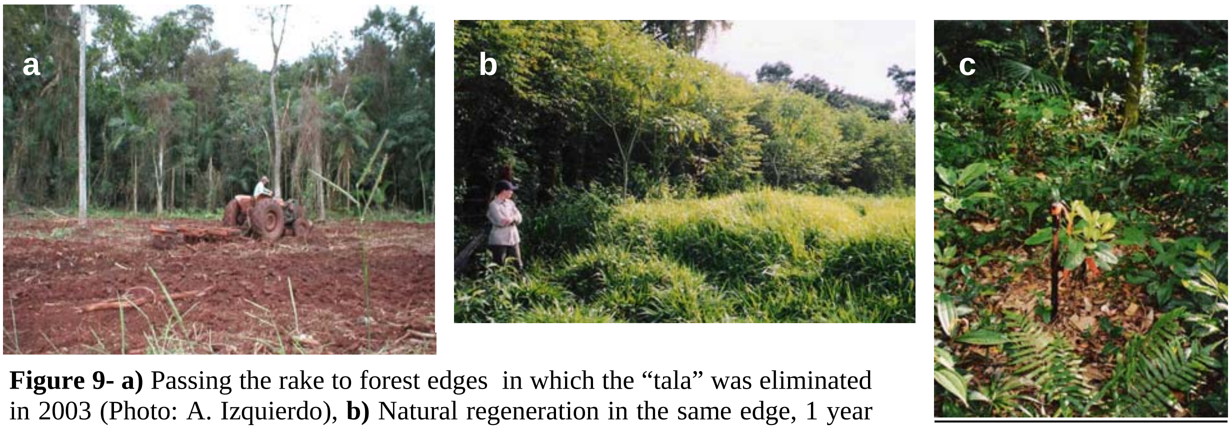


Figure 9- a) Passing the rake to forest edges in which the "tala" was eliminated in 2003 (Photo: A. Izquierdo), **b)** Natural regeneration in the same edge, 1 year after treatments was installed, **c)** Sapling of yerba mate growing in this edge .

The **objectives** of these treatments are 1) To evaluate the production of "yerba" in cleared edges and in sectors under forested cover, 2) To evaluate the effectively of the "tala" elimination method, 3) To analyze natural regeneration in forest edges.

Monitoring- 2005

Two kinds of monitoring have been employed:

Intensive Monitoring: In each plot, growth of yerba mate saplings planted and naturally established native species was measured (diameter at base: DAB, and height). There have been 1 intensive monitoring in 2004, the height of all planted yerba mate saplings was measured. In the future, this type of monitoring will take place every 3 years.

Quick Monitoring: in which we went round every treatment, taking photographs and writing down general facts on the evolution of each plot. These rounds have occurred about every couple of months and will be continued with the same regularity.

Results-2005

The areas where the Tala was eliminated were speedily colonized by native trees of rapid growth (*Trema micrantha* and *Solanum verbascifolium* principally) (Figure 9-b). Recent monitoring has evidenced a great number of saplings of other species of native trees growing in these places.

Tala removal with bulldozer and rake has proved efficient, since the place was not invaded again and few tala saplings have been found. However, given the invading capacity of this species, we should wait longer to ascertain whether or not this cleaning method is efficient in the long term.

Yerba saplings planted during these treatments had high mortality rates. Based on quick monitoring, it should be up to 50% in all treatments. This high mortality is mainly attributed to the strong drought towards the end of spring in 2003 and the summer of 2004.

Surviving Yerba saplings have grown slowly and have larger and thicker leaves than those of the species in traditional open-air single crops (Figure 9-c). It is estimated that the leaves of these plants will be ready for harvest and selling in approximately 3 years.

<u>*Cost analysis*</u>

Based on the set up tests, costs were worked out for yerba mate plantations in forest edges (Table 4). The sums worked out correspond to the ones a local producer would have to afford if they wanted to set up these kind of plantations on their own land. Higher costs for these treatments were those of initial clean-up with bulldozer and rake.

Activity	Detail	Cost (U$S)
Set up plantation (Ha/ year)	800 stem/Ha	399.33
Weeding (Ha/ year)		479.87

Tabla 4 - Description of the costs of yerba mate plantations in forest edges in Northern Misiones, with a 800 stem/ha density, under similar conditions as those experiments set up on degraded edges.

