(Paper in progress)

ANALYSIS

Economical valuation of Allspice (*Pimenta dioica*) production for the restoration strategies proposed for the recovering of "Los Tuxtlas" livestock pastures (Veracruz, Mexico)

Luz Aliette Hernández-Prieto [a]*, Martin Ricker [b]

a *Instituto de Investigaciones Sociales, Universidad Nacional Autónoma de México, Ciudad de la Investigación en Humanidades*, Insurgentes Sur 3000. *Delegación Coyoacán, D.F*. 04510, *México*

b *Jardín Botánico del Instituto de Biología, Universidad Nacional Autónoma de México, Apartado postal* 70 -614, *Delegación Coyoacán, D.F*. 04510, *México*

* Corresponding author. Fax: +52-5-556227508

E-mail address: xuealiette@gmail.com (Luz Aliette Hernández-Prieto)

Abstract

Laguna Escondida is an "ejido" that is part of the natural protected area "Reserva de Biosfera Los Tuxtlas." Currently, 71% of the surface of Laguna Escondida is occupied by livestock, which strongly influences the loss of the "ejido" forest. The cultural acceptance of this productive activity is a result of several social factors related to the lack of alternative opportunities and the pressure for better incomes from the local population. Restoration initiatives for the region should incorporate these socio-economic demands and the stakeholders' participation in the proposal's design. As an alternative, in this study a restoration strategy was analyzed on the basis of the establishment of live fences with commercial use - using *Pimenta dioica* (L.) Merr.- in the cattle ranch area. The viability of the proposal was evaluated on the basis of the performance of *P. dioica* on: (1) the establishment of a demonstrative plot; (2) the growth and yield projection for the species; (3) the analysis of the individuals' morphological variation according to their growing site; (4) the analysis of the environmental modifications as consequence of the presence of *P. dioica* in the cattle area; and (5) the analysis of the commercial value of the proposal. As a result, it was observed that: (1) survivorship of *P. dioica* was successful (58%) on pasture land conditions; (2) in the pasture area, trees grew three times faster than trees developing inside the forest; (3) *P. dioica* trees improve the environmental conditions of the pasture; and (4) its establishment in live fences around the cattle area is profitable and economically competitive with the current "ejido" livestock activity. These results allowed us to conclude that *P. dioica* has a high biological potential for the restoration initiatives; and its use as part of the live fences system is a commercial valuable alternative for the restoration of the pasture areas of Laguna Escondida.

Key words: Restoration ecology, economic valuation, livestock, live fences, tropical forest, *Pimenta dioica*

Introduction

The biosphere reserve "Los Tuxtlas" in Veracruz (Mexico) is a natural protected area with high biological importance for the conservation of tropical rainforest (Dirzo and Garcia, 1992). Its importance and establishment is recognized by UNESCO (United Nations Educational, Scientific and Cultural Organizations) and the Mexican federal law (Presidencia de la República, 1998). Laguna Escondida is a community (an "ejido") that is part of this reserve. Its location in one of the reserve's nucleus zones implies drastic legal restrictions for the population's management and use of forest resources, especially for activities as land transformation and timber extraction (Brañez, 2000; Reserva de Biosfera "Los Tuxtlas", 2003 and CONANP, 2004). Even though, Laguna Escondida has an increasing 71 % of its territory covered with livestock pastures supported by governmental programs focused in the promotion of agriculture activities (INEGI, 2000).

This discrepancy in the federal government dispositions for the management of the Mexican natural resources is mainly due to the discordance between productive and conservational programs (Paré, 1995). An alternative to coordinate the results of these programs in the territory of the natural protected areas is to develop ecological restoration initiatives that incorporate socio-economic alternatives for population´s development. This study proposes a restoration strategy adapted to the biological and social contexts of Los Tuxtlas region. This strategy consists in the implementation an agro-ecological system based on the grown of live fences around the livestock pasture plots using species with well known commercial value, in this opportunity *Pimenta dioica* (L.) Merr. was used as case of study. The viability of the proposal was evaluated trough the analysis of the commercial value of the *P. dioica* product (Allspice) obtained from the system designed, following the methods proposed by Ricker and Daly, 1998.

Pimenta dioica as resource ("Allspice")

Pimenta dioica is a dioic tropical forest tree, up to 15 m of height, distributed throughout Central America and the Caribbean. In Mexico it is wild present in the South part of the country, in the rain forest regions of Veracruz, Tabasco, Campeche and Southern Yucatan. It has exfoliable brown-silver crust and pinkish hard timber. Its leaves are very aromatic, dark green on the upper side and light green below. It flowers in panicules of 6 – 12 cm length, with white small flowers structurally bisexual, but functionally dioic. *P. dioica* wild populations are conformed by functionally feminine and masculine trees (in a ratio of 1:1). Fruits are dark purple berries when mature and represent important food resources for different mammals in the forest (Landrum, 1986; Sanchez Vindas, 2001). *P. dioca* flowering season goes from March to June, and fruiting season from June to August. When the fruiting set is

initializing, at the beginning of the fruiting season, its immature berries are hard, green and very aromatic and flavorful. This resource is known as “Pimienta gorda” or “Allspice”. It has been historically harvested and dried to be used as flavoring for food, and as an oil source for the pharmaceutical industry (Martínez et. al, 2004).

