Agrosilvopastoral Systems: a Win-Win Strategy for Tropical Mexico

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Section 1:

Summary

Worldwide, animal agriculture is the leading cause of habitat destruction, species extinction, and a large contributor to greenhouse emissions. Conversely, it represents the main economic activity of many rural communities. We are faced with an immense challenge; to maintain biodiversity and the people's livelihoods. Loss of native habitat affects biodiversity, but also impacts agricultural production by degrading ecosystem services. Tree patches provide ecosystem services with indirect effects on cattle production. Integrating fruiting trees in the productive system promotes inter-fragment migration of many plant and animals species. Comparative studies in the Neotropics have shown that silvopastoral systems (agroforestry arrangements that combine grasses with shrubs and trees for animal nutrition and complementary uses) may reach production levels equal to or higher than conventional grazing systems, but provide a longer lifespan for productive lands. Through this project, we will test how combining silvopastoral systems as the matrix of fruit-baring planted patches into AgroSilvoPastoral Systems (ASPS) may assist in improving the livelihoods of low-economy cattle ranchers in the tropics as well as maintaining landscape connectivity, ecosystem services and conserving species from the tropical rain-forest. Additionally, ASPS will provide landscape complexity which will result in more resilient systems in the face of climate change.

Background

Worldwide, animal agriculture is the leading cause of habitat destruction, species extinction, and water source pollution. 51% of global greenhouse emissions are linked to the production of animal source foods. Conversely, agricultural activities are the main economic activity of many rural communities. We are faced with an immense challenge; to create integrated landscapes that can maintain biodiversity and the people's livelihoods. In previous work, plantings of fruiting trees increased species richness in the agricultural pasture. Silvopastoral systems provide more benefits to communities and maintain ecosystem services, favoring conservation and production. This combined management strategy aims to help solve the challenge.

Section 2:

Summary of Objectives, Activities and Outputs

Objective 1. Promote knowledge and establishment of ASPS as a biodiversity conservation strategy and sustainable livestock production.

Activities 1.1 Conduct 5 participatory workshops with cattle ranchers from 5 rural communities in the region of Los Tuxtlas.

Outputs 1.1

To promote Agrosilvopastoral Systems as an alternative cattle management strategy in rural communities, we conducted 3 workshops with the cattle ranchers of Balzapote, Veracruz, Mexico. In the workshops we addressed the economic and environmental benefits of agrosilvopastoril systems as an alternative to conventional livestock production (figure 1). We emphasized the importance of maintaining ecosystem services in terms of conservation but also in terms of long-term cattle production. Additionally, we had two invited guests that talked about the application of rotational systems and the methods to establish silvopastoral systems; topics ranged from electric fencing to seed germination and cattle nutrition. We had an attendance of 55 people from the community of Balzapote and the participation from women and men was remarkable. There were many questions and we were able to perceive good acceptance of agrosilvopastoril systems.
In the last workshop we selected one of the cattle owners to establish a demonstration plot to continue to advance with the community in adopting changes in livestock productions towards a more sustainable and profitable model.

Up to date the landowner continues to work and maintain the ASPS and has established plant nurseries to replant Leucaena and other foraging trees. He has become a promoter of this type of management and has reported that the system delivers better results in producing biomass for these cattle year-round.
Once the ASPS are fully established and functional, our future are to invite interested cattle ranchers for a demonstration visit where the landowner can explain the management and share his experience with ASPS.

Figure 1.1 First workshop in Balzapote, Mexico

Activity 1.2 Visits to other silvopastoral systems for learning exchange (Coatepec, Agrosol, Organización Produce, Colpos, Santa Marta).

Ouputs 1.2

Rather than bringing ranchers to different sites with alternative cattle management, we invited two speakers to Balzapote to be able to expand the audience to more people in the community.

In September 2016 Engineer specialist Jürgen Gläser, director of AGROSOL cooperative, a training center for green technologies, participated in a training workshop in the community of Balzapote. In the workshop, he presented us with the experience of the AGROSOL ranch and the different cattle management strategies that they have tested

over the years like. He invited participants to visit the ranch and he offered scholarships to the cattle ranchers to assist.
We also had the assistance of Dr. Silvia López Ortiz, from the Postgraduate College (Colegio de Postgraduados, COLPOS), Veracruz. She shared her experience in the production and establishment of foraging trees. We have maintained contact with both specialists to keep open the learning exchange between cattle ranchers of different regions.

Figure 1.2. Second workshop and learning exchange

Activity 1.3 Conduct surveys of the perception of ASPS to ranchers participating in the workshops.

Ouputs 1.3

The ranchers participating in the workshops practice intensive cattle ranching. This activity is deeply rooted in the region and, in the case of the interviewed ranchers, represents the main source of income (> 70%).

The average size of the pastures of the participating cattle ranchers is 6.78 ha, while the mean cattle herd is 12.46 cattle heads, so the grazing coefficient, 0.54 hectares per animal unit, is lower than that recommended by SEMARNAT for the state de Veracruz (0.8)

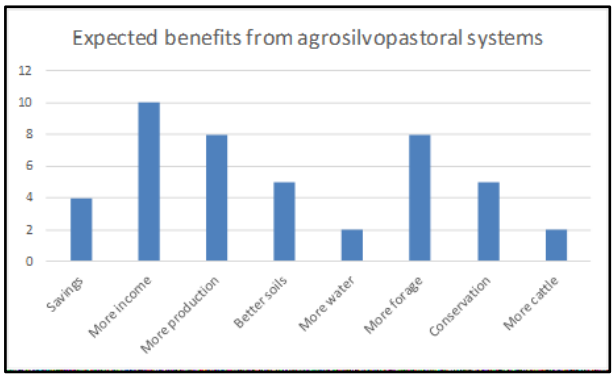
Most livestock are dual purpose. The milk is sold to cheese producers in the area (La Palma and Catemaco) at an average price of 4.1 pesos (.2 US dollars) / liter in the rainy season, and 4.3 pesos (.215 US dollars) / liter in the dry season. The cattle are sold mainly to cattle fattening farms or intermediaries in Catemaco and San Andrés, but also in Puebla, Hidalgo or the State of Mexico. The average age at which cattle is commonly sold is 14 months with an average weight of 308 kg at an average price of live cattle of 42.5 pesos per kilo (2.15 US dollars).

The conventional maintenance of the pastures requires periodic actions (every three to six months) such as weeding pasture, the maintaining fences, and the application of agrochemicals such as fertilizers, herbicides and insecticides. These activities are carried out between every three and six months and involve an expense of approximately $1,500 pesos (75.2 US dollars) per hectare for supplies and wages.

Most of the farmers attending the workshops had heard about silvopastoral systems (SSP). At the end of the workshop, the majority (85%) had a good perception of the ASPS and 90% said they were interested in establishing an ASPS. Increasing economic income is the main benefit that farmers expect from the ASPS, followed by the increase in milk and meat production, and forages. The livestock farmers also recognized the benefits of the implementation of the ASPS, the conservation of the soil and the environment (Fig. 1.3.1a).

