The importance of floristic diversity in agroforestry systems on small scale farmers livelihoods in Misantla, Central Veracruz, México

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THE IMPORTANCE OF FLORISTIC DIVERSITY IN AGROFORESTRY SYSTEMS ON SMALL SCALE FARMERS LIVELIHOODS IN MISANTLA, CENTRAL VERACRUZ, MÉXICO

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SUMMARY

México is a tropical country with a rich cultural and biological diversity. Currently, México witnesses increased anthropogenic pressure on its remaining tropical landscapes. Expansion of human activity due to a relatively fast economic growth is the most important factor causing landscape changes and an associated and often irreversible loss of biodiversity as well as a loss of traditional knowledge on these natural ecosystems and its uses. Well known and managed agroforestry systems can prevent this loss. The study area - in which the above effects are visible - is an anthropogenic landscape in the region of Misantla, central Veracruz, México which is called "ejido Los Ídolos". It is one of the research areas of CITRO (Centro de Investigaciones Tropicales, Universidad Veracruzana). The main research question, established in close cooperation with CITRO, was "to what extent does the ligneous plant diversity of agroforestry systems in ejido Los Ídolos contribute to the cultural identity, economical and subsistence security of local farmers?". In order to answer this question, the research focused on answering four sub questions:

1. Which agroforestry systems, and associated practices, can be identified within ejido Los Ídolos, and where are these systems broadly located, using a map?
2. What is the floristic/botanical diversity of usable ligneous plant species identified between different agroforestry systems?
3. To what extent do provisional and cultural services derived from agroforestry systems contribute to the subsistence security and cultural identity of surrounding rural household's?
4. To what extent do agroforestry systems differ in relation to the number of useful introduced and native ligneous plants species?

Five different agroforestry systems (Forest gardens (FG), Home gardens (HG), Plantation crop combination with perennial cultivates (PCCPC), Plantation crop combinations with annual cultivates (PCCAC) and Trees on Pastures (TP)) were identified and their relative proportions in hectares were calculated and displayed on a practical map. FG systems appeared to have the highest floristic diversity, followed by the HG, TP, PCCPC and PCCPA systems. Farmer interviews showed that FG, HG PCCPC and PCCAC systems were especially important for maintaining cultural identity and secure subsistence needs, while PCCPC and especially TP systems were important for improving the economic situation of farmers. Additionally, TP and PCCPC systems were perceived to contain the most useful ligneous plant species for economic and subsistence needs. FG and HG were perceived to be used less, despite the fact that these systems contained a higher diversity of potentially useable species. The floristic diversity of exotic plants was the highest in in the PCCPC system, followed by the HG, PCCAC, TP systems. The FG systems contained only native species, while the proportion of used exotic plants differed among the other systems. The most useful exotic plants were found in the HG system and the least in the FG system. The study demonstrated that agroforestry systems such as FG are not exploited to their full potential, despite their high floristic diversity of useful plants. Systems with a lower floristic diversity such as the PCCAC, PCCPC and TP systems were actually used more intensively for subsistence needs. In addition, this study also indicates that more intensively managed HG systems, despite their higher amount of exotic species, replaced the FG system as being the more species rich system for subsistence needs.

It was also demonstrated that the diversity in each different agroforestry system corresponded well with the diversity of needed goods for specific cultural, ecological, economical and subsistence purposes. Furthermore, results indicated that the maintenance of a high (indigenous) species diversity in the different agroforestry systems serve as an important safety-net for the security of energy, construction and food supplies. Therefore, it is recommended that farmers assisted by scientific institutions and representatives of local food and timber product chains conduct feasibility studies on the marketing and promotion of products derived from specific agroforestry systems.

FOREWORD AND STRUCTURE OF THE REPORT

This bachelor thesis describes the work done in the period April-July 2014 by Sjoerd Pietersen for the fulfilment of the requirements for the degree Bachelor of Science in Tropical Forestry at the Van Hall Larenstein University of Applied Sciences in Velp, the Netherlands.

The study focusses on an investigation of the floristic diversity of ligneous plants in agroforestry systems and their contribution to the economic and subsistence security and cultural identity of local farmers in Los Ídolos, a small community in the state Veracruz, eastern México.

The work described in this thesis has been carried out under the local supervision of Professor J.C Lopez Acosta using the scientific philosophy of CITRO (Centro de Investigaciones Tropicales) as part of the UV (Universidad Veracruzana). CITRO is an acknowledged academic institution located in Xalapa, Veracruz, México, which mission is to seek solutions for challenges in the field of sustainable utilization of natural resources, derived from tropical Mexican ecosystems (see website CITRO: http://www.uv.mx/citro/).

This thesis is dived into nine chapters.
Chapter 1 provides a general introduction to the issue to deforestation in Mexico and describes the research and problem context. The first chapter also introduces the specific study area, the relevance of the research, the main research objectives, and states the main research question and the related sub questions, each with their specific goal(s).
Chapter 2 is the methodological chapter which explains in detail which approaches and data analysis were used to answer the research questions and which geographical, ecological and social research methods have been used to gather field data. Besides describing these methodologies, it discusses the advantages, disadvantages and possible biases of the applied research methods.
Chapter 3, 4, 5 and 6 respectively show and describe the results of the research results of the sub questions. **Chapter 3** summarizes the identified agroforestry systems and their specific management and plant components. The location and proportion of different agroforestry systems are shown on the map of the study area. **Chapter 4** summarizes the relative ecological importance and composition of ligneous plant species within the identified agroforestry systems. **Chapter 5** addresses the perceived cultural, economic and subsistence importance of the agroforestry systems by the local farmers. The proportion of collected useful ligneous plant species per different agroforestry system are shown to identify the main function of the respective systems. Subsequently, the plant species which are being extracted most frequently from an agroforestry system for their different uses are listed. **Chapter 6** shows the differences between identified agroforestry systems and their share of native and exotic species. In addition, the intensity of local ligneous plant product extraction (exotic and native plants) has been is measured and shown in bar charts.
Chapter 7 discusses the methodology and the obtained results and evaluates whether the floristic diversity in different agroforestry systems is a critical factor for securing economic and subsistence needs and sustaining cultural identity of the farmers in the area investigated.
Chapter 8 summarizes the conclusions for each identified agroforestry system and the formulated sub-questions and ends with the final conclusion, answering the main research question.
Finally, **Chapter 9** formulates recommendations, focusing on both future research challenges of scientific institutes in the study area as well as on practical recommendations for the local farmers in the studied area.

1 INTRODUCTION AND DESCRIPTION OF THE PROBLEM

1.1 MEGADIVERSE MÉXICO

México is a tropical country with various heterogenic landscapes reflecting the presence and anthropogenic history and contrasting socio economic development of many cultures within a time span of a few thousand years. The resulting cultural and ecological diversity implicates that México is nowadays considered as one of the 17 most “megadiverse” nations worldwide and forms the habitat of 10 – 12% of the world’s species diversity (CONABIO 2006; Miitermeier and Goettsch 1992). After Brazil, Colombia, China and Indonesia, Mexico is the fifth country with the highest diversity of vascular plants, worldwide. With respect to endemic vascular plant diversity México holds a third place after China and Indonesia. Next to vascular plants, México is the 4th country with the highest diversity of (endemic) vertebrates (CONABIO 2009). However, this ecological and cultural richness is currently not fully reflected into social and or economic benefits.