Until recent times Jamaica had been the most important Allspice exporter in the world, followed by Mexico. In the global market major Allspice buyers are Germany, Holland, France, England and United States. Currently Jamaica has changed Allspice market activities for tourism activities as its major source of income. For Mexican producers (Tabasco, Puebla, Veracruz and Chiapas, and in minor scale Oaxaca, Quintana Roo, San Luis Potosí, Campeche and Hidalgo) this represents an important opportunity to increase their participation in Allspice international trade (Bancomext, 2001; Martínez et. al, 2004). This study explores the state of art of the Allspice production system in Los Tuxtlas region and determines its potential profit, competitiveness, and possibilities of growth.

Methods

Area of Study

This research was conducted in Ejido Laguna Escondida (18°35´34´´ N; 95°5´3´´W), in the Gulf of México, at the Southeast margin of Veracruz State, and Northeast of the mountain formation Sierra de Los Tuxtlas (Fig. 1). This Sierra is a volcanic region of tropical forest which presents altitudes from 0 to 1680 m.a.s.l., 24 °C of mean annual temperature, and a mean annual precipitation of 2500 - 3500 mm. These conditions vary strongly during raining season, between June to February (Guevara et al., 2004). Laguna Escondida is located in the Volcan San Martin´s nucleus zone, adjacent to the area where the most conserved ecosystem of the region exists (INEGI, 2000).

Evaluation of the importance of livestock activity as livehood strategy between Laguna Escondida’s population

To evaluate the conformation of the population of Laguna Escondida a census was made during June and July 2004 in family units, including 100 % town population (N=22 family units). Census was based in a questionnaire designed to recover information about age structure, schooling, land tenure and migration. We applied this questionnaire through a semi-structured interview directed to the head of each family unit (Table 1). Moreover, 12 family units (55 % population) where randomly selected to apply a second semi-structured interview based on a second questionnaire designed to recover information about sources of income and other subsistence alternatives practiced. This information was used to characterize the importance and diversity of different sources of income in family units, and then to compare them between families with different land property rights (ejidatarios and

avecindados) (Figure 2). Ejidatarios are those ejido´s inhabitants that hold land property rights that let them use ejido´s productive and collective areas, besides its familiar gardens (located in town); and avecindados are those ejido´s inhabitants that do not hold land property rights, and only can use the land delimited by their town familiar garden.

Characterization of traditional livestock system practiced in Laguna Escondida

To characterize Laguna Escondida traditional livestock system nine of the families with land property rights (ejidatarios) where randomly selected (56 % of ejidatarios' population). With this sample we applied a third semi-structured interview directed to each head of family, following a questionnaire based on the information of livestock activity's characterization. We included in the analysis only those management practices reported by more than 50 % of the sample (Table 2). This typified situation constituted the setting to develop further economic profit and competitiveness analyses.

Analysis of Allspice market in Los Tuxtlas region

To describe Allspice market in Los Tuxtlas 36 sessions of the participant observation method were developed during harvest, selling and buying practices. Harvest practices where registered and characterized in three different agro-ecosystems in Laguna Escondida (forest, isolated trees in pastures, and small plantations located in town familiar gardens). These observations where complemented with qualitative information obtained trough open interviews applied to collectors, producers, buyers, and intermediaries. Observations and interviews provided the information to design the restoration strategy proposed (Table 3). This strategy was the setting to develop the economic profit and competitiveness analysis that compared Allspice production in live fences with the traditional livestock system practiced in Laguna Escondida.

Analysis of economic valuation of traditional livestock and Allspice live fences as production systems

Economic valuation was applied to the system of production of Allspice in live fences established around livestock pastures, and to the traditional livestock production system practiced in Laguna Escondida. It was made based on the previous systems characterizations, through the application of the Net Present Value index (NPV) (Ricker and Daly, 1998). NPV results allowed to compare both systems yield in one hectare of pasture, and evaluate their commercial value and competitiveness in production cycles of 50 years (cycles time was fixed to make both systems comparable, according to the length of *P. dioica* productive life stage = 50 years).

NPV is an adequate index for economic valuation of long term investments, where the benefits are not received immediately (as livestock and tree plantations), because it makes evident the economic benefits of this type of investments, if they exist, through the annual analyzes of the system´s cost-benefits relationship, and its posterior sum, until the system production cycle is completed. Besides, NPV includes in the analysis the cost of waiting for those years that are needed to reach the systems' production stage, trough a producers´ compensation that is an interest rate (discount rate), equivalent to the one that producer would receive if he had decided to invest his money in bank instead of livestock or trees (Ricker and Daly, 1998).