Figure 1.3.2 Results from the previous interviews based on what they expect as benefits and what the cattle ranchers would be willing to invest to establish ASPS

a)



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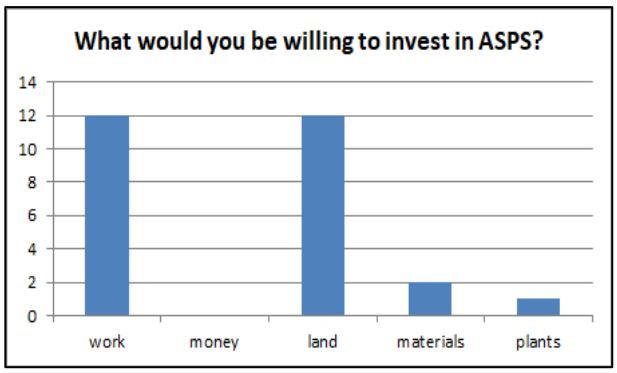


All ranchers said they were interested in knowing established ASPSs, as well as in the establishment of plots / plantations of fruit trees.

Regarding the establishment time, most of the farmers understood that the change from extensive livestock to ASPS requires between two and three years, and they showed willingness to allocate land and work for it. The small size of the land and the high dependence on income for livestock are circumstances that make the transition to an ASPS difficult. The implementation requires a period of at least 8 months that allows the establishment of forage plants, time in which the farmers would reduce their income and hinder the possibility of investing economically on the system (Fig. 1.3.2b).

Activity 1.4 Promote the creation of network of cattle ranchers interested in ASPS as a management strategy

Outputs 1.4

This objective was not fully met. At the beginning we addressed the other members of the community that had been in the workshops to see if there was an interest in forming a network to secure funding for the establishment of ASPS in other plots, but the ranchers were worried about how the change would happen and if they would have to put more effort, work and money to establish a different system. The results from figure 1.3.2b show that the biggest resistance for changing is the money that they perceived that would have to be invested. The team decided that once the demonstrative plot was established, we would then reach out again so they could better understand the management and functioning of the plot. The establishment and functioning of the demonstrative plot took more time than we had expected but had been working for 2 years.

PENDING: On one further visit, we would like the landowner to address the community and to talk about his experience with this new management system.

Activity 1.5 Promote the collaboration between the local communities and other institutions (governmental and non-governmental).

Outputs 1.5

For the workshops in Balzapote, we invited locals to participate in the federal Conservation and Sustainable Development Program (PROCODES in Spanish), which is funded by the National Commission of Protected Areas (CONANP in Spanish). 21 cattle ranchers participated and representatives from CONANP assisted in the inauguration of the workshop series. On the other hand, collaborations with the National University of Mexico and the State University of Morelos have been put into place to conduct studies on soil recovery and livestock production.

Preliminary results were presented at the and shared with a research group at the Institute of Ecology from UNAM, but the collaboration did not develop further. On the other hand, the UNAM Field Station Chief has shown interest in the proposal and has put us in contact with cattle ranchers from other parts of Los Tuxtlas.
There has also been great interest from the Secretary of Sustainable Development in the state of Morelos and a pilot study was set up in Xicatlacotla, Morelos using formaging trees. Some interest was also shown by the National Institute of Ecology and Climate Change (INECC in spanish), also in the community of Amacueca, Jalisco through the Western Institute of Technologic Studies (ITESO in spanish) and in the community of Armería, Colima though PRONATURA México.

Figure 1.5. a) Workshop with cattle ranchers in Armería, Colima; b) Land in Amacueca, Jalisco to establish ASPS

a) Workshop at Armería, Colima

b) Land in Amacueca, Jalisco

Forthcoming activities planned 1.5
We will continue to build collaborations with Universities and governmental agencies.

Objective 2: Establish a demonstration plot of ASPS (high intensity rotation, a protein bank and fruit plantations) in 10 ha

Activity 2.1 Land characterization for ASPS establishment

Outputs 2.1

The ideal land characteristics for the establishment of ASPS have not been completely defined, they could be established in sites with low soil fertility in sites with compacted soils, in steep terrains, open sites with or without any vegetation. Needless to say that

these characteristics will influence the successful establishment and functioning or ASPS. In other words, sites with higher quality, in terms of biotic and abiotic factors, will require less time and resources to establish, while sites with lower quality may take longer and need more resources and effort.

One goal of ASPS is to improve the quality of the diet for cattle through the incorporation of foraging trees and shrubs with high protein contents, generally legumes. Established leguminous species are known to incorporate soil nutrients, principally nitrogen, but also increase organic matter for future decomposition. This helps to decompact the soil and increase humidity which allow the arrival and establishment of flora and fauna that reestablishes important ecosystem functions.

Experimental design:

During the workshops, we met Frankis Chang, a local cattle rancher who agreed to establish an ASPS pilot plot in this land in the community of Balzapote. The land is 5.3 hectares and is in a nonuniform terrain 25° steep hill 100 m a.s.l. The land had few remnant mid-size trees (~10 m tall) dispersed throughout. The vast majority of the soil is covered with an exotic grass locally known as "insurgente" (*Brachiaria brizantha*) and a few native grasses. The southern side of the land has a small seasonal stream. At the eastside there is a small forest patch with a larger permanent stream

Figure 2.1 Land characteristics and disposition of the rotation segments and the restoration plots

Frankis' land originally had three ~2 ha separations made with barbed wire (yellow lines figure 2.1). Using satellite imagery, we made a new design to separate the land in smaller plots for rotation using the previous separation design for a total of 12 subplots. The design also maintained a central aisle that served to move the cattle from one subplot to another and allow access to the water sources.

For the installation of the ASPS we first strengthened the existing corner poles and installed new wooden corner poles in the new divisions. We established a fixed electric fence as well as mobile electric fencing for the smaller divisions. The fixed electric fence was established along the whole perimeter of the land and the main divisions. The fixed electric fence consists of two lines of triple galvanized wire, the first line is at 40cm in height and the second at 1.2m. Wire lines are kept in place with 1.5 m ⅜ inch wire rods with a coat of paint to prevent oxidation. The wire rods were set at 2 m apart. To avoid electric leaks through the wire rods we installed plastic insulators that also work to set the fence wires.

The mobile eclectic fence was established to be able to ration the land sections that will be occupied by cattle at a given time. The mobile fence consists of a line of electrified thin wire with metallic filaments that is flexible.

Figura 2.1.2 Electric fenece

The whole electric fence is powered by a 12 volt battery that charges through a 120 watt solar panel. The battery is connected to an electric pull button which is what sends slight electric shocks through the fence wires. The electric fence system (battery, solar panel and pull button) are all installed in a concrete and wire rod tower 4 m high. Finally, there is a structure that sets to land to avoid electric shocks in the site (figure 2.1.3)

2.1.3. Electric fence system

We also established 15 gateways for cattle using triple galvanized wire and insulating handles. The insulating handles function as anchorage between the wire and the fence posts (figure 2.1.4). The process of installing the fence system took two weeks and we had a specialized technician (Moises Piña) that led the work and trained five workers in the correct functioning and management of electric fencing. Maintenance of the electric fencing has continued throughout the following years as some parts had to be replaced and the wood corner poles were replaced with concrete poles to resist the high humidity in the region.