Deforestation in Mexico and the issue of inadequate land tenure regulations
Worldwide, characteristic cultural and natural landscapes in tropical countries are currently facing rapid changes due to intensive agricultural and livestock farming to produce products for human consumption. However, tropical landscapes still have the potential to fulfil a broad range of ecosystem services and functions in order to satisfy the needs of local, regional, national and global involved stakeholders. Due to diverging interests among involved stakeholders and actors, the current pressure on tropical landscapes increases or remains the same at best. These developments often result into a continuation of unsustainable land use and management and loss of biodiversity (J. Chavez, 2014). The loss of México’s anthropogenic natural landscapes and ecosystems can be quantified by México’s national deforestation rates. According to the global forest resource assessment of the FAO (FAO 2010), more than 61 million hectares (33%) of México’s terrestrial ecosystems is covered by forests, of which 34,3 million hectares is considered as primary forests (52,9%). Despite a slight decrease of national deforestation rates [between 2005 and 2010], deforestation is still a continuing process in México to date.

The direct causes of the deforestation rates are interrelated and complex, thus making it impossible to designate one main cause. In the case of México increased conflicts about land tenure and foreign policies, which marginalized the economic position of farmers in the past, are considered to be the most important indirect causes of deforestation. Many farmers overexploit available natural resources which affects their well-being on long term (CONABIO 2009). With reference to the Mexican rural population, the Worldbank concluded that more than 16,9 million peasants (63,6% of the rural population) live below national rural poverty lines (Worldbank 2012). Together, indigenous farmers occupy 14,3% of the total land surface in México (CONABIO 2009) and are generally considered as the poorest group of land dwellers (USAID 2011).

The loss of vegetation cover in México is aggravated by the land tenure regulations of the Mexican Federal Government to “register and title land right in ejidos [1] and communidades[2] in order to strengthen land tenure security, improve the efficiency of rural and credit markets, and pave the way for privatization”. Improvement of the economic situation of peasant farmers trough the implementation of PROCEDE (Programa de Certificación de Derechos Ejidales y

[1] An ejido consists of various land parcels which are collectively held by peasants who each manage a parcel individually . [2] Communidad is a group of farmer peasants whom manage and share a collective ownership over a piece of land.

Titulación de Solares) appeared to be counterproductive: many less viable peasants lost their land which was given to them 70 years before as a result of the Mexican constitution in 1917 (Perramond, 2008; USAID 2011).

According to Myers (1994), landless or displaced peasants generally migrate to unoccupied forest lands. Through various factors, such as limited knowledge about sustainable agriculture and -use of forest ecosystems, the slash and burn cultivation is generally perceived as very unsustainable. The slash and burn activities in México resulted in the promotion of cattle ranching and, to a lesser extent, intensified cultivation of cash crops such as banana's, coffee, cacao and sugarcane, as main agricultural economic activities.

1.2 INDIGENOUS AGROFORESTRY SYSTEMS IN MÉXICO – THE PROBLEM

As described above México witnessed increased anthropogenic pressure on the remaining (unattached) tropical landscapes. Expansion of human activity caused an irreversible unalterably transformation of its natural ecosystems and also believed to have let to cultural consequences caused by a loss of traditional knowledge with respect to usable plant species associated to these ecosystems (Caballero and Cortés 2001).

Practical approaches to identify evaluate and provide hands-on tools to counteract these irreversible processes at a local level are however still largely lacking.

It is important to take the current use and management of agricultural land into account when studying deforestation. All types of forest management systems represent a particular degree of management intensity: from the uncontrolled gathering of natural forest products till the intensive management of domesticated tree crops in monoculture plantations (Wiersum 1997). Between these two extremes, hundreds of site specific intermediate agroforestry exist (Nair 1993). Eventually most of the character and appearance of an anthropogenic landscape results into a mosaic of different land use types which occupy a transitional position between monoculture agriculture and natural forests. (Belcher et al. 2000; Micron 2005; Scrota et al. 2004; Wensum 1997). This transitional position of agroforestry systems depends on a local subsistence strategies aiming to increase the presence of valuable species maintained by the local population according to their socio-economic and cultural needs. This may differ significantly on a local scale (Wiersum 1997).

Especially in Central American countries such as México, agroforestry systems are important assets in strategies to maintain and sustain subsistence security and cultural needs for the rural poor, which are generally considered as primary beneficiaries (Nair 1993). Wilken (1977) investigated that Central American farmers planted on average 24 species in various vegetation strata on plots of only 0,1 hectare. Nair and Kumar (2006) evaluated 23 studies which were carried out between 1993 and 2003, using statistics, personal experiences and observations and available reports on agricultural censuses. Their evaluation concluded that species rich agroforestry systems, such as home gardens, were maintained closely to households in more than 50% of the rural settlements.

Various studies confirmed the important role of plant diversity in Mexican agroforestry systems. A study in the Mexican state Quintana Roo measured plant diversity in several systems and concluded that the agroforestry systems in this region contained on average 39 useable species while specific systems contained up to 150 useable plant species (De Clerck and Castillo 2000). In the Mexican state Tabasco 195 different useful species where found (van der Wal & Bongers 2012) in 61 home gardens (a distinctive agroforestry practice mainly used to satisfy subsistence needs). A study in the Mexican states Jalisco and Nayarit identified in total 69 different tree species in pineapple dominated agroforestry systems (Adame, Guzmán, Gliessman, Benz, 2014).

When not subject to slash and burn methods, most of the plant and animal diversity which remains in these transformed landscapes are relatively well conserved by indigenous farmers in México. Their limited economic resources require them to maintain a diverse range of plant species in order to satisfy basic economic and subsistence needs. Next to these necessaries, several authors emphasized the role of agroforestry systems as strategy for biodiversity conservation (Belcher et al. 2000; Schroth et al. 2004; Wiersum 1997). 19% of the inhabitants who live in or nearby natural protected areas in México (ANP's: Áreas Naturales Protegidas), indigenous farmers could play an important role for biodiversity conservation and maintenance of traditional knowledge (CONABIO 2009).

1.3 ECO SYSTEM GOOD AND SERVICES: A TOOL THE MEASURE THE FUNCTIONING OF ECOSYSTEMS

A relatively new concept, indicating which "Ecosystem goods (such as food) and services (such as water assimilation) represent the benefits human populations derives, directly or indirectly from ecosystem functions" (Costanza, R., 1997), is summarized in box 1. This approach can also be applied to define the cultural, economic and subsistence benefits derived from agroforestry systems.

Box 1: CATEGORIZATION of ECO SYSTEM GOODS AND SERVICES

Based on the MEA 2005 and de Groot et al (2002), ecosystem functions and services are grouped into four primary categories:

• Production functions (or provisioning services) consist of the processes that combine and change organic and inorganic substances through primary and secondary production into goods that can be directly used by mankind.

• Regulation functions (or regulating services) relate to the capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems through biogeochemical cycles and other biosphere processes. In addition to maintaining ecosystem (and biosphere) health, they provide many services with direct and indirect benefits to humans such as clean air, water and soil, nutrient regulation, disturbance prevention, biological control and pollination.

• Information functions (or cultural services) are those services that contribute to human mental well-being. Major categories of cultural services associated with forests are aesthetic and recreational use, spiritual and religious services and importance to cultural heritage.

• Habitat functions (or supporting services) relate to the importance of ecosystems to provide habitat for various stages in the life cycles of wild plants and animals, which, in turn, maintain biological and genetic diversity and evolutionary processes. Since these species and their role in the global ecosystem maintain most of the other ecosystem functions and services, the maintenance of healthy habitats is a necessary requirement for the provision of all ecosystem goods and services, directly or indirectly.