NPV for the Allspice production system proposed was calculated using the following formula:

$$VPN_{Allspice} = \sum_{i=1}^{MA} [(P-C) * F_i * S_i * N/2 - K_i * S_i] * e^{-ri} .$$

"$VPN_{Allspice}$" is the present commercial value of an hectare with an establishment of 277 *P. dioica* trees grown for Allspice production, according to the Allspice production system characterized and the strategy proposed previously. "$_i$ " is *P. dioca* plantation age. "^{MA}" is species maximum production age (for *P. dioica* 50 years is known). "*P*" is the market price for each kilogram of Allspice commercialized. "*C*" is the harvest cost for each kilogram of Allspice obtained. "F_i" is the expected annual yield of Allspice obtained from a *P. doica* tree. "S_i" is the survivorship observed in field for *P. doica* trees. "*N*" is the number of productive trees established in the live fence (N= 277 in the setting of the strategy proposed, but only N/2 = 139 are expected to be productive individuals because of *P. dioica* diocity). "*K*" is the present value of plantation and management costs for one hectare of live fences. And "*r*" is the discount rate applied for waiting years to production to start (for long time investment r = 0.05, according to Ricker and Daly (1998)).

NPV for traditional livestock system practiced in Laguna Escondida was calculated using the following formula:

$$VPN_{Livestock} = \sum_{i=1}^{MA} ([((F_{i\,(milk)} * P_{milk}) + (F_{i\,(meat)} * P_{meat})) - C_{cow}] - K_{pasture}) * e^{-ri}$$

"$VPN_{Livestock}$" is the present commercial value of a livestock hectare where a double purpose cow is maintained following the traditional livestock system characterized previously. "$_i$ " is the year of inversion. "^{MA}" is the livestock system production time included in the NPV analysis (50 years according to maximum age of production of *P. dioica* trees). "P_{milk}" is the market price per liter of milk commercialized. "P_{meat}" is the market price per kilogram of calf meat commercialized. "C_{cow}" is the maintenance cost of a cow following the traditional livestock system of Laguna Escondida. "$F_{i\,(milk)}$" is the annual yield of milk expected by cow in liters. "$F_{i\,(meat)}$" is the annual yield of meat expected by cow in kilograms. "*K*" is the present pasture maintenance cost. "*r*" is the discount rate applied for waiting years to production to start (r = 0.05 (Ricker and Daly, 1998)).

NPV results where compared to determine economic competitiveness between the production systems analyzed. As both results were negative and implied economic loses for producers in the characterized settings, the real current condition of job cost being subsided by farmers was included in the analysis (Table 4). Moreover, critical parameters that determined Allspice NPV results were identify, and a sensitivity analyses was carry out trough the identification of each parameter threshold value needed to get a competitive Allspice NPV (Table 5).

From these results different alternatives over the implementation of the pastures' restoration strategy proposed where suggested to be used for decision makers.

Results

Evaluation of the importance of livestock activity as livehood strategy between Laguna Escondida's population

Ejido Laguna Escondida is configured by 22 family units. Only 55 % of these family units had recognized land property rights and are the group which takes joint decisions on the territory and natural resources management. They legally manage 68 % of total ejido's territory and 96 % of its plotted area. Ninety percent of these land owners practice livestock production as their main source of income (Fig.2). However, 60 % reported to depend also on more than two additional sources, 10 % reported to have diversified sources – up to seven -; and only 30 % reported to practice livestock as their unique source. This income practices and the irregular pasture openings promoted that 71 % of Laguna Escondida territory is currently covered by livestock pastures.

Characterization of traditional livestock system practiced in Laguna Escondida

Regularly, in one mean productive plot in Laguna Escondida a regular farmer use to establish a pasture of Insurgentes grass (*Brachiaria brizantha*), delimited using a live fence of Palo Mulato (*Bursera simaruba*) and barbed wire. At each hectare of this plot a double purpose cow is maintained for milk and meat selling (for economic valuation analysis the cow is considered to be four years old and to had its first offspring). During the first eight months after birth, during lactation period, farmers dedicate approximately ten minutes daily to milk the cow that produces three liters of milk per day. After milking, the farmer carries the milk to be sold at the path that is half an hour away from his plot. Milk buyer set the price for transaction – no more than $2 pesos MXN per liter -. Also, farmers dedicate an additional hour to maintenance of the cow and / or pasture daily.

At the end of the year, the cow's offspring reaches 200 kilograms weight and is ready to be sold. The farmer sells it to the closest slaughterhouse, which picks up the animal alive in the farmer's plot. Animal price is negotiated between farmer and slaughterhouse, and they usually agree to pay $15.5 MXN per kilogram. Slaughterhouse applies a discount of 5 % of the total weight, estimating loses for concept of bones and casings.