Figure 2.1.4 Gateways in the electric fence

Activity 2.2 Design the high intensity rotation system

Outputs 2.2

The rotation design was planned considering the growth times of the grass, the slope of the terrain and the number of cattle heads (12). As a first approximation, it was defined that the cattle would spend 3 to 5 days in each subsection of land. After a few months of evaluation and calibration, we were able to determine that the cattle cannot spend more than 5 days per subsection of land since, after this time, grass growth is affected. Once adequate times of rotation were established, we also tested the feasibility to other fractions of land could be occupied simultaneously if these had already been recovered from the livestock forage, regardless of whether that fraction of land was already used in the rotation schedule. This was especially useful during the dry season when feed is scarcer.

Activity 2.3 Establish a nursery for growing foraging trees

Outputs 2.3

A rustic nursery was established in August 2017. The nursery was 100 m^2, this was established with a shade mesh of a 90% caliber, and 2.5 m high wooden posts to support it. Approximately a thousand bags with soil were placed, and in each bag three to five seeds of *Leucaena esculenta* were placed. The Leucaena esculenta species is widely used to improve livestock feeding since it can provide 13 to 15% of vegetable protein compared to the grasses that are frequently used and only provides 5% protein content. Additionally, it was decided to establish a nursery on the site. An area of approximately 100 m^2 was cleaned and the seeds of Leucaena were seeded (Figure 2.3). We decided to establish this additional nursery on site since it facilitates the transport and handling of the seedlings, in addition to the lower production costs.

Figure 2.3 a) First nursery established in Balzpote, b) in site nursery

Activity 2.4 Establish a foraging system that combines trees and grasses in the demonstration site

Outputs 2.4

In December 2017, *Leucaena esculenta* seeds were sown directly on an area of 2 ha on site. Three to five seeds were placed in each point and distance from the next by 1 meter, we also left 1.5 m corridors between rows. This attempt failed, since the emergence of the seeds was approximately 1% (120 plants). We attribute this low percentage of emergence to the hostile conditions of the site, having a very high solar incidence added to a high temperature and humidity. At this point, we doubled efforts in the plant nurseries to plant the Leucaena seedlings directly.

Figure 2.4 One of the few Leucaena seedlings that survived and established

Activity 2.5 Establish a protein bank with foraging species

Outputs 2.5

In mid-2018, the Leucaena foraging plants that were established in the nursery were transplanted in an area of 1.8 ha at the site. The plants were transported bare root in order to facilitate their transportation. On average, the plants were 70 cm high, it is worth mentioning that the

performance (survival and growth) was better when the plants were transplanted above one meter in height (figure 2.5).

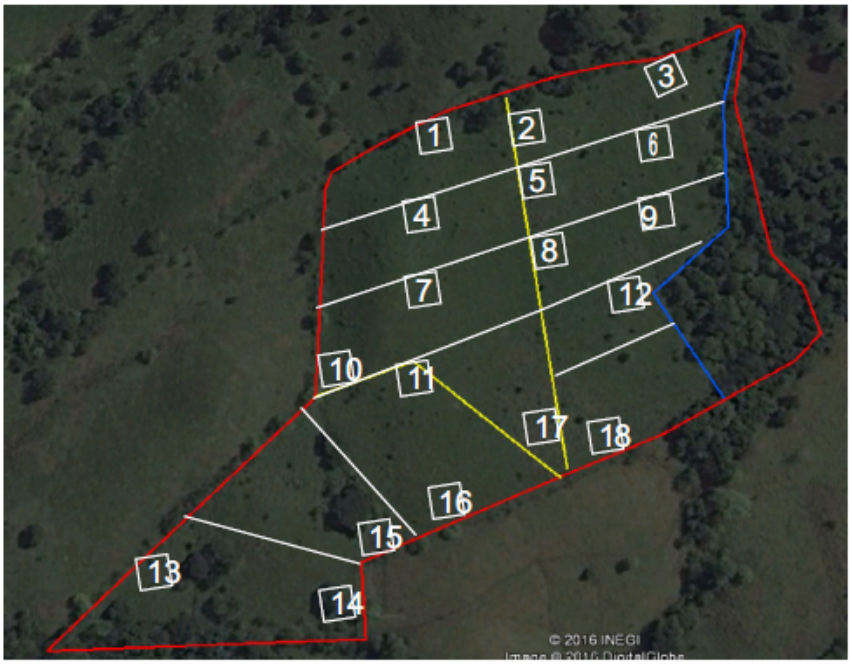
Figure 2.5 a) Landowner Frankis holding a planted Leucaena after a few months of establishment, and b) established Leucaena bearing fruits after only a few months of establishment

Activity 2.6 Establish plots with fruiting trees

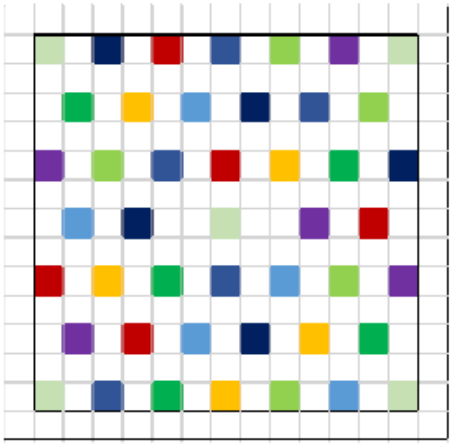
Outputs 2.6

In June 2018, just after setting up the electric fence, eighteen 15 × 15 m plots of were established in a three-block design based on geomorphologic and soil characteristics of the land. Each block is made up of six plots, in two of them were planted with eight species of economic importance distributed at random (table 2.6). Two more were established eight species of interest for conservation and two more were left unplanted as control plots. We made the decision to call the plots where no plants were established as a control treatment because we encounter difficulties problems to germinate and establish the *Heliocarpus appendiculatus* species. The species named as conservation interest are species that local people identify as very rare in the region. The plants were established by transplanting from the nursery to the pasture in the month of November of the same year and were established in an arrangement of eight rows by eight columns with a separation between plants of 1.5 m each plot with plantation has 60 plants. The total number of established plants was 720. The plants came from the “El Maduro” nursery in the community of Tebanca, Veracruz.