1.4 INTRODUCTION TO THE RESEARCH

1.4.1 Study area

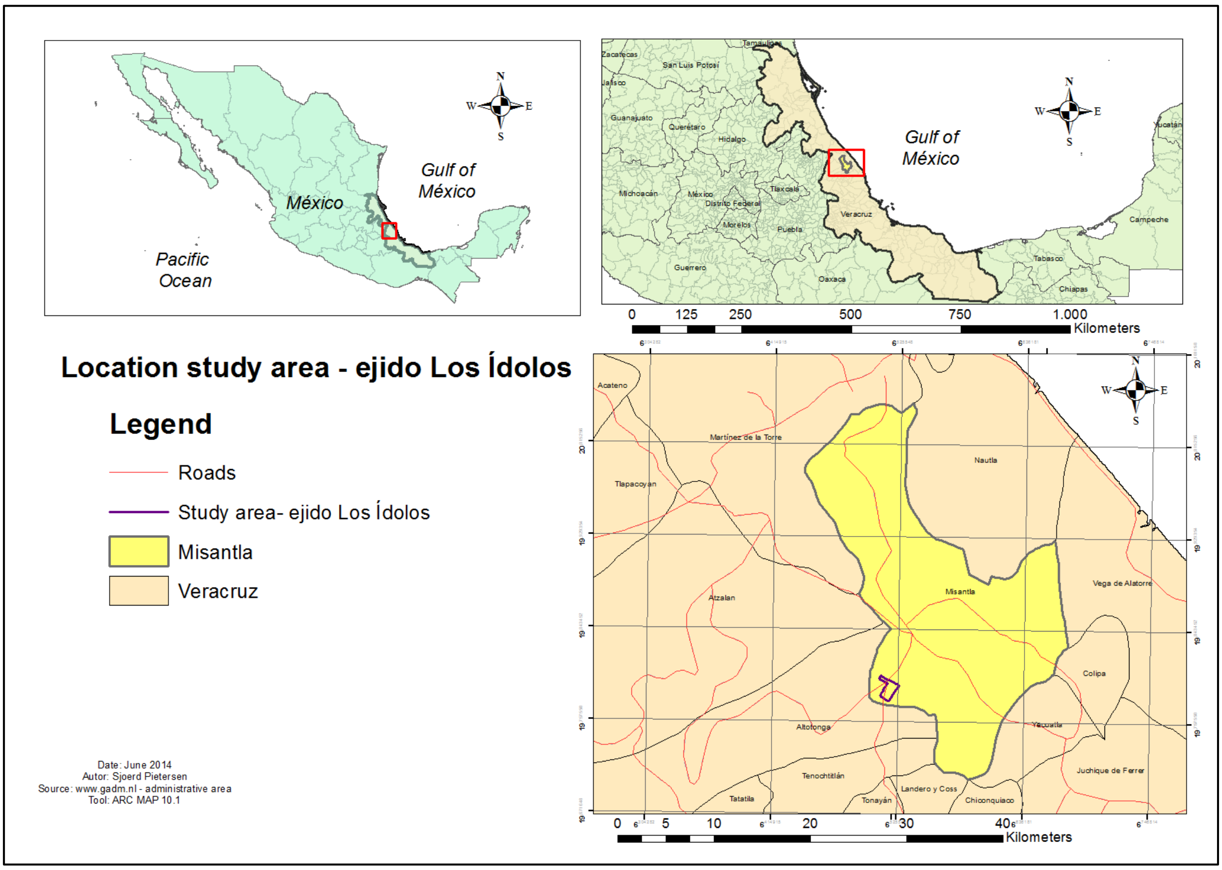
The state of Veracruz is located in the east of México and borders to the Gulf of México (see map 1). Despite the fact that Veracruz still is home to more than 8000 plants (98% endemic species), 190 mammals, 635 birds, 214 reptiles and 109 different amphibians species, conversion of forest lands into agricultural land resulted in 1993 that already half of the state's land (13.000 ha) was dedicated to livestock farming, representing more than 4 million heads of cattle (Gónzales-Montagut, 1999).

One of the most important academic research institutes in this province is CITRO which has various research sites in the state Veracruz to investigate and find solutions for problems in the field of sustainable utilization of natural resources, derived from regional (sub) tropical ecosystems. This study is therefore carried out in one of CITRO's research sites called "ejido Los Ídolos".

This ejido is part of the municipality Misantla which is located in the center north of Veracruz, in the south middle east of México (see map 1 and figure 1). The ejido Los Ídolos covers 239 hectares and consists of different types of agricultural land with an altitude ranging from 360 to 630 meter above sea level. Nearly 400 inhabitants are divided over 150 families which use the surrounding land for various commercial purposes, such as shade grown coffee plantations, citrus fruits, maize and bean cultivates, pastures with scattered trees for livestock and unregularly logging of high valuable timber species. For their subsistence, the peasants collect fruits, nuts, bark, firewood, fibers, and medicinal subsistence's and construction material subtracted from a wide range of present tree species in the ejido (Sánchez y Gándara, 2012).

Figure 1: Village Los Ídolos (Photo Sjoerd Pietersen)

Map 1: Location of the study area



1.4.2 Research relevance

Much research by CITRO and others in Misantla, Veracruz, México focused on investigating the floristic diversity of the natural ecosystems. Arturo Gómez Pompa (1966) realized a complete ecological and botanic description of "La Sierra de Misantla" and reported the presence of 286 tree and shrub species. The floristic diversity within traditional agroforestry systems in the region has been investigated by Lopez and Lacurain (2014) who identified the 74 woody plant systems. Extensive studies which determined the amount of useable and medicinal plant species was carried out by Ambrosio Montoya (1996) and Hérnandez and López (1988), which respectively identified 327 and 195 useable plant species. Finally Lascurain, Avedaño, del Amo and Nembro (2011) elaborated a practical guide which describes 106 of the 140 edible tree species in de state Veracruz in detail, many of which are traditionally used in de region of Misantla.

However, until the present study, there were no studies which identified and evaluated which woody plant species from traditional agroforestry systems are contributing or could (potentially) contribute to the subsistence and cultural needs, based on the point of view of the farmers of La Sierra de Misantla using the concept of the ecosystem goods and services approach.

Eventually the final validation of ecosystem services from agroforestry systems in the area helps local stakeholders - such as indigenous communities, donors and governments - "who need to become able to understand and monitor the effects of landscape-level interventions" (J.Chavez, 2014). These landscape-level interventions refer to activities such as tree-crop promotion for agricultural development, reforestation and nature conservation. Before undertaking any management decision , "all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices need to be considered" (website CDB 2009, principles Ecosystem Approach).

1.4.3 Objectives of the study and field of expertise

1.4.3.1 Study goals

The main goals of the study - formulated in close cooperation with CITRO – were therefore:

i) to identify and map the agroforestry systems in ejido de Los Ídolos;
ii) to identify, using both literature as well as local knowledge, the role of ligneous plant species found in the identified local agroforestry systems which are contributing or could (potentially) contribute to the subsistence and cultural needs of farmers living in the ejido Los Ídolos.
iii) to identify a small set of provisional cultural ecosystem services, qualifying the identified agroforestry systems.
iv) to identify the extent of edible exotic and edible native ligneous plant species in local agroforestry systems.
v) to translate goals the results I to iv into practical local implementable tools (e.g. a map) and recommendations.

1.4.3.2 Research questions

To examine whether local agroforestry systems are potentially contributing to the cultural and subsistence needs of local farmers the following main research question was formulated.

Main question:

To what extent does ligneous plant diversity of agroforestry systems in ejido Los Ídolos contribute to the cultural identity, economical and subsistence security of local farmers?
Goal: Assess the floristic diversity of ligneous plants (which provide provisional and cultural ecosystem services) in local agroforestry systems in order to make an initial evaluation of the respective contribution of these species to the subsistence and cultural needs of farmers living in ejido Los Ídolos.

The main research question was answered by formulating the following 3 sub questions:

Sub question 1: Which agroforestry systems, and associated practices, can be identified within ejido Los Ídolos, and where are these systems located?
Goal: Identify the agroforestry systems and map the current proportions of land uses and its associated management practices within the ejido.

Sub question 2: What is the floristic/botanical diversity of usable ligneous plant species identified between different agroforestry systems?
Goal: Make an initial inventory to indicate the relative dominance of useable ligneous crops, shrubs and trees, to evaluate which agroforestry system has the highest species diversity and composition and could potentially contribute with the subsistence needs of farmer families.