After the first offspring is sold, the original cow is crossed to be reproduced again. The farmer must be aware that gestation (nine months) and lactation periods (eight months) do not overlap. Using this system a cow gives the farmer a new offspring every two years. During gestation the cow is fed with pasture, and it does not produce milk or meat for selling.

This system is repeated every two years for each cow until the cow is ten years old and has reached 300 kilograms. Then, the cow and its last offspring are sold together to the slaughterhouse. Cow follows the same system that offspring's selling, but price paid for each kilogram is less. Depending on the condition and health of the animal, the farmer can receive between $ 7 - $ 10 pesos MXN per kilogram ($ 8.5 pesos MXN mean). At this time, original cow is replaced by a new three-year old calf, which can be purchased by farmer or brought from another hectare of the farmer's plot. Detail costs and benefits of this traditional livestock system practiced in Laguna Escondida are reported in table 2.

Strategy proposed for Los Tuxtlas' livestock pastures restoration, based on the analysis of Allspice market in the region

In a mean livestock pasture plot (regularly around 14 hectares big) one hectare is distributed around the internal margin of the plot perimeter, beneath the 1666 m of existing fence. There, a farmer could plant 277 trees of *P. dioica*, following indications specified by Hernandez (2008), being aware that each *P. dioica* tree should be planted at least six meters away from each other (Figure 3). To do this farmer should invest $5,650 MXN to buy 4,998 m of the barbed wire that would be used to exclude plants from livestock. Also he should invest $26,232 MXN for the payment of the work days required to the establishment of exclusion fences and planting. Alternatively, the farmer could dedicate 254 days of work during the first year to: look for *P. dioica* seeds in Laguna Escondida communal forest areas, sew and care of seedlings at nursery conditions created at its own home garden; cut and carry out 925 wood stands obtained from trees located at communal forest areas, fix exclusion barbed wire in fence, clean and prepare circle areas in pasture land for planting, open holes and plant seedlings grown after a year of nursery, and to sporadically clean circle areas of weed. Once plantation is established it only requires maintenance work of cleaning of weeds, twice a year. Outside the excluded area - that remains at the margin area between original existing fence and new established barbed wire exclusion fence -, livestock activity continue following the livestock production system characterized previously.

Survivorship expected is 58 % of seedlings transplanted after one year of planting. From the second year annual survivorship expected for established plants is 97 % (Hernandez, 2008). Seven years after planting, plants reach an adult age; they develop trunks and canopies, reach at least two meters height, and about half individuals produce fruits (N=139). At this stage the farmer can remove exclusion fence and start to harvest fruits. Fruit yield increases every year, during more than 50 years and then start to decrease (Hernandez, 2008). Fruiting season

and harvest occur from June to August each year, but it can be different for each plantation, and probably depends on planting site conditions.

To harvest, during first years of production, farmer counts with family workforce and dedicates twelve days of one person work to fruit collection. Once trees reach more than two meters height – when they have ten years approximately -, harvest requires more work intensity and harvesters special abilities; then farmer has to contract collectors and paid $1 MXN peso per kilogram of green fruit collected. After, farmer carries out total production to Catemaco. To do this farmer pays $20 MXN pesos for personal transportation and $ 20 MXN pesos for each 70 kilograms transported. In Catemaco production is sold to the intermediary who offers the best price. It depends at which part of fruiting season production is sold. If it is sold between June and July intermediaries pay around $3 MXN pesos per kilogram; but if production is sold between July and August price can reach $6 MXN pesos per kilogram. For each farmer selling season depends on the month at which his trees fructify. Farmer can not wait price rising because fruits can be sell only immature, if fruits mature farmer loses the complete fruit yield. By mean, during harvest season, collectors pay around $4.5 MXN pesos per kilogram.

Detail costs and benefits for the proposed system of Allspice production in live fences are reported in table 3.

Analysis of economic valuation of traditional livestock and Allspice live fences as production systems

NPV results shown that in the current conditions of production both productive systems analyzed are not profitable. The commercial value of one hectare of *P. dioica* fence used for Allspice production has a NPV = $ - 28,867.3 MXN pesos, indicating that after 50 years of practice this productive option the result is a lose equivalent to $ 28,867.3 MXN current pesos. That indicates that the Allspice production system currently practiced in Los Tuxtlas implies high investment costs and low benefits received. Meanwhile, the commercial value of one hectare of livestock traditional system has a NPV = $ - 81,359 MXN pesos, indicating that after 50 years of practice this productive option the result is a lose equivalent to $ 81,359 MXN actual pesos, three times less profitable than Allspice production option.