Figure 2.6 Restoration plots arrangement, assigned treatments by plot and species distribution



Parcela	Tratamiento	
1	2	Ecologico
2	1	Helio
3	3	Economico
4	1	Helio
5	2	Ecologico
6	1	Helio
7	3	Economico
8	2	Ecologico
9	3	Economico
10	2	Ecologico
11	3	Economico
12	1	Helio
13	3	Economico
14	2	Ecologico
15	1	Helio
16	3	Economico
17	2	Ecologico
18	1	Helio



Economico

- *Pimenta dioica*
- *Pseudolmedia oxyhyllaria*
- *Pouteria sapota*
- *Dyospiros digyna*
- *Switenia macrophyla*
- *Juglans olanchana/ J. pyriformis*
- *Tabebuia rose*
- *Nectandra lanceolata*
- *Heliocarpus appenduculatus*

Ecológico

- *Tababuia gayacan*
- *Tapirira macrophylla*
- *Manilkara sapota*
- *Cordia megalantha*
- *Calophyllum brasiliense*
- *Ilex valerioi*
- *Roupala montana*
- *Cojoba arborea*
- *Heliocarpus appenduculatus*

Species selection:

The treatment to which the 16 species were assigned is shown in Table 2.6. Among the species with economic value for the region, there are two species that are found on the IUCN Red List: α endangered (en) and β vulnerable (vu) (Table 2.6)

Table 2.6 Planted species list by treatment

Treatment	Specie	Family
Conservation value	*Cojoba arborea*	Fabaceae
	Roupala montana	Proteaceae
	Tabebuia guayacan	Bignoniaceae
	Manilkara zapota	Sapotaceae
	Ilex valerioi	Aquifoliaceae
	Tapirira macrophylla	Anacardiaceae
	Calophyllum brasiliense	Calophyllaceae
	Cordia megalantha	Boraginaceae
Economic value	*Tabebuia rosea*	Bignoniaceae
	Juglans olanchana[α]	Juglandaceae
	Swietenia macrophylla[β]	Meliaceae
	Diospyros digyna	Ebenaceae
	Nectandra lanceolata	Lauraceae
	Brosimum alicastrum	Moraceae
	Pseudolmedia oxyphyllaria	Moraceae
	Pouteria sapota	Sapotaceae

Objective 3: Monitor the success of ASPS as conservation strategy (density and richness of seeds, birds and bats species)

Activity 3.1 Evaluate richness and abundance of seed rain in planted plots of fruiting tree

Outputs 3.1

PENDING: Since the ASPS was not fully established, we were not able to start with the assessment of seed rain. In a second phase of the project we will monitor richness and abundance of the arriving seeds. In a previous project in the same region, we have assessed the seed rain since the establishment on experimental restoration plots and showed that, at the beginning of cattle exclusion and planting, seed rain in almost entirely

composed of small wind dispersed seeds, mainly from grasses (Martínez-Garza et al. 2009; de la Peña-Domene et al. 2017)

Activity 3.2 Monitor seedling establishment under plantings

Outputs 3.2

PENDING: As with seed rain, this part of the project will be carried out in a second phase once the whole system is well established. From a previous project in the region, we have shown that seedling establishment is limited at the beginning by overgrown grasses and by the lack of ideal microsites to establish. Once plantings overgrow the grasses, they will start to develop enough shade and create microsites that will allow the establishment of other recruiting trees. However, in early stages of the planting establishment, seedling recruitment tends to be very scarce, if at all (Howe, H. F. et al. 2010; de la Peña-Domene et al. 2013)

Activity 3.3 Monitor density and richness of birds and bats species in ASPS

Outputs 3.2

We conducted the baseline censuses for birds and bats on June 15 and 16th, 2018. For each planting treatment we placed two 18m mist nets. To monitor birds, the nets were opened before sunrise at (05:00 hr) and remained open for 4 hours and checked every hour. To assess bat species, mist nets were opened before sunset (18:00 hr) and remained open for 5 hours and checked every hour. All captured birds and bats were identified to the species level and morphometric measurements were taken following the methodology of Reid, 1997; Howell y Webs 1999 and Medellín et al. 2008.
In the first census, only 6 birds were captured with a sampling effort of 864 m/hr/net. The six birds were from families Thraupidae, Fringillidae, Tyrannidae and Parulidae (table 1).

Table 1. Family and species of birds and their abundance and diet

Family	Species	# individuals	Diet
Thraupidae	*Tiaris olivaceus* (Linnaeus, 1766)	1	Seeds, fruit and buds
Fringillidae	*Euphonia laniirostris* d'Orbigny & Lafresnaye, 1837	1	Fruits and insects
Tyrannidae	*Myiodynastes luteiventris* P. L. Sclater, 1859	1	Insects
Parulidae	*Geothlypis poliocephala* S. F. Baird, 1865	1	Insects
Tyrannidae	*Tyrannus couchii* S. F. Baird, 1858	1	Insects
Tyrannidae	*Pitangus sulphuratus* (Linnaeus, 1766)	1	Omnivore

From the bat census, only 2 individuals were captured in a sample effort of 1080 m/hr/net, both from the family Phyllostomidae.

Table 2. Family and species of bats and their abundance and diet

Family	Species	# individuals	Diet
Phyllostomidae	*Artibeus jamaicensis* Leach, 1821	1	Frugivore
Phyllostomidae	*Sturnira parvidens* Goldman, 1917	1	Frugivore

Activity 3.4 Evaluating the establishment success of the trees in plantations

Outputs 3.4

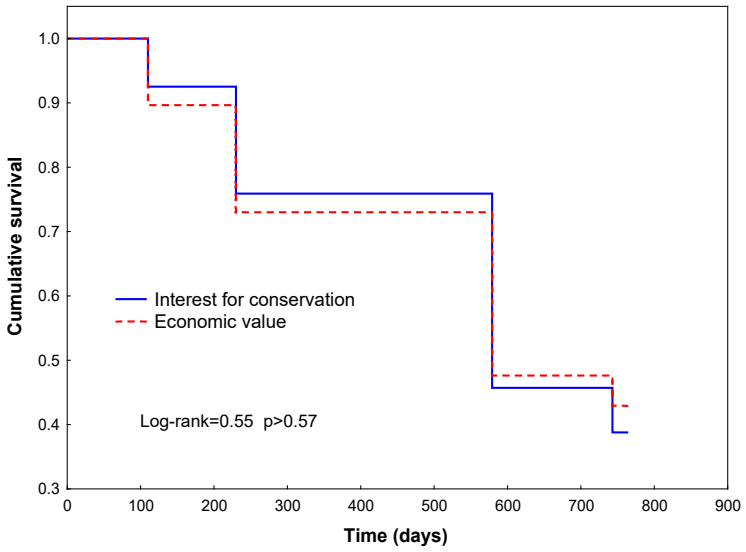
Four survival and growth censuses were carried out, these censuses were at 110, 230, 579 and 763 days after transplantation, in each census it was recorded if the plant was alive, it's height and its diameter at base height (DAB).

Survival

At 763 days of evaluation, the overall survival was 40.7%, equivalent to 294 individuals.

Survival was higher in the treatment with species of economic value (42.9%) than in the treatment with species of interest for conservation (38.8%), however, this difference was not statistically significant (figure 3.4.1).