Sub question 3: To what extent do provisional and cultural services derived from agroforestry systems contribute to the subsistence security and cultural identity of surrounding rural household's?
Goal: Identify, from the point of view of local farmers, which agroforestry systems provide important cultural and provisional ecosystem services (ligneous plant products), in order to validate the perceived subsistence and cultural value of both plants and the agroforestry system.

Sub question 4: To what extent do agroforestry systems differ in relation to the number of useful introduced and native ligneous plants species?
Goal: Assess the proportion of the actually exploited exotic and native used ligneous plant species in the agroforestry systems on the basis of obtained ecological and social data analysis.

1.4.3.3 Research limitations

There appeared to be several practical limitations given the above mentioned study goals:

1. **Weather conditions:** In order to reach the research site a 3 hour during travel needed to be undertaken by the local bus line and pick-up truck. However during periods of heavy rains, the mountainous roads which lead to Misantla and the study area could not be used.
2. **Availability of field assistance:** It was strongly recommended to travel with a CITRO student(s) who speaks Spanish at a professional level and has experience in the field of natural or social sciences in México. This reduces the risk for miscommunication between the researchers – whose linguistic skills are sufficient, but sometimes lacked for details - and local farmers and ensures helpful assistance during the fieldwork. It also has a safety reason as daily activities in México can be interrupted by unexpected violence and criminality and it was therefore strongly recommended to travel in company with another (native) person. Without the availability of another student, entering the research site was not possible.
3. **Availability of local field guide:** To prevent conflicts with local landowners it was obligated to enter land parcels together with a local farmer with a respectable status within the ejido, who could reassure the other farmers. Without the company of a local farmer, entering the research site was not possible.
4. **Willingness of farmers to participate in the interviews:** Despite the curiosity and good intensions of the researcher, it appeared two times that a farmer did not feel confident or distrusted the aims of the research which resulted in less than anticipated interview data.
5. **Traditional knowledge of interviewed farmers about edible plants:** To elaborate an extended and various lists of edible ligneous plants which are collected in different agroforestry systems, a critical factor is the traditional knowledge about useful plant species of farmers. Limited knowledge – or a lack of communications skills - of some farmers resulted in a slightly smaller sample of both ecological data, as social data, which would make it harder to indicate statistically significant differences between agroforestry systems
6. **Time:** A general limitation of the research was the limited time available for this research (3,5 months), given the above mentioned constraints. At CITRO, the period in which this research had to be carried out was considered to be very short and therefore an extensive statistical evaluation of the obtained data was not considered to be meaningful. The intention of this study was to identify the floristic diversity within the different agroforestry systems but not to identify significant differences between these systems. The results should therefore rather be seen in the context of their general innovative approach, including mapping as a tool. The study also provided additional ecological data on species diversity and their perceived local use which could serve as starting point for more focused future research in the area.

2 METHODOLOGICAL APPROACH AND DATA ANALYSIS

2.1 IDENTIFICATION OF AGROFORESTRY SYSTEMS

2.1.1 Stakeholder meeting

In order to answer the first sub question "Which agroforestry systems and associated practices can be identified within ejido Los Ídolos, and where these systems located are?" a meeting with the "comisariado ejidal[3]" was organized. During the first meeting the intended aim and outcome of the research were explained with the aim to encourage the comisariado ejidal to ask questions about the research process and ensure his willingness to participate and be available for consultation during the data collection. The choice to first inform the comisariado ejidal was made because this village member and his function are sufficiently representative in the ejido (Rosas-Robles 2006). Apart from this representative role the commissioner executes agreements made during village meetings. It turned out that the commissioner served as a reliable informant for both the researcher as well for other village members.

Besides informing the village leader, Arturo Sánchez Gándara, who is functioning as the chairman of a local civil movement called Asociación para el Desarrollo Integral de la Región de Misantla, A.C. (ASODIREMI, A.C.) was informed about the research activities. This movement is integrated with civilians who have a common interest in the municipality of Misantla. This association promotes and realizes scientific and cultural projects and organizes activities such as courses, conferences, workshops, conventions and seminars in order to identify principal problems within the municipality and region. To goal of the ASODIREMI is to develop cultural, environmental and socio economical programs which propose plausible solutions in these fields. One of the objectives of the association which closely relate to the subject of this thesis is: "To design and implement projects with the aim to protect and optimize sustainable use of local natural resources" (M. Andrade, 2012).

The goal of this meeting was to create an informal and pleasant working atmosphere to eventually overcome conflicts with local land owners during the fieldwork and schedule planned activities according to the availability of farmers to participate and assist in the research (Sheil, D., Puri. R.K., Basuki. I., van Heist M., 2002).

2.1.2 Mapping of the study area: localize the borders of ejido Los Ídolos

Satellite images and aerial photographs of the ejido were retrieved at the INEGI (Instituto Nacional de Estadística y Geografía) in Xalapa and subsequently processed in Arc GIS. Next, a first rough identification of expected vegetation types was carried out. In collaboration with a prominent "ejiditario[4]", the first -and only- version of ejido map (appendix 1) was analyzed and discussed. This resulted in an indication of the location, size and distribution of parcels, roads and rivers as well as the general shape of the ejido. As a result, a rough basic map of the area was established which served as geographical reference during the collection of data, using GPS for exact positioning.

[3] In accordance to Article 32 of the "Ley Agraria" this commissioner is charge for the implementation of the agreements made in the local assembly, represents all ejiditarios and manages the administration of the ejido . His or her position as commissioner is constituted by a local major, secretary and local landowners (Rosas –Robles, 2006).

[4] Male or female ejido members with land use rights including: usufruct rights to a portion of land for their house; (2) usufruct rights to a portion of land to farm individually; and (3) rights to shared access to communally held property and land of the ejido (USAID, 2011)

The exact borders of study area were subsequently delineated and complemented with GPS "ground truthing" data which were obtained after an 8 km transect which followed the actual borders of the ejido (ESRI, 2014).

To prevent misinterpretation of the borders of the ejido, and enhance accuracy and reliability, GPS reference measurements were taken on locations identified in the satellite image, as well as known locations interpreted to be relevant by local landowners. The resulting map with the "final" shape of the ejido can be found in appendix 2. This map has a legend and a scale of 1:11.000.

In addition to the localization of the ejido borders, field data was collected and noted down in the field form (appendix 3). Data included information on the classified agroforestry systems, land uses, distinctive landscape features (e d. rivers, archaeological sites), landowner, neighboring terrains and dominant distinctive woody plant species, according to both its official and as well as their local name.

2.1.3 Identification agroforestry systems and associated practices

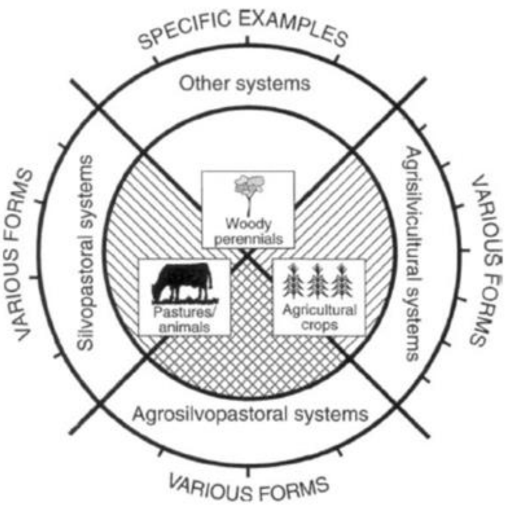
After the localization of the borders and first data collection on land use and tree components, transects were established within the 'delineated' study area. The goal of the transects was to systematically plan the identification of various sets of land uses and vegetation. In total 6 transects of variable lengths were set out (appendix 2). Apart from the collected data mentioned in sub paragraph 2.2B, information about terrain access (common or private land), intensity of forest management practices (Wiersum, 1997) and exploitation phase of field and tree crops (Harris 1989 and Wiersum 1997) were collected by using classification keys (appendix 4). To structure the abundance of prevailing tree species dominant ligneous components (both trees, shrubs as well as cultivates) were noted in a separated column. The agroforestry system was classified according to the structural system classification of Nair (1993). Agroforestry systems were first classified on the type of their components (figure 2), and were subsequently subdivided into the following four main systems:

- Agrisilvicultural systems: crops (including shrubs/vines) and trees.
- Silvopastoral systems: pastures, animals and trees
- Agrisilvopoastoral systems: crops, pastures, animals and trees
- Other systems: specific examples such as apiculture (insects and trees) and aquaculture (trees and maritime organisms).