One explanation that helps to understand why people continue practicing both productive options, despite that they are non profitable alternatives, is the willingness of farmers to subsidy the job cost, as an alternative to the unemployment context of the region (Figure 2). This implies that farmers are willing to do not receive a payment for the job invested in these activities as long as they receive the final profit from sells. Including job subsidy in the analysis the Allspice system has a NPV = $ 7,052 MXN pesos, and the livestock system has a NPV= $ 8,908;

indicating that in job subsidy conditions both activities are profitable and close competitive; in this case livestock has 21 % more of competitiveness than Allspice option (Table 4). Even though, sensitive analysis indicated that Allspice productive option can be more competitive than traditional livestock if some critical parameters are managed (seedlings and saplings survivorship, and price paid in market per kilogram commercialized, for example) (Tabla 5). In these cases, even if the actual prices paid in market for Allspice kilogram are conserved, Allspice production option reaches until 71 % more competitiveness than traditional livestock (Allspice NPV = $ 31,179 MXN pesos) and becomes in an attractive option for farmers investment.

Discussion

In the current Laguna Escondida´s conditions of production both productive systems analyzed are unprofitable because of job cost is not being paid to farmers. Between them, in the characterized settings, livestock is less profitable than Allspice production because is more time consuming, and this increases the need of farmer´s job subsidy for the activity.

In other hand, milk, meat and Allspice yield and quality observed in the Laguna Escondida´s systems analyzed were low in comparison with the mean yields and qualities obtained from livestock and Allspice production systems reported from other parts of Los Tuxtlas region (Barrera-Bassols, 1995; Martinez et al, 2004). This means that improvements can be made in these systems to obtain better profits. To do this, governmental programs and community efforts focused in support technology access and process improvements can be helpful. Also, government and local institutions intervention for the market improvement can be an alternative to secure better prices paid for unit of product commercialized, as has been demonstrated in previous certification experiences for different Mexican forest products (Merino et al, 1999).

Several studies on the *P. dioica* biology have shown the potential of this spieces for the restoration strategies proposed for livestock pastures. Martinez-Garza (2003) showed *P. dioica* tolerance to light intensity and dryness, even from its early stage of grown. Anguiano (2000) shown that this species has a faster and better grow curve in pasture than in forest conditions, and Hernandez (2008) shown that it has better survivorship responses if it is grown in pasture than in forest soil, and also if it is transplanted to pastures with high light intensity and dryness conditions than to shadowed and more humid ones. As long as this biological potential of the specie is demonstrated, to reach the economic competitiveness of the strategy proposed is important to incentive farmer´s active participation in natural resources management and conservation, and to make possible to do a better use of

the resources designed for the operation of the different governmental programs for production and conservation (Merino, 1999).

Practices that can improve Allspice production system competitiveness are: improving seedlings and saplings survivorship, as indicated by Hernandez (2008); practicing annual replacement of death or damaged trees, increasing the number of productive female individuals in fence, and taking care of fertilization and weed management around trees. Also, Allspice market price for producers can be improved drying green fruits before selling, and taking care of maintain the quality of the product during the harvest process.

As conclusion it was observed that the establishment of *P. dioica* in livestock plot´s live fences for Allspice production can be profitable and economically competitive with the current livestock activity practiced in Laguna Escondida. This also allows to conclude that *P. dioica* has a high economical potential that can be use in restoration initiatives; its use as part of live fences system is a valuable alternative for the restoration of the livestock pasture areas of Los Tuxtlas Reserve´s nucleus zones. Moreover, the study demonstrated that the strategy proposed is adequate to promote simultaneously: the restoration of some forest ecosystem attributes in pastures, Allspice production grow, and incentives to stop deforestation and irregular pasture openings in Los Tuxtlas region.

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Tables

Table 1. Laguna Escondida´s population census (2004). Family unit conformation, age structure, schooling, land tenure and migration. Source: Semi-structured interviews directed to the head of each family unit in 100 % of ejido´s population (N=22). **a.** Avecindados. **b.** Ejidatarios.