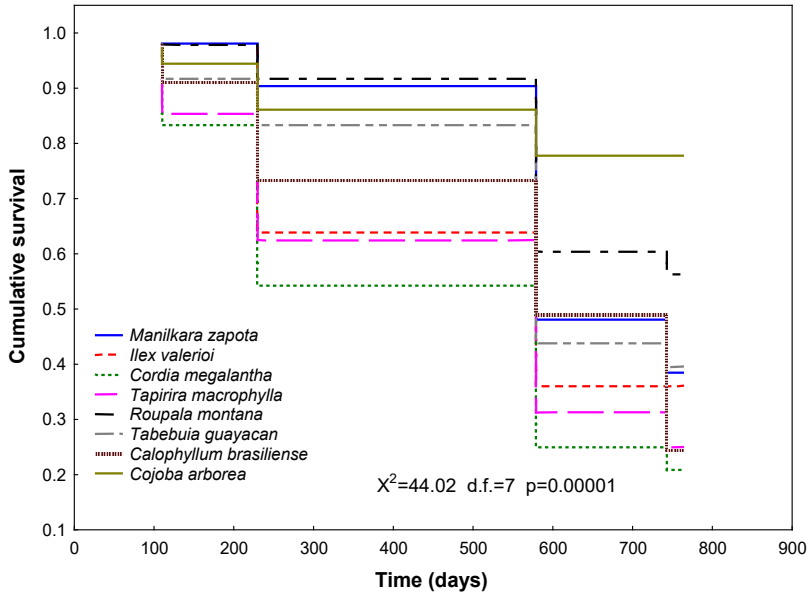
Figure 3.4.1 Cumulative survival of all planted species by planting treatment



The species with the best survival were *Cojoba arborea*, *Tabebuia rosea* and *Juglans olanchana*, presenting from 70 to 77% survival. Within the two plantation treatments, there were significant differences regarding survival of each species, this was a result that we expected given the biology of the species (figure 3.4.2 a and b)

Figure 3.4.2 Cumulative survival of each species in treatment a) species of economic importance and b) species of conservation concern

a)



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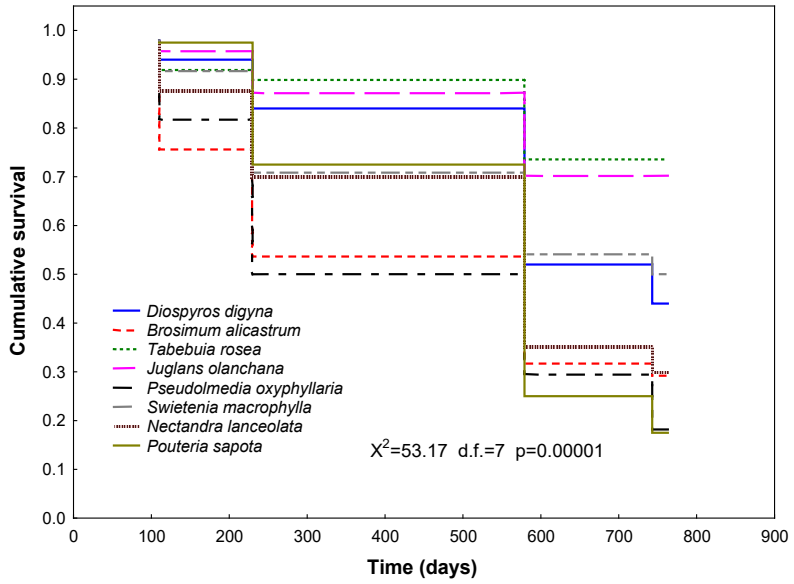


Growth

Tree growth was calculated as the difference in tree height and basal diameter, this was done by subtracting the value of the last census minus the value of the first census.
For the statistical analysis, the data on height gain and basal diameter gain were transformed with the logarithm function and two one-way ANOVAs were performed, using the gain in height or basal diameter as the dependent variable and the plantation treatments as the independent variable. The results section shows the mean ± standard error.

Height

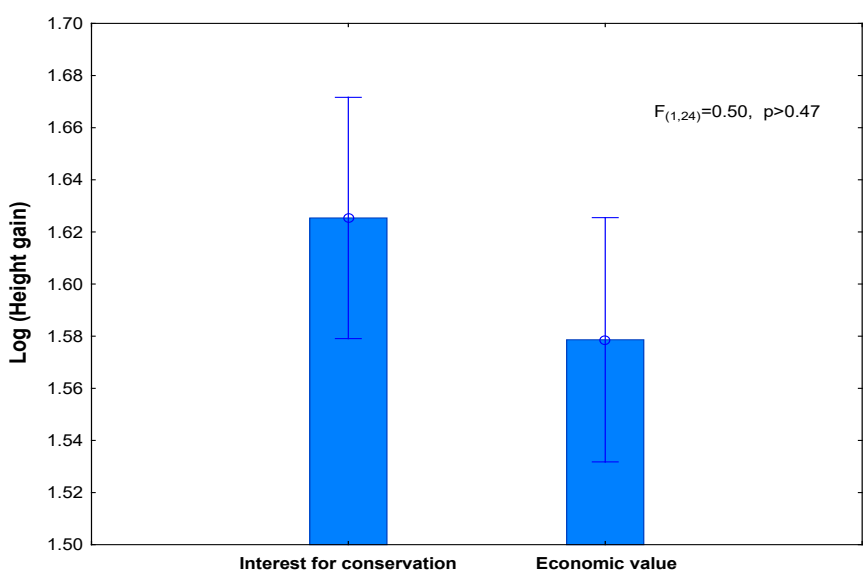
The growth in height gain was greater in the treatment with species of conservation interest (69.39 ± 4.81cm) than in the treatment with species of economic value (64.60 ± 5.83 cm), however, this difference was statistically similar (figure 3.4.3).

Basal diameter

The gain in basal diameter was greater in the treatment with species of conservation interest (13.72 ± 1.15 cm) than in the treatment with species of economic value (13.33 ± 1.42 cm), however, there were no statistical differences

Figure 3.4.3. Growth in a) height and b) basal diameter of all planted species by planting treatment

a)



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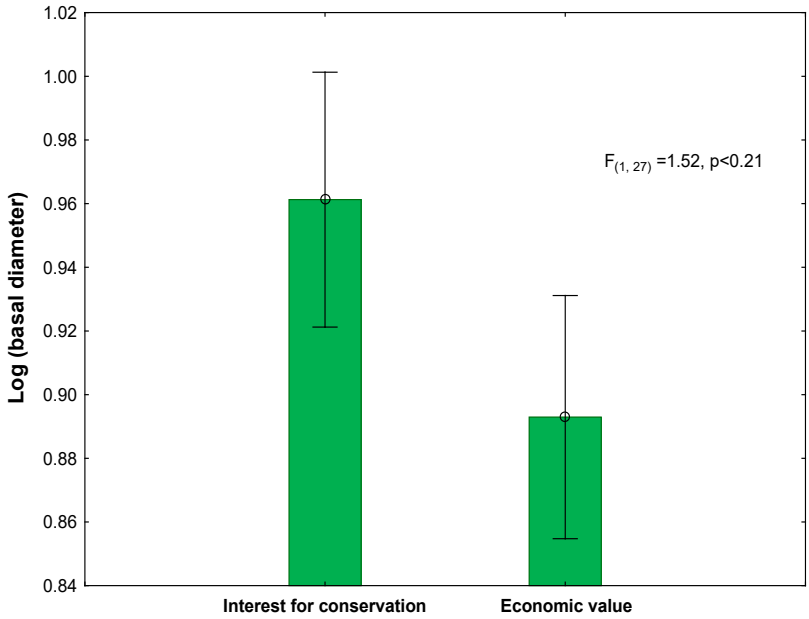


Within the treatment interest for conservation, the species that presented the highest gain in height was *Cojoba arborea*, this species also recorded the highest gain in basal diameter (Table 3). Within the economic value treatment, the highest gain in height, as well as the gain in basal diameter was for the species *Tabebuia rosea* (Table 3).