After this initial classification the agroforestry systems were further classified based on the following two parameters (Nair 1993):

- Agroforestry system: "Specific local example of a practice, characterized by environment, plant species and their arrangement, management and socio economic functioning".
- Agroforestry practice: "A distinctive arrangement of components in space of time".

Figure 2: Classification of agroforestry systems based on the type of components (adapted from Nair 1985)



2.1.4 Arc GIS mapping of the agroforestry systems

In order to prepare a map for the farmers showing the location of agroforestry systems in Los Ídolos GPS measuring points were taken every 20 – 500 m, depending on significant changes in the terrain. Afterwards coordinates and additional field data are put in Microsoft Excel and subsequently uploaded in Arc Map 10.1 using the "Display X Y coordinates function". The locations of agroforestry systems are displayed on a satellite image of the study area and afterwards connected to establish new map shape files. Location of rivers were referenced with GPS data and further finished by making a new shape file. Typical vegetation around the river is clarified trough establishing a vegetation buffer of 10 meters wide around the river by using a the geo-processing toolkit in Arc Map 10.1. To express the quantities of different agroforestry systems and other land use systems, the size in hectares per land use is system has been calculated by using the 'calculate geometry' tool in Arc Map 10.1.

2.2 Determination of species diversity and dominance of agroforestry systems

2.2.1 General approach

In order to answer the second sub question: "What is the diversity of usable ligneous plant species identified within agroforestry systems?" the diversity and relative dominance of ligneous plants in the selected agroforestry system was identified.

For the sampling procedure 6 transects of 2X 25 m (covering a total area of 300 m^2) per identified agroforestry system were set up in order to measure all ligneous plant variables. Transects were sampled semi-randomly, in such a way that there was no overlap between other agroforestry systems. Within these transects all woody plant species with a DBH (diameter on breast height) <1,5 cm were measured.
One method to measure the relative dominance of species in a forest community is expressed as the Importance Value (IV). Importance values rank species within a site based upon three criteria (Kuers, 2005, Lamprecht, 1990):

1) How commonly does a species occur across the entire agroforestry system? This is expressed as species frequency (F)
2) The total number of individuals of the species. This is expressed in species density (D)
3) The total amount of forest area occupied by the species. This is expressed in species basal area (BA).

To compare different plant communities it is easier to compare communities that may differ in size, or that were sampled at different intensities, importance values of woody plant species are calculated using relative rather than absolute values (Kuers, 2005). After calculating the three relative importance values of F, D and BA of the identified plant species in the sampled area, the cumulative Importance Value (IV) of all measured plant individuals sums up to maximal 300 (Lamprecht 1990) using the formula below:

IV= ((100 * TotalD/DR) + (100* TotalF/FR) + (100 * TotalBA/ BAR)), in which:

- DR is the relative density, the number of individuals of one species as a percentage of the total number of individuals of all species.
- FR is the relative frequency, the number of occurrences of 1 species as a percentage of the total number of occurrences of all species.
- BAR is the relative basal area, the total basal area of one species as a percentage of the total basal area of all species.

2.3 CONTRIBUTION OF PROVISIONAL AND CULTURAL ECOSYSTEM SERVICES DERIVED FROM AGROFORESTRY SYSTEMS TO THE CULTURAL AND SUBSISTENCE NEEDS OF FARMERS.

2.3.1 Interview questions

To answer sub question 3 “To what extent do provisional and cultural services derived from agroforestry systems contribute to the subsistence security of surrounding household’s?” interviews were carried out with the aim to:

1. Calculate possession rates of the identified agroforestry systems by farmers, to check which agroforestry system is the most popular.
2. Validate the different agroforestry systems based on perceived cultural, economic and subsistence values, to indicate the main functions of each agroforestry system.
3. Measure the subsistence potential of agroforestry systems, to identify which agroforestry system contains the highest amount of provisional ecosystem services.
4. Indicate the perceived importance ligneous plant species for subsistence needs in order to establish a small list of useful species for reforestation purposes and agroforestry design.

Suggestive questions were avoided during the interview to prevent a biased responses from the interviewed farmers.

2.3.2 Selection of the target group – some considerations

The initial aim was to only interview all 14 ejiditatrios who are living in the village of Los Ídolos, because these villagers are in possession of a land parcel title which is retrieved by the Mexican government (USAID 2011). Besides working on an entitled land parcel, ejiditarios have the right to vote on new land tenure regimes and regulations, provided that agricultural production is maintained in their certified land parcels.

This obligation to actively manage the land parcels is a critical factor which determines whether farmers have or don´t have extended knowledge about local usable tree and shrub species. Interviewing randomly selected villagers would probably have resulted into less varied and knowledgeable responses with respect to woody plant diversity and their uses (provisional ecosystem services) since not every villager of Los Ídolos is currently working in the agricultural sector or manages an agroforestry system . Secondly, interviewing random villagers would have made it practically impossible to validate perceived provisional and cultural services of the available agroforestry systems, because not every villager fully depends on its extracted resources. Finally selecting the full village population would have drastically increased the number of people to be interviewed, which was not realistic due to the time limitations of this research.

2.3.3 Interview questions – details

2.3.3.1 Possession rates

Farmers were asked which agroforestry systems are on their land property. Relative possession rates were obtained through calculating the total amount of farmers which owned a certain system as a percentage of the total amount of counted terrains.

2.3.3.2 Identifying perceived cultural, economic and subsistence values of agroforestry systems

In order to access to what extent the provisional and cultural ecosystem services of identified agroforestry systems are perceived as important, farmers were asked to rank the cultural, commercial and subsistence value of agroforestry systems on a scale of 1 till 10. Subsequently all the scores per category (cultural identity, commercial and subsistence value) were summed up and the mean score was calculated for each agroforestry system.

2.3.3.3 Measuring subsistence proportion for each agroforestry system

To measure the subsistence proportion of plant products which are extracted from agroforestry systems, farmers were asked to rank 10 ligneous plant species which delivered the following provisional ecosystem services (De Groot, Van der Meer, 2010):

1. Crafting materials
2. Food products
3. Medicinal products (including products for cultural rituals)
4. Construction materials (for both commercial as well non-commercial purposes)
5. Shadow and fencing trees
6. Fodder
7. Firewood and/or carbon
8. Ornamental species
9. Reforestation species.

After ranking the ligneous plant products farmers were asked in which agroforestry system each product was collected from and if the product was used mainly for commercial or subsistence purposes. The idea behind this exercise was to generate the same type of quantitative data as has been collected in the transects trough determining the "Subsistence Proportion" (SP) of the identified agroforestry systems. This subsistence proportion was based on the relative density values: the number of times a plant species for a specific use (provisional ecosystem service) was collected from a certain agroforestry system, as percentage of the total number of all registered plant individuals, perceived to be important for the provisional ecosystem services mentioned above.