Treatment Upkeep

This year weeding by hoeing was carried out around each yerba sapling. Vegetation will only be removed in paths around treatments so as to have easier access to these experiments.

c.2) <u>Rehabilitation of palm heart (*Euterpe edulis*) populations in degraded forests edges</u> (Since 2004)

Trials were settled at forest edges, where bamboos were cleared (Figure 10). The **objectives** of these treatments are: 1) To evaluate the efficacy of the bamboo elimination method, 2) To analyze natural regeneration in forest edges, 3) Evaluating the need to plant palm seeds to increase density at the rehabilitated forest edges or whether natural regeneration for this species will ensure a large hearts of palms production.

Figure 10: Clearing bamboos in forest edges (Photo: Silvia Holz).

Monitoring-2005

Two kinds of monitoring have been employed:

Intensive Monitoring: In each plot, growth of saplings of naturally established native species was measured (diameter at base: DAB, and height). There have been 1 intensive monitoring in 2004, the height of all saplings was measured. In the future, this type of monitoring will take place every 2 years.

Quick Monitoring: In which we went round every treatment, taking photographs and writing down general facts on the evolution of each plot. These rounds have occurred about every couple of months and will be continued with the same regularity.

Figure 11- Measuring trees in forest edges (Photo: Anahi Flenck)

Results-2005

During quick monitoring rounds, cut-out lianas and bamboos have been found to dry fast and have not regenerated up to date. Monitoring during 2006 will determine if it is necessary to have another bamboo clean-up.

Cost analysis

Based on the set up tests, costs were worked out for clearing lianas and bamboos in forest edges (Table 5). The sums worked out correspond to the ones a local producer would have to afford if they wanted to set up these kind of plantations on their own land.

Activity	Cost (U$S)
Set up test (Ha/ year)	40.27
Weeding (Ha/ year)	33.56

Table 5- Description of the costs of clearing invading species bamboos treatments in forest edges in Northern Misiones, with a 400 stem/ha density, under similar conditions as those experiments set up on degraded edges.

Treatment Upkeep

Monitoring during 2006 will determine if it is necessary to have another bamboo clean-up. Vegetation will be removed in paths around treatments so as to have easier access to these experiments.

d) Restoration of forests in abandoned cattle breeding fields (This treatment will be installed in the next month)

The areas formerly covered by forests, deforested and used for different types of activities (grazing, agriculture, wood extraction, etc.) are again invaded by forests if these activities are abandoned. However, in areas where the system is very degraded, the recovery process can be extremely slow or inhibited (Aide *et al*., 1995) (Figure 12). The key question for the people who work in forest restoration is how to "accelerate" this process.

There are different tools to stimulate regeneration (Holz y Placci, 2005). The elimination of "barriers" and the use of "facilitators species" for regeneration is a potential tool to use in recovery of abandoned cattle fields (Ferretti, 2003). As the forest recovery accelerates, increase the productive capacity of this sites which will result in an economic benefit to their owners (since time in which the forest can begin to be used for extraction of palm hearts, firewood, or wood is shorter).

Figure 12- Field work in sites with secondary forest in the first stage of regeneration (Photo: Lia Montti).

We will to apply restoration treatments in abandoned cattle fields in which we will initially eliminate grasses and compaction (identified as barriers for regeneration).

Moreover, high densities of pioneer species of rapid growth native trees will be planted. These species will function as "facilitators" of regeneration: as they grow quickly they produce shadow and so they decrease the grass cover, facilitating, in this way, regeneration of other tree species.

Grasses were periodically eliminated through manual methods in treatments applied in 2002 in abandoned cattle fields (See section "a"). In these new treatments, grasses will be eliminated using pioneer species of rapid growth (facilitators species), which will decrease maintenance costs (manual elimination of grasses) of restored areas.

The **objectives** of these treatments are: 1) to evaluate which density of pioneer species is more efficient (at an economical and ecological level) to inhibit the development of grasses and to stimulate natural regeneration in abandoned cattle fields, 2) to evaluate if it is necessary to initially eliminate grasses and compaction when high densities of rapid growth pioneer species are planted.

Rapid growth native tree species will be used, some of which are economically important for local farmers. These treatments will allow to obtain complementary information to studies already initiated in 2002.