Table 3. Growth in height and basal diameter of each species by treatment (mean ± sd)

Treatment	Specie	Height gain	Basal diameter
Conservation Interest	*Calophyllum brasiliense*	90.63 ± 11.96	13.36 ± 1.45
	Cojoba arborea	118.10 ± 8.14	35.96 ± 2.47
	Cordia megalantha	13.83 ± 6.17	3.60 ± 1.14
	Ilex valerioi	29.09 ± 7.91	7.53 1.84
	Manilkara zapota	26.11 ± 6.95	4.85 ± 0.93
	Roupala montana	88.25 ± 10.47	11.81 ± 1.01
	Tabebuia guayacan	49.00 ± 10.80	7.52 ± 1.65
	Tapirira macrophylla	41.27 ± 9.42	6.25 ± 1.05
Economic value	*Brosimum alicastrum*	33.00 ± 16.47	4.25 ± 1.05
	Diospyros digyna	42.29 ± 8.10	7.63 ± 1.19
	Juglans olanchana	76.06 ± 12.17	17.06 ± 3.36
	Nectandra lanceolata	46.00 ± 11.73	5.33 ± 1.37
	Pouteria sapota	21.25 ± 14.29	4.42 ± 1.55
	Pseudolmedia oxyphyllaria	33.2 ± 14.53	6.62 ± 3.01
	Swietenia macrophylla	66.13 ± 13.38	12.5 ± 2.27
	Tabebuia rosea	86.19 ± 15.10	22.88 ± 4.35

Activity 3.5 Communicate the results through local media and scientific publications

Outputs 3.5

We presented the results of the two projects that we have carried out in Los Tuxtlas, Veracruz, with financing from CLP in the project "The restoration of terrestrial ecosystems in Mexico: current situation, trends, needs and opportunities"; carried out by universities and non-governmental organizations. The project aimed to make a diagnosis of the different projects in Mexico. The results from the study can be found at CIFORs repository

We also presented the results of this project at the academic event "50th anniversary of the Los Tuxtlas Tropical Biology Station", organized by the National Autonomous University of Mexico (Figure 3.5, see appendix 4). Additionally, results were presented at the ATBC 2017 meeting in Mérida, México and at the 2016 13th COP 13 in Cancun, Mexico.

Figure 3.5 Poster presentation at the 50th anniversary of Los Tuxtlas Biological Station, Mexico City and at de 13th COP in Cancun

Objective 4: Monitor the success of ASPS as a sustainable livestock production (costs and incomes of conventional livestock production vs ASPS)

Activity 4.1 Evaluate cost reduction of cattle maintenance

Outputs 4.1

To monitor the success and overall acceptance of ASPS we conducted an interview with landowner Frankis to learn about his experience and perceptions. We made a video with the interview and we address the main results in this section.

SASP requires a greater investment of time and work compared to traditional pastures at the establishment phase. The rotation of cattle, from one plot to another, in a SASP should be done every two or three days in the rainy season, and daily in the dry season. In comparison, in a traditional pasture the cattle are rotated every fortnight (Frankis had an improved pasture / rotation system] or are simply not rotated [free grazing, single parcel).

Activity 4.2 Evaluate milk production

Outputs 4.2

The amount of forage has increased both in the rainy season and in the dry season compared to the land of the neighbors. The body condition of the cattle has improved (fair

condition, six and seven, optimal), reflected in a decrease in rearing time (from calving to weaning) and an overall increase in milk production. The quality of the milk is a difficult characteristic to measure in the area because the dairymen pay for it at a fixed price, regardless of the quantity / percentage of fat and protein it has.

Activity 4.3 Record and compare costs and incomes between an ASPS and conventional pasture

Outputs 4.3

The amount of medicine supplied to livestock has been reduced. The amount of forage has increased. Although it implies a greater investment in time and work, the improvement in the quantity and quality of the forage produces an improvement in the body condition of the cattle, thus, when doing the math, the investment is paid little by little.

Changes to original project plan

Due to an earthquake and changes in the work and residence status of the members, the project has been delayed much beyond what was stipulated

> In September of 2017, a high magnitude earthquake hit in the center and south on Mexico, many communities of Morelos, the state were most of our team lived were badly affected. During this time, the whole team changed focus and started to work towards helping the nearby communities in every way we could find. We gathered supplies to bring to the people that lost their hose, their family and everything. We crowdfunded to buy temporal roofs for the people that were living outside their homes. We helped then to clean the land from their fallen houses, and we made dirt bricks to help them build new houses, this went on for several months. We could not focus on anything else because it was so painful to see the vast affectation in all the state.
>
> UAEM, the university where we worked and where we were when the earthquake occurred, was damaged. No buildings fell during the earthquake, but we did lose 6 buildings that had to be torn down afterwards. As a result, the university was shut down for several months. During this time, we were not able to enter the university, but various crews entered to restore our building during the months after the earthquake. We lost track of several paperwork for our project there. After that UAEM went bankrupt and we had a strike that shut down the university again.

Additional changes were related to the census of seeds and recruits was thought to start from the beginning, but it could not be done because we did not have a permanent person

in the field who could be emptying and processing the seed samples and that for a long period of time we could not periodically go to the recruitment field. In the original plan, it was intended to monitor production through milk quantification, but Frankis cows are not milked systematically and have more meat purpose, which has a greater challenge to measure in the field. Visits to different sites with silvopastoral systems were changed to workshops within the same community to achieve greater scope

Also, the plots that we had originally planned to sow with Heliocarpus were left as controls since it was not possible to achieve germination of Heliocarpus in the field.

We added to the original plan soil censuses from inside and outside the restoration plots as well as in nearby forest remnants and neighboring pastures. Additionally, we made three soil profiles to determine soil type, texture and other physicochemical properties of the soils that could drive the survival and growth of the planted specie as well as recruiting species

We visited sites where Silvopastoral systems had been established in the area, but found that their systems did not have a conservation focus as no trees were integrated in the rotation system and it functioned more as a rotation pasture.

We had some changes in our budget changes:

- we were not able to complete all programmed workshops due to political campaigns occurring at the time our project was being established.
- Increases in costs of gas and tolls lead us to spend more in field trips than what we had anticipated
- Currency change also lead to a higher budget being required for materials to implement the ASPS
- Education and outreach materials were more electronic versions, and some were paid by PROCODES

Section 3:

Achievements and Impacts, Problems Encountered and Lessons Learnt and Future Planned Activities

Achievements and Impacts

Environmental achievements and impacts

With the established ASPS we increase in biodiversity as 16 planted species were integrated into the bare pasture system. We also integrated Leucaena as a foraging tree. Once the plantings grow, we expect that countryside biodiversity will continue to increase as more plant-animal interactions are established, leading to a recovery in ecosystem functions previously lost. The successful establishment of 40% of the planted trees was achieved, although this presents many variations according to the species. We were able to test the efficiency of the species in the establishment in cattle pastures. The diversification of the terrain will increase the permeability of the matrix and generate more connectivity in the landscape. Moisture is better retained because it has coverage for most of the year and this favors the microclimate, which also catalyzes the establishment of the planted trees and other self-recruiting ones.