Figure 3: Obtaining data about tree and agroforestry preference trough holding interviews with farmers (Photo Ismael Aparicio)

Figure 4: Collecting data about species density, frequency and basal area, to identify species dominance and composition. (Photo Ismael Aparicio)

2.3.3.4 Measurement of ligneous plant importance based on their variety of provisional services

To indicate which ligneous plant species are especially important due to the range of (non) timber products provided, subsistence importance values (SIV) were calculated. The subsistence importance value of a socially important perceived plant species was based on two relative values:

- Relative frequency (FR): Number of times 1 species is perceived as useful for any purpose as a percentage of the total number of all individuals.
- Relative number of uses (UR): Number of different uses of 1 species as a percentage of the total number of uses/provisional services of all species.

Calculated relative values of single plant species were subsequently summed up together to give the final subsistence importance value which summed up to 200 as cumulative value.

2.5 Identifying the difference of used exotic and native plant species among agroforestry systems.

In order to show how much agroforestry system differ in relation to the number of useful traditional and exotic ligneous plant species, the obtained ecological data from the transects and the retrieved social data from the interviews were analyzed to indicate possible differences.

First, transect data, which include records of measured plant individuals were used to calculate the Importance Value of present exotic and native plant species. Subsequently the total IV of all exotic and native plants was summed up to indicate the share of exotic and native species per agroforestry system. Secondly, in order to check to what extent exotic and native species were used for subsistence needs, interview data were used to calculate the relative share of exotic and native plants individuals per agroforestry system.

3. Results – Sub question 1

This chapter describes the agroforestry systems and practices which were identified in the field. The results of sub question 1 are described by using the classification scheme of Nair, P.K.R. (1991) and partly on Young, A. (1997).

3.1 Classification of agroforestry systems and associated practices

Table 1 represents the five prevailing agroforestry systems and its associated practices.
In the first column the management of the system is briefly described. The second column displays the plant components and the third column the agro ecological adaptivity. The data in the fourth and fifth columns assess the domestication phase of forests and tree species within the area: the fourth column assesses the diversity of people plant interactions in Los Ídolos trough showing the extent of natural forest exploitation in Los Ídolos, while the fifth column represents the degree of forest manipulation, which is a useful indicator connecting a prevailing agroforestry systems to a specific tree crop exploitation and domestication phase (Harris 1989 and Wiersum 1997). Figures 5 - 9 illustrate the 5 classified agroforestry systems in the area.

Figure 5: Forest garden (Photo Sjoerd Pietersen)

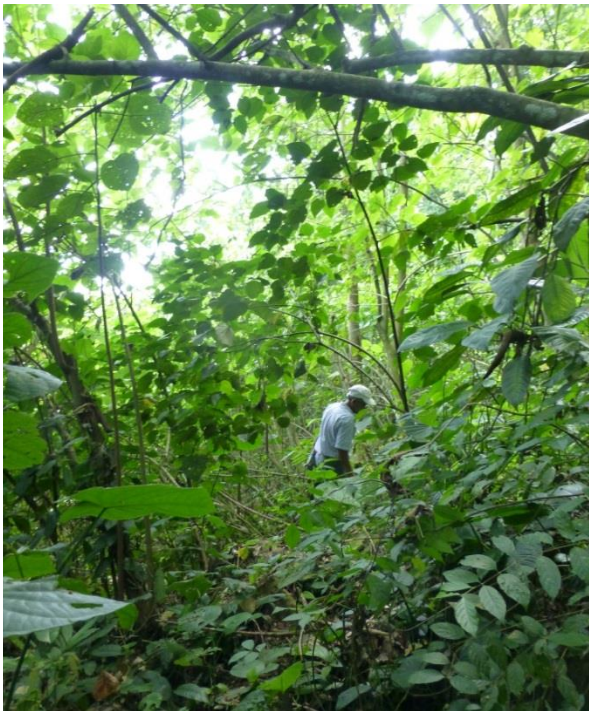


Figure 6: Homegarden (Photo Sjoerd Pietersen)

Figure 7: Plantation crop combination – perennial cultivates (Photo Sjoerd Pietersen)

Figure 8: Plantation crop combination – annual cultivates (Photo Sjoerd Pietersen)

Figure 9: Trees on pastures (Photo Sjoerd Pietersen)

Table 1: Description of identified agroforestry system and associated practices within Los Ídolos.

Agroforestry practices within the study area ejido Los Ídolos (Nair 1991)	*Column 1* Description of tree crop management (Nair 1991) (Young 1997)	*Column 2* Major group of components (Nair 1991)	*Column 3* Agro ecological adaptivity (Nair 1991)	*Column 4* Exploitation phase of field and tree crops (Harris 1989 and Wiersum 1997)	*Column 5* Intensity of forest manipulation (Wiersum 1997) + local example
Agrisilvicultural systems					
Forest garden (Figure 6)	Trees, shrubs and herbaceous plants are grown in a dense, intimate spatial mixture, partly natural forest fallow . More than 25 years no destructive human activity in Forest gardens in Los Ídolos .	w: dense tree stand with (potentially) multipurpose tree crops h: high density of herbs and vines	In shifting cultivation areas	Phase 1: Uncontrolled, open access gathering of forest products	Modification of forest: Enriched natural forest with e.g native timber species as Caoba and Cedro
Plantation crop combination – perennial cultivates*	Shade trees for intercropped perennial plantation crops; shade trees scattered on parcel	w: fruit, fodder, shade and timber tree species. Plantation crops like coffee, capulín, lime and oranges h: only shade tolerant herbs and vines	In humid lowlands or tropical humid/subhumid highlands (depending on the plantation crops concerned); usually in smallholder subsistence system	Phase 4: Cultivation of domesticated tree crops in intensively managed plantations	Forest transformation: Plantations of selected & improved cultivars: -Smallholder cachinal, coffee, lime and orange plantations. - (mixed) fruit orchards of Mamey, Peach, Mango, Capulin, Guyaba
Plantation crop combination – annual cultivates*	Trees intercropped with predominate annual agricultural crops	w: timber species predominate, fruit, fuelwood trees. some woody plantation crops. h: annual cultivates such as maize, sugar cane, beans, banana's	In humid lowlands or tropical humid/subhumid highlands Usually in smallholder subsistence system	Phase 4: Cultivation of domesticated tree crops and agricultural cultivates in intensively managed plantations/fields	Scattered tree growing on agricultural fields: -Individual Multipurpose fruit, fodder, fuelwood and timber trees. -Genetically modified trees on cropland (e.g oranges, timbers)
Silvopastoral systems					
Trees crops on rangelands or pastures	Trees scattered irregularly or arranged according to some systematic pattern (in the case of fruit orchards or timber plantation with cattle grazing in the understorey	w: multipurpose trees a: cows	In areas with less pressure on plantation crop lands	Phase 4: Cultivation of domesticated tree crops in intensively managed plantations	Scattered tree growing on pastures: -Individual Multipurpose fruit, fodder, fuelwood and timber trees. -Genetically modified trees on cropland (e.g. oranges, timbers)
Agrosilvopastoral systems					
Homegarden	Intimate, multi-storey combination of various trees and crops around homesteads	w: (exotic) fruit trees predominate, (exotic) firewood, ornamental, woody cultivates such as coffee, lime, oranges h: (shade tolerant) agricultural species a: Chickens, Pigs, Turkeys	In all ecological regions with high density of human population	Phase 3: Cultivation of selective native (and exotic) tree species in artificially established plantations	Forest transformation: multi-storeyed tree cropping systems -Homegardens containing various indigenous/exotic woody and herbaceous (ornamental) plants

** Both systems contain an integrated multi storey of (mixed/dense) scattered trees in combination with plantation crops. However, a distinction is made between the domination of annual (maize, beans, tomatoes, banana's) or perennial cultivates (coffee, cassava, lime, oranges) because the type of cultivate influences the density of the tree layer and the intensity of management.*