Family Unit number	Family Unit Name (FU)	Total number of members	Total number of descendants	Descendants that conformed new FU in town	FU migrants			Economic Dependants	Age structure of FU members that inhabit Laguna Escondida town			
					Temporal migrants	Permanent migrants	Total		Children below six years old	Children above six years old, and below 15	Members above 15 years old	Total
1	Braulio Gómez and Maria Helena Sinaca [a]	5	3	0	1	1	2	4	0	1	2	3
2	Lázaro and Lourdes Velasco [a]	4	2	0	0	1	1	3	1	1	1	3
3	Oneida Sinaca [a]	3	2	0	0	0	0	3	1	1	1	3
4	Ramiro Sinaca and Susana [a]	4	2	0	0	0	0	4	2	0	2	4
5	Jesús and Gloria Sinaca [a]	5	3	0	0	0	0	5	2	1	2	5
6	Porfirio and Salomé Campechano [a]	6	4	0	2	0	2	6	0	2	2	4
7	Abraham Paxtion and Victoria [a]	6	4	0	0	0	0	6	0	4	2	6
8	Juan Gómez and Lucia [a]	3	1	0	0	0	0	3	1	0	2	3
9	Luís Paxtion and Marina [a]	3	1	0	0	0	0	3	1	0	2	3
10	Ernesto Campechano and Teresa Sinaca [a]	12	10	2	0	8	8	2	0	0	2	2
11	Domingo Velasco and Minerva Sinaca [b]	5	3	2	0	1	1	2	0	0	2	2
12	Aurelio Sinaca and Odilia David [b]	12	11	2	0	8	8	2	0	0	2	2
13	Jorge Velasco and Luisa Campechano [b]	6	4	0	0	3	3	3	0	1	2	3
14	Nereo Sinaca and Delfina Ortiz [b]	9	7	3	0	4	4	2	0	0	2	2
15	Armando Sinaca and Martha [b]	5	3	0	2	0	2	5	1	0	2	3
16	Felicita Sinaca [b]	13	12	2	0	10	10	1	0	0	1	1
17	Pedro Paxtion and Lucia [b]	5	3	1	0	2	2	2	0	0	2	2
18	Tomas Sinaca [b]	2	1	0	0	1	1	1	0	0	1	1
19	Juan Gómez and Margarita [b]	12*	5	2	1	3	4	7	0	3	3	6
20	Eladio Velasco and Maribel [b]	2	0	0	0	0	0	2	0	0	2	2
21	Isauro Sinaca [b]	5	3	0	0	0	0	5	2	1	2	5
22	Antonio Suárez [b]	7	5	0	0	0	0	7	5	0	2	7
	Total	**120**	**89**	**14**	**6**	**42**	**48**	**78**	**16**	**15**	**41**	**72**
	Mean	**6**	**4**	**1**	**0**	**2**	**2**	**4**	**1**	**1**	**2**	**3**

Table 2. Cost and benefits of livestock traditional system practiced in Laguna Escondida. Economic yield of one double purpose cow, maintained in a hectare of pasture, with the workforce of one person, during a regular production year, following the mean system practiced for livestock production in Laguna Escondida.
Source: Interviews applied to 56% of Ejido's land owners.
One dollar = $11.29 MXN (2004)
(http://www.cefp.gob.mx/intr/e-stadisticas/copianewe_stadisticas.html).
One work day (jornal) = Eight work hours = $100 MXN (2004).
***** expenses calculated for total units, not by doses.

COSTS (MXN pesos)					
Pasture maintenance costs					
Workforce	**Time inverted by event**	**Frequency**	**Work days employed annually**	**Annual cost ($) (Payment for work days employed)**	
To clean the weed manually	5 days	Twice a year	10	1000	
To apply chemicals	3 days	Twice a year	6	600	
Milking	11 minutes	Once daily during eight months each two years.	1.8	270	
Carry out and selling of milk	1.5 hours	Once daily during eight months each two years.	15	1500	
Livestock maintenance	1 hour	Once daily during 317days a year	13.2	1320	
Livestock maintenance Costs:					
Inputs	**Quantity employed by event**	**Frequency**	**Annual quantity employed**	**Unit cost ($)**	**Annual cost ($)**
Vaccines	One application against the following diseases: "carbon", "carbonosa" and "mal de paleta"	Each six months	2 applications	37	74
	One application against "derrengue"	Once a year	Once a year	100	100
Parasites medicine *	One application (Farmers buy one liter for one year)	Once a year	Once a year	531	531
Tick baths *	One bath (Farmers buy one liter for one year)	Each two weeks	24 applications	218	218
Contingencies*	Usually once a year (in disease case includes medicine and transportation)	Once a year	Once a year	450	450
Mean Annual Costs					**$6,640 MXN**
Mean Biannual Costs for the two year system					**$13,280 MXN**
Benefits (MXN pesos)					
Benefits	**Daily production**	**Daily Benefits ($)**	**Annual production**	**Unit price ($)**	**Biannual benefit ($)**
Milk selling	Three liters of milk	6	720 a year	2	1440
Meat selling	---	---	190 Kilogram of meat each two years (200 kilogram of calf weight less 5% of loses by concept of bones and casings)	15.5	2945
Mean Annual Benefits					**$2,192 MXN**
Mean Biannual Benefits for the two year system					**$4,385 MXN**
Balance for the two year system (Benefits – Costs) = ($4,385 MXN - $13,280 MXN) = - $8,895 MXN					
Balance for the two year system with farmer subsidizing workforce costs ($9,380 MXN for two years) (Benefits – Costs) = ($4,385 MXN - $3,900 MXN) = $485 MXN					

Table 3. Cost and benefits of the system proposed for Allspice production in commercial live fences located around livestock pastures (2005)**.**
Source: Participating observation on one demonstrative plot.
One dollar = $11.29 MXN (2004)
(http://www.cefp.gob.mx/intr/e-stadisticas/copianewe_stadisticas.html).
One work day (jornal) = Eight work hours = $100 MXN (2004).