Social achievements and impacts

We were able to successfully establish the rotation system so that people know first-hand how it works and what benefits it has, as a result, there were more people interested in forage trees and particularly Leucaena and its implementation. Cattle ranchers were also interest in different species in the region that have forage potential after hearing one of the invited speakers of our workshop and how she has used different regional trees as cattle feeds. After the workshops and some years after the ASPS was established, we noticed that some community ranchers had reduced their resistance to change. The demonstration plot established in Frankis land, has served to bring farmers closer to different alternatives that can be more productive and mitigate their concerns to learn new production strategies. Our project was the first to receive funding by PROCODES in Balzapote which helps to bring the government environmental agencies to the region.

Economic achievements and impacts

We observed a reduction in the costs of maintenance by not depending on external inputs for food. Livestock production improved because: calves gain weight faster, the cattle got sick less and had fewer ticks, which results in a decrease in the use of agrochemicals. Also, the cattle improved in complexions to optimal levels. Because cattle make better use of forage and not selective foraging, the land was less wore down and there was also an increase in the amount of forage and the ability to support cattle in the dry season.

Problems encountered and lessons learnt

Community participation has been a mayor component of this project, through the workshops we has great participation of the community but, that participation has to maintain the interest not only of Frankis, but also of several farmers in the region who are beginning to see SASP as alternatives. We believe that there was some resistance that can be associated with the risk of the investment in which they do not yet trust that it can be successful. Cattle ranchers at some point got demotivated because they associated ASPS as an economic investment that they could not assume or because of the time of uselessness of the land during the establishment period. We believe that having a better plan build up for the network of ranchers, could have eased this tension. Our plan was to gather an interested group of ranchers and then seek financing to implement ASPS, but we think some of them got confused thinking that they would have to come up with the money. For this reason, we think we need to improve our communication strategies towards livestock production alternatives. One thing we did not account for was the excessive erosion in the central aisle of our setting due to erosion being controlled in other parts of the land through to planting establishment. We will need to plant an erosion barrier to protect the aisle. Clearing the land due to the overgrowth of insurgent grass has also been a struggle, because we did not account for this expense.

We were complicated with other activities and we did not calculate the times associated with the development of the project, we would have benefited from better planning to achieve the objectives we set for ourselves. The organization of the financial report was also a challenge, it could have served to have photographic backups to keep better control of our project finances. After the earthquake we focus all our energy in helping affected communities, not only the CLP team, but also Frankis. This set us back in our project and we ended up extending a lot of the activities. CLP has helped us to find solutions and not remain immobile, we apply this to the context of the earthquake, and we recognize that this was a priority for the entire team when seeing the situation in which we found ourselves, our state and our country. Furthermore, the context of the pandemic has also set us behind in continuing our project, but we maintain close contact with Frankis for the basic activities.

As a team we did not throw the towel, despite all the obstacles. Our weakness in having many occupations we have turned it into a strength by being able to expand our networks and impact to

different areas. We believe the team complemented each other and was always understanding within.

Future planned activities

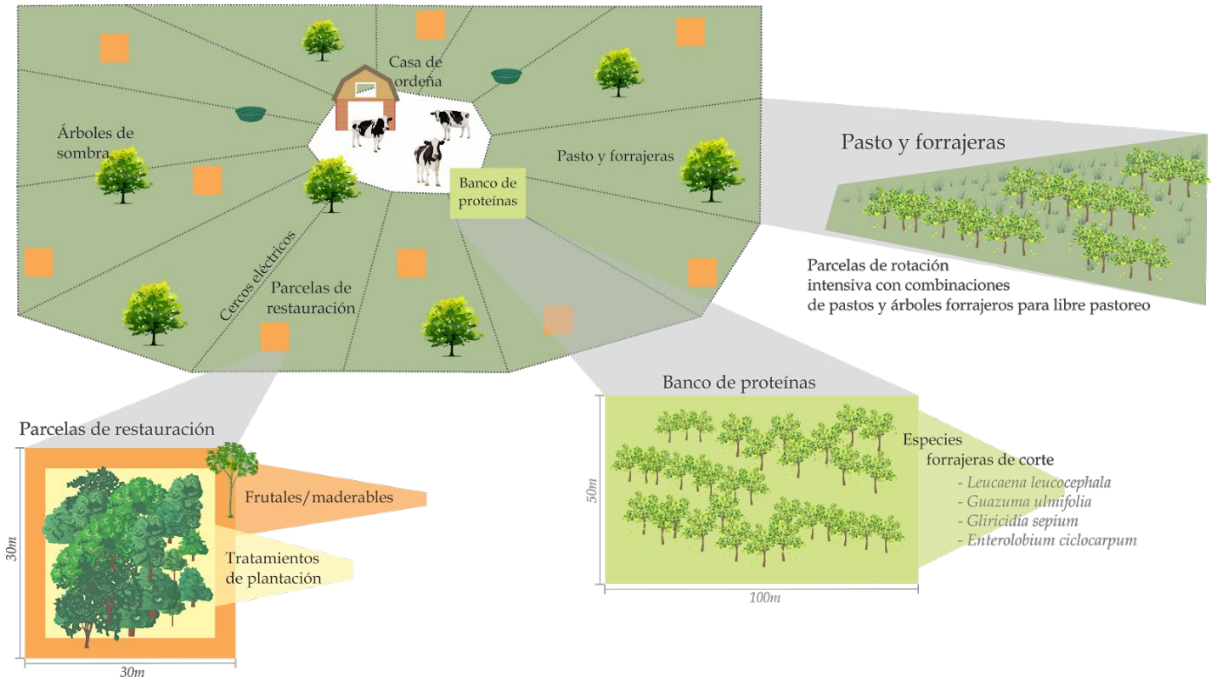
We plan to make one more visit to give continuity to the project and make a general evaluation of the system and summon different farmers to see how the Frankis field works, its advantages and the things that have had to change. We will continue to follow up closely with Frankis and support him in managing the terrain. We plan to make this visit in the summer of 2021, if the COVID conditions in the country and the state have improved.

Section 4:

Appendices

Appendix 1. Agrosilvopastoral System Scheme

Further details on the layout and functioning of the systems can be found here



Appendix 2. Materials used for the workshops and evidences

a. Assistance to the workshop can be consulted here

b. Interview instrument used for the workshops can be consulted here

c. Brochures made for the workshops and to reach out to cattle ranchers can be consulted here

¡¡¡Con árboles ahorramos parte de lo que gastamos en mantenimiento!!!

Además podemos incrementar en más del **20 %** la producción de leche

¿CÓMO?

Con **SISTEMAS AGROSILVOPASTORILES** en los que se incluyen diferentes tipos de forrajes, se mantienen los árboles en los potreros y se hace una rotación intensiva del ganado.

Con estos sistemas podemos producir más leche en menos hectáreas, **¡hasta 15 litros por vaca al día!**, porque los forrajes son más nutritivos y las vacas bien comidas producen **MÁS LECHE.**

Además, llueva o no llueva, la producción de leche es constante porque hay pasto todo el año.

¿Cómo vez? ¿Nos quedamos igual o cambiamos?

¡¡¡TÚ DECIDES!!!

¿Has notado últimamente que...
- las lluvias son más escasas?
- hace más calor?
- en temporada seca hay cada vez menos pasto?
- es más difícil mantener al ganado y que este produce menos leche?