3.2 Distribution and localization of distinguished agroforestry systems.

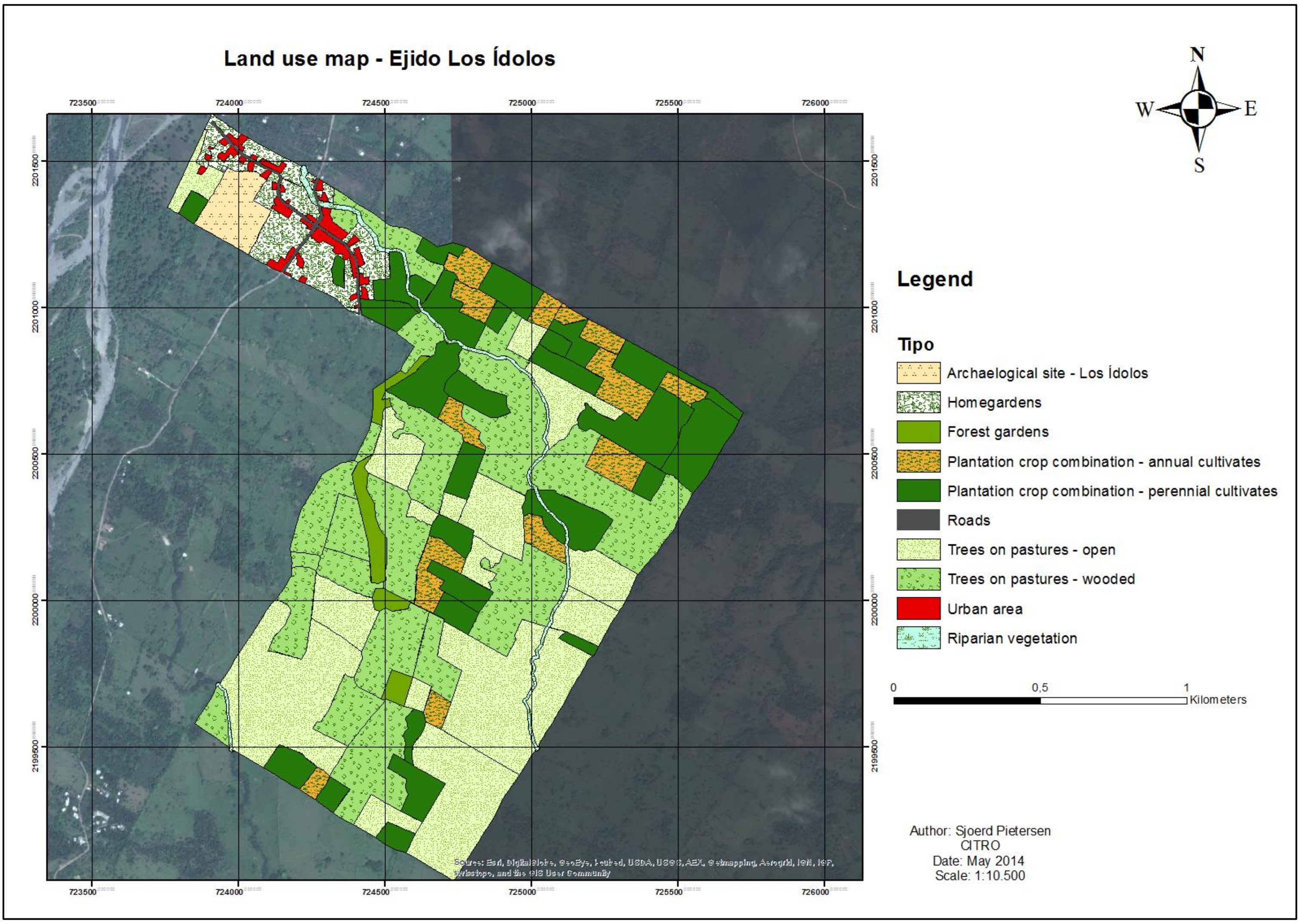
3.2.1 Localization

Shape files were made which resulted into map 2 which shows the location and distribution of the map features (agroforestry systems) in the study area. In contrast to the results summarized in table 1, figure 2 classifies extra land use types.

With regard to silvopastoral systems, a distinction was been made between trees on pastures ("open" or "wooded"). This distinction was made to show the differences in land use and type of livestock management: grazing of cattle in dense silvopastoral versus open pastures fields. Field data on observed tree abundance confirmed the assumed difference in tree density between the two silvopastoral agroforestry systems. In addition, the field data was compared with satellite images as a check on consistency.

Apart from this sub-classification, also the location of the archaeological site, urban areas, roads and riparian vegetation has been indicated on the land use map, in order to make the map practically useful for the farmers.

Map 1: Location of identified agroforestry systems in ejido Los Ídolos



3.2.2 Distribution

As is visible in figure 2, it appears that agroforestry systems which involve the highest management intensity are situated closely to urbanized areas. Home gardens which require daily management are located around the homestead. Next to home gardens, plantation crop combination systems were – apart from some exceptions - generally located within a range of 50 – 1500 m from the center of the village. In these type of systems practices such as tillage, weeding, pruning, fertilizing, collection of coffee, fruits, firewood, staple crops and occasionally logging took place. In contrast to agrisilvicultural systems, most silvopastoral systems started to appear 750 – 2500 away from the ejido center because extensive pasturing of cows and horses generally requires less supervision and management by local peasants.

3.2.C Proportion

To express the quantities of different agroforestry systems and other land use systems, the size in hectares per land use is system was calculated in Arc map 10.1 to calculate the relative proportion of an individual agroforestry system within the study area. An overview of the results is given in table 2.

Silvopastoral systems account for 60 % of the total area. Agrosilvipastoral systems such as plantation crop combinations and home gardens which involve more intensive cultivation and collection of food and cash crops cover approximately 34% of land in the ejido. Abandoned semi natural or less manipulated ecosystems like the Forest garden (2%) and riparian vegetation (2,4%) cover only 4,4% of the land surface. Roads and urban areas which are by definition unsuitable for any kind of agroforestry/land use management have a share of 2% within the whole ejido.

Table 2: Proportion of agroforestry systems ejido Los Ídolos

Agroforestry systems	**Size in hectares**	**Percentage**
Forest garden (FG)	4,7	2,0
Home gardens (HG)	11,2	4,7
Plantantion crop combination - annual cultivates (PCCAC)	16,4	6,8
Plantantion crop combination - perennial cultivates (PCCPCC)	49,2	20,6
Trees on pastures – open (TP)	70,6	29,5
Trees on pastures – wooded (TP)	72,1	30,1
Total	*224,2*	*93,7*
Other land use types		
Roads	1,2	0,5
Urban area	3,5	1,5
Archaelogical site	4,5	1,9
Riparian vegetation	5,8	2,4
Total	*15,0*	*6,3*
TOTAL	**239,2**	**100**

4 RESULTS – SUB QUESTION 2

4.1 FLORISTIC DIVERSITY ON EJIDO LEVEL

The floristic diversity in the ejido was expressed by the total amount of edible and useful plant species. In total 550 woody plant individuals were measured in 30 established transects, corresponding to 71 different ligneous plant species which together covered a basal area of 98,2 m^2. Of the 71 found species, 63 (89%) species were native and 8 (11%) were exotic. Table 4 shows the 10 plant species with the highest IV within the whole ejido. Apart from relative values which give the final importance value, also the absolute data on relative plant density, frequency and basal area of the 10 most common are summarized in table 4. In addition, the same results are also shown for all 61 other species found in the ejido.