One hectare stablishment costs	**Demostrative plot establishment (0.072 hectare, 720 m fence, 120 *P. doica* plants)**		**Hypothetical setting costs for economic valuation (One hectare, 1,666 m fence, 277 *P. doica* plants)**	
	Quantity	**Total cost (MXN pesos)**	**Quantity**	**Total cost (MXN pesos)**
Livestock exlusion fence cost				
Barred wire ($)	2160 m	2442	4998 m	5650
Workdays for cut and carry out wood stands obtained from forest communal areas of Laguna Escondida($)	400 stands	5200	925 stands	12025
Workdays for new livestock exclusión fence stablishment ($)	400 stands	3000	925 stands	6937
Planting				
Workdays to obtain 120 *P. dioica* plants of one year age ($)	120 plants	1150	277 plants	2654
Workdays for cleaning planning areas, holling and planning. ($).	120 plants	2000	277 plants	4616
Total establishment costs ($)		**13,792**		**31,882**
Annual costs to maintein *P. dioica* fence plantation	**Demostrative plot establishment (0.072 hectare, 720 m fence, 120 *P. doica* plants)**		**Hypothetical setting costs for economic valuation (One hectare, 1,666 m fence, 277 *P. doica* plants)**	
	Quantity	**Total cost (MXN pesos)**	**Quantity**	**Total cost (MXN pesos)**
Planting maintenance at fence				
Workdays for weed clearing, twice a year. ($)	10 workdays	1000	12 workdays	1200
Annual maintenance costs of *P. dioica* fence plantation ($)		**1,000**		**1,200**

Table 4. Comparison of NPV indexes results with and without job being subsided by farmers. One dollar = $11.29 MXN (2004) (http://www.cefp.gob.mx/intr/e-stadisticas/copianewe_stadisticas.html).

Commercial value of the system proposed for Allspice production in live fences located around livestock pastures (NPV)	**Commercial value of livestock traditional system practiced in Laguna Escondida (NPV)**
• Allspice production in the setting characterized = $ - 28,867	• Livestock production in the setting characterized = $ - 81,359
• Allspice production in the setting characterized, including job cost being subsided by farmers. = $ 7,052	• Livestock production in the setting characterized, including job cost being subsided by farmers. = $ 8,908

Table 5. Sensitive analysis of the critical parameters that determine the results of NPV index in the Allspice production system. Threshold values and its respective new NPV are reported. One dollar = $11.29 MXN (2004).(***** optimum setting).

Seedlings survivorship (0-1 years old)	**Sapling survivorship (from 1 year old)**	**Plantation annual management cost**	**Allspice threshold price in the market (Kilogram)**	**VPN**
0.58	0.97	$1200	$12,5	$166
0.58	0.97	$600	$7.6	$343
0.63	0.97	$600	$7.1	$70
0.58	0.97	$0	$3.0	$1608
0.58	0.97	$0	$6.0	$12496
0.63	**1.00**	**$0**	**$3.0**	**$9080***
0.63	**1.00**	**$0**	**$6.0**	**$31176***

Figure legends

Fig.1. **a.** Location of Sierra de Los Tuxtlas, Gulf of Mexico, Veracruz. **b.** Biosphere Reserve "Los Tuxtlas" and study area at Northeast corner, close to San Martín Volcano. **c.** Ejido Laguna Escondida at the margin of the road Catemaco – Montepío.

Fig. 2. Percentage of Laguna Escondida population which counts with each source of income reported.

Fig. 3. Restoration strategy proposed for the recovering of Laguna Escondida´s livestock pasture plots. Agro-ecological system that consist in the grown of live fences around livestock pastures, using species with known commercial value (*Pimenta dioica*, in this case).

Figure captions

Figure 1.