The saplings needed to set up these treatments are currently being grown in tree nurseries.Four abandoned cattle fields had been selecting. In each field, the following treatments will applied:

Density of planted young trees	With initial elimination of grasses and compaction (WE)	With no initial elimination of grasses and compaction (NE)
5,000 ind/ha (DA)	DA + WE	DA + NE
2,500 ind/ha (DB)	DB + WE	DB + NE
With no plantation (NP)	NP + WE	NP + NE

Each parcel will have a surface area of 0.25 ha. Compaction and grasses will be eliminated initially using a rake. Young trees will be planted in regular lines to facilitate plantation. Permanent monitoring parcels will applied to analyze changes in vegetation of the site along time. Survival, growth of present individuals and establishment of new individuals will be evaluated.

3) *Training of local people in different activities involved in restoration and rehabilitation of forests*

a- Andresito producers keep growing saplings of native species for their own farms and for trade. On the other hand, through the management of FVSA-WWF, they have agreed on selling their "yerba" production with a North-American company dedicated to the commerce of organic "yerba" generated under forest. This implies to markedly increase their profits, since with production and selling of organic "yerba" they will earn three times more per ton than what they were earning until that moment. From the conservational point of view, this initiative is very important since trees of native species will be planted within the "yerba mate" monocultures, i.e., they will contribute to increase the forest surface area..

b- Producers from a tree nursery in Eldorado (a town near to Andresito) have started working on the project. These producers are devoted to the growth of saplings of exotic species. Nowadays they are being trained in the production of native species saplings.

c- Local people, who were specially hired for this area, participated in the installation of treatments and their monitoring. As work advanced, they got more interested in native trees planting and have expressed their wish to continue collaborating with the project. As this work continues, they will be trained in specific tasks related to native species plantations.

4) Dissemination of information

a- The information generated by this project is reaching producers of the area by means of printed material and orally through meetings with local producers (Figure 13-a).

b- We have been participating in local workshops (organized by FVSA and WWF) to analyze conservation strategies for the region (Figura 13-b y c).

Figure 13: a) Meeting with local producers, b y c) workshops (organized by FVSA and WWF) to analyze conservation strategies for the region.

- Part of the information generated in the first years of the project was also shared in the "World Conference on Ecological Restoration", organized by Society for Ecological Restoration in September 2005 in Zaragoza (Spain). The trip and participation in this meeting was funded by WWF International. The following studies were presented:

√ Holz, S. and G. Placci. Up scaling restoration in highly populated environments (In: "*Simposium Forest Restoration in Latin America: Experiences and opportunities*").

√ Guerrero Borges, V.; Holz, S. and G. Placci. Landscape design as a tool for strategic planning for forest landscape restoration (In: "*Symposium WWF experiences in forest landscape restoration*").

Financial Report

A summary of the money spent with the funds given by Fundación Vida Silvestre Argentina (FVSA), Education for Nature Program (EFN-WWF) and RSG in 2004 is shown as follows. Money that will be spent in the following two years, related to monitoring and maintenance of installed treatments, is also shown.

	Amount financed by FVSA-2004 (£)	**Amount financed by EFN-2005 (£)**	**Amount financed by RSG (used in 2005) (£)**	**Amount financed by RSG (to be used in 2006) (£)**	**Amount financed by RSG (to be used in 2007) (£)**	**Total amount financed by RSG (£)**
Monitoring materials	199,85		362,23	45,42	45,42	**453,07**
Generation of saplings			982,36			**982,36**
Transport	1362,65	472.22	526,75	545,06	545,06	**1616,87**
Technical services	3670,05		908,43	145,35	327,04	**1380,82**
Field materials		777.77				
Living expenses		2944.44				
Others	308,87		181,69	181,69	181,69	**545,07**
Total	**5541,42**	**4194.44**	**2961,46**	**917,52**	**1099,21**	**4978,19**

Planned activities for 2006

Different activities have been planned, including: 1) to continue maintaining (cleaning) and to monitor the treatments, 2) to train the local inhabitants and students to work in greenhouses and to monitor the restored areas, 3) information generated during the first years of the project and complementary studies will be used to carry out estimates as regards biomass production.

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- Universidad de La Plata (ULP)
- Andresito farmers (Misiones, Argentina).
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