En promedio, cada vaca lechera que tienes en el potrero produce entre 8 y 10 litros de leche al día

Si por cada litro recibes **$4.60**, diariamente, por cada vaca recibes entre: **$36.80 y $46.00**

¿Esa es tu ganancia verdadera?

¿Sabías que...?

El gasto diario en alimento balanceado, garrapaticida, chapeos y plaguicida por vaca es de aproximadamente: **$19.77**

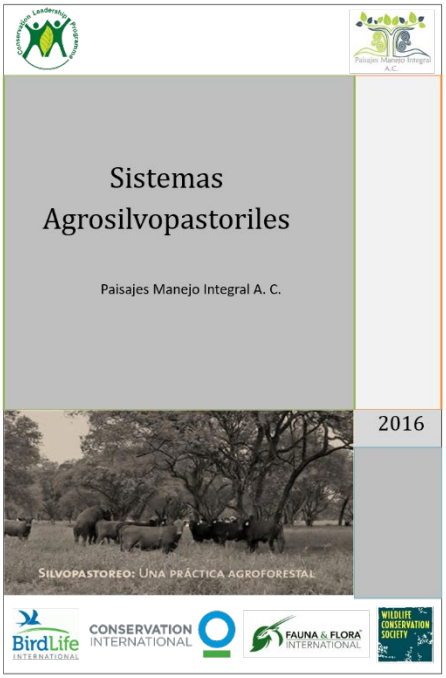
Esto significa que al día por vaca solamente tienes: **$17.03 y $26.00**

Por cada vaca recibirías, más o menos: **$15 000 anuales**

Pero, si de mantenimiento pagas: **$7 200**

Solo te quedan como: **$7 800**

¡Casi la mitad de mi lana!



¡Oh! ¿Y ahora quién podrá defendernos? **¡Los Árboles!**

Porque...

Sin árboles	Con árboles
El suelo es más caliente y se seca con facilidad	El suelo se mantiene fresco y conserva la humedad
El suelo es compacto y necesita fertilizantes	Se favorece la presencia de escarabajos peloteros y lombrices que aran y ventilan el suelo, además incorporan estiércol y hojarasca al suelo fertilizándolo
Necesitamos garrapaticidas y plaguicidas	Atraemos aves que se alimentan de garrapatas y otras plagas
El suelo funciona como un espejo que refleja la luz y calor calentando el aire y alejando las lluvias	Se absorben la radiación solar y produce más vapor de agua que generan lluvias locales
Los pastos escasean en secas	Los pastos se mantienen verdes en la temporada seca
Únicamente tenemos pastos	Podemos obtener más frutos y algunos árboles pueden servir de forraje para el ganado
Solo hay pastos poco nutritivos	Hay variedad de pastos y forrajes más nutritivos que mejoran la cantidad y calidad de la leche

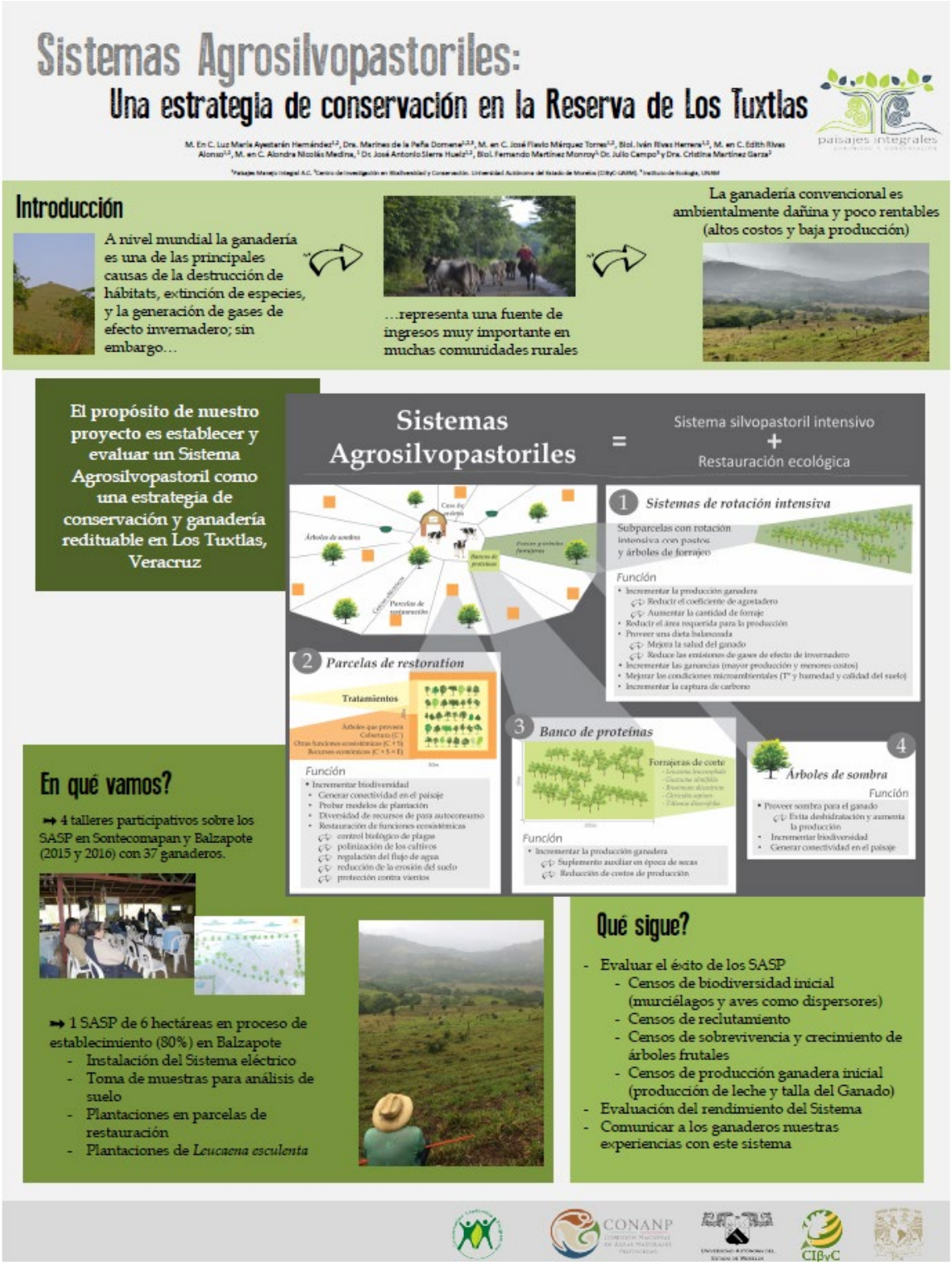
d. Presentations for the different workshops focused on understanding the conventional cattle ranching practices and on presenting alternatives that can be more sustainable and economically viable.

https://drive.google.com/file/d/0BzKsSrXWdmv0NEQ0NXRlUDI3aHc/view?usp=sharing

https://documentcloud.adobe.com/link/review?uri=urn:aaid:scds:US:d624fe46-9757-43d0-b608-9df3ede73335

e. Workshop report for our first workshop

Appendix 3. Posters presented in national and international scientific meetings



Appendix 4. Photo gallery