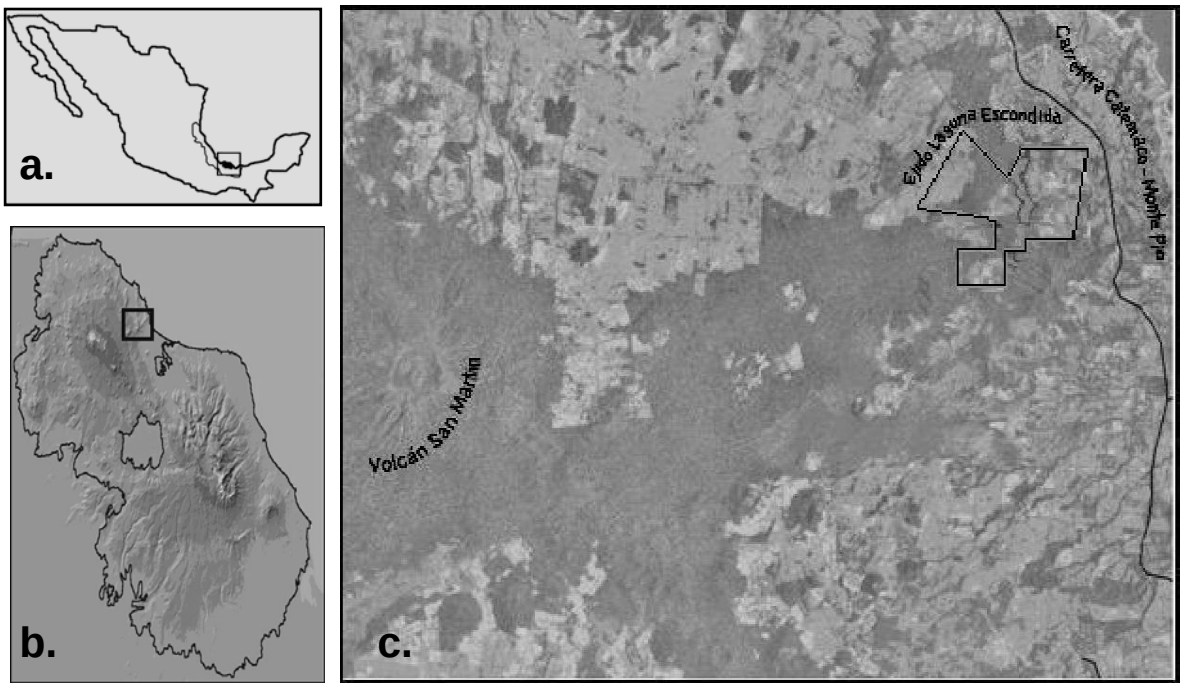


Figure 2.

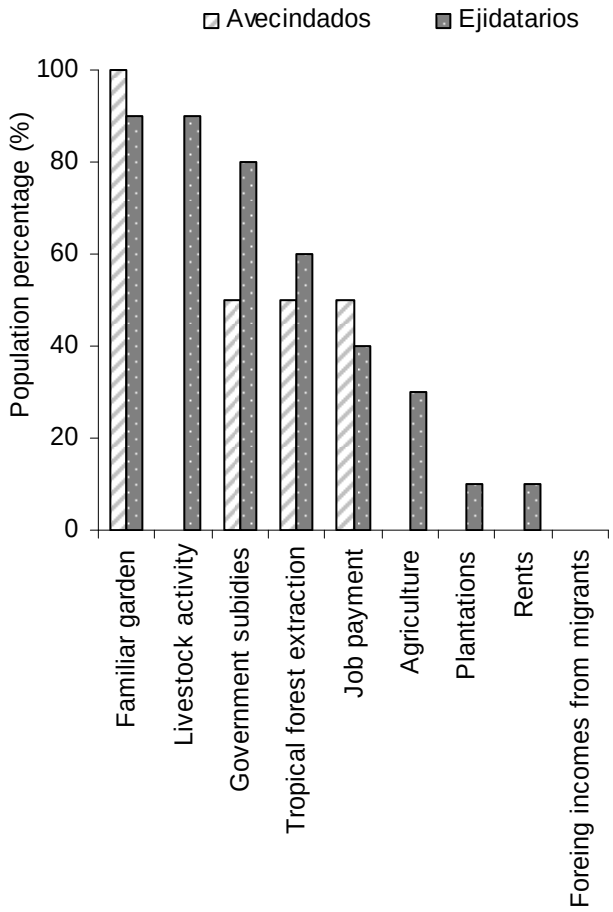
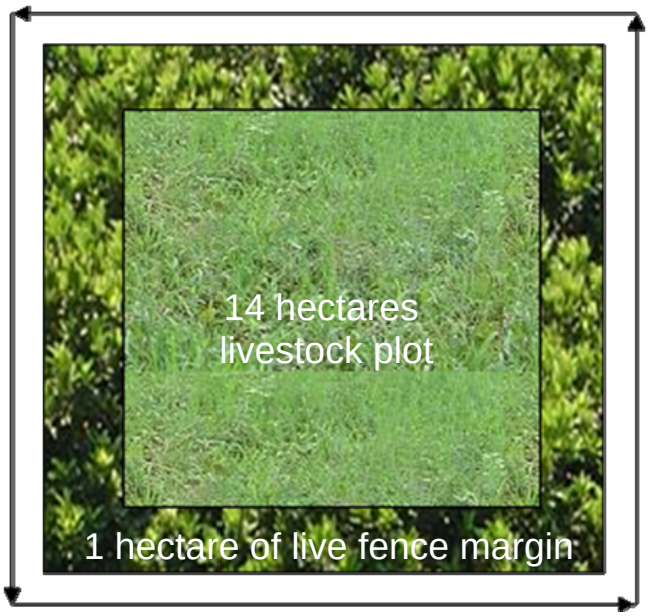

Avecindados
Ejidatarios
Population percentage (%)
100
80
60
40
20
0
Familiar garden
Livestock activity
Government subidies
Tropical forest extraction
Job payment
Agriculture
Plantations
Rents
Foreing incomes from migrants

Figure 3.


14 hectares
livestock plot
1 hectare of live fence margin
1,666 m plot perimeter


Existing live fence
Commercial valued
new live fence
6 m