Table 4: Tree species with the highest Importance Value in ejido Los Ídolos

Name	Density	Frequency	Ba m^2	DR	FR	BaR	IV
Cedrela oderata	29	15	14,0	5,3	6,7	14,2	26,2
Coffea arabica	70	12	1,3	12,7	5,4	1,3	19,4
Pseudolmedia glabrata	41	5	9,1	7,5	2,2	9,2	18,9
Ardisia compressa	46	15	0,6	8,4	6,7	0,7	15,7
Eupatorium quadrangulare	44	6	1,3	8,0	2,7	1,3	12,0
Thouinidium sp.	7	3	8,7	1,3	1,3	8,8	11,4
Inga vera	17	11	3,3	3,1	4,9	3,4	11,4
Oecopetalum mexicanum	33	4	2,8	6,0	1,8	2,9	10,7
Ficus aurea	2	2	8,0	0,4	0,9	8,1	9,4
Citrus sinensis	10	8	2,0	1,8	3,6	2,0	7,4
Other species (61)	251	142	47,6	45,6	63,7	48,1	157,5
Total	**550**	**223**	**98,8**	**100**	**100**	**100**	**300**

When analysing the Importance Value for all species found in the ejido, it is evident that Cedro (Cedrela Oderata) has the highest IV (26). Due to its high basal area and relative high frequency among the transects, it is considered as the potentially most important arboreal species and appears to be planted frequently for timber in the agrosilvicultural and silvopastoral agroforestry systems. The well-known Coffee (*Coffea Arabica*) has a IV of 19.4 which can be explained because it is frequently intercropped with high amounts in various widespread agroforestry systems such as plantation crop combinations and home gardens. In the fallow/abandoned fragments the native fruit tree species Tepetomate (*Pseudolmedia glabrata*) is very abundant with locally a high density and basal area and an IV of 18,9. The 10 species with the highest score account together for 142,5 of the total Importance Value (300) of the whole ejido. Importance values of all the in total 71 identified species can be consulted in appendix 6.

4.2 Floristic diversity on agroforestry system level

Table 4 also provides an indication of the abundances of the ligneous plant species in the ejido. However table 4 lacks the context on a system level because the specific or common ligneous plant species composition in cultivation methods remained unclear. Therefore, the 4 species with the highest IV and their main use are summarized in tables 5 till 9 to indicate the variety of species composition per agroforestry system. Note that the abbreviations refer to the analyzed agroforestry systems.

4.2.1 Forest garden (FG)

Total number of identified species: 40

Total number of identified native species: 40 (100%)

Total number of identified exotic species: 0 (0%)

Important species components in the agroforestry system and their main use:
Tepetomate (Pseudolmedia glabrata) with an IV of 39 and has food production as main use. Canutillo (Eupatorium quadrangulare) with an IV of 28 is mostly used for firewood collection. Bienvenido (Thouinidium sp.) has an IV of 24 and the timber of this tree is generally used for construction material. Higuera blanca (Ficus aurea) is often left standing after a clearing to serve as shadow tree for cattle.

The importance value of 10 most common species is ≈ 190,7, which indicates a relative high complexity and variety of ligneous plant species composition.

Table 5: IV Forest garden

Name	Density	Frequency	Ba m^2	DR	FR	BaR	IV
Pseudolmedia glabrata	40	4	8,7	16,7	4,7	17,6	39,0
Eupatorium quadrangulare	44	6	1,3	18,4	7,1	2,7	28,2
Thouinidium sp.	7	3	8,7	2,9	3,5	17,7	24,1
Ficus aurea	2	2	8,0	0,8	2,4	16,3	19,4
Urera caracasana	27	2	1,4	11,3	2,4	2,8	16,5
Diospyros digyna	5	4	3,9	2,1	4,7	8,0	14,8
Bernoullia flammea	14	5	0,8	5,9	5,9	1,7	13,4
Bunchosea chococa	14	5	0,8	5,9	5,9	1,6	13,3
Phoebe paniculata	1	1	4,9	0,4	1,2	9,9	11,5
Cupania glabra	11	3	1,1	4,6	3,5	2,3	10,4
Other species (30)	74	50	9,6	31,0	58,8	19,5	109,3
Total	**239**	**85**	**49,2**	**100**	**100**	**100**	**300**

4.2.2 Home garden (HG)

Total number of identified species: 32

Total number of identified native species: 27 (84%)

Total number of identified exotic species: 5 (16%)

Important species components in the agroforestry system and their main use:
Capulín (*Ardisia compressa*) with an IV of ≈ 31 has food production as main use. Coffee (*Coffea arabica*) with an IV of ≈ 23 is mostly used for consumption as beverage and generating income. Cedro (*Cedrela oderata)* also has an IV of ≈ 23 and the high quality timber of this tree is generally used for construction of furniture and artisanal crafts. Oranges (*Citrus sinensis*) has an IV of 21 and is planted mainly for personal consumption, since its market value declined over the past decades (Sánchez y Gándara, 2012).

The importance value of the 10 most common species is ≈ 193, indicating a relative high complexity and variety of ligneous plant species composition.

Table 6: IV Home garden

Name	Density	Frequency	Ba m^2	DR	FR	BaR	IV
Ardisia compressa	18	5	0,16	18,8	10,4	1,4	30,6
Coffea arabica	16	2	0,27	16,7	4,2	2,3	23,1
Cedrela oderata	3	2	1,80	3,1	4,2	15,4	22,7
Citrus sinensis	5	3	1,12	5,2	6,3	9,6	21,0
Pimienta dioica	4	3	1,04	4,2	6,3	8,9	19,3
Citrus reticulata	3	2	1,18	3,1	4,2	10,1	17,4
Inga jinicuil	4	2	1,04	4,2	4,2	8,9	17,3
Gliricidia sepium	9	2	0,24	9,4	4,2	2,0	15,6
Bursera simaruba	1	1	1,18	1,0	2,1	10,1	13,2
Mangifera indica	1	1	1,10	1,0	2,1	9,4	12,5
Other species (23)	32	25	2,56	33,3	52,1	21,9	107,3
Total	**96**	**48**	**11,7**	**100**	**100**	**100**	**300**

4.2.3 Plantation crop combination – annual cultivates (PCCAC)

Total number of identified species: 13

Total number of identified native species: 9 (69%)

Total number of identified exotic species: 4 (31%)

Important species components in the agroforestry system and their main use are Cedrela oderata (*Cedrela oderata*) with an IV of 115 and coffee (*Coffea arabica*) with an IV of ≈ 41. Chalahuite peludo (*Inga vera)* has an IV of ≈ 31 and is generally used as shadow tree for growing coffee, with personal consumption and firewood collection as additional uses. Chinine (*Persea schiedeana*) has an IV of ≈ 24 and is used for personal consumption and as construction material or firewood.

The importance value of the 10 most common species is ≈ 283, which indicates a low complexity and variety of ligneous plant species composition is this agroforestry system.

Table 7: IV Plantation crop combination – annual cultivates

Name	**Density**	**Frequency**	**Ba m^2**	**DR**	**FR**	**BaR**	**IV**
Cedrela oderata	17	5	6,90	32,1	18,5	64,4	115,0
Coffea arabica	12	4	0,37	22,6	14,8	3,5	40,9
Inga vera	5	4	0,71	9,4	14,8	6,6	30,8
Persea schiedeana	3	2	1,19	5,7	7,4	11,1	24,2
Wigandia urens	4	2	0,13	7,5	7,4	1,2	16,2
Citrus sinensis	2	2	0,47	3,8	7,4	4,4	15,6
Ardisia compressa	3	2	0,09	5,7	7,4	0,8	13,9
Pseudolmedia glabrata	1	1	0,47	1,9	3,7	4,4	10,0
Bursera simaruba	2	1	0,18	3,8	3,7	1,6	9,1
Citrus reticulata	1	1	0,16	1,9	3,7	1,5	7,1
Other species (3)	3	3	0,05	5,7	11,1	0,4	17,2
Total	**53**	**27**	**10,71**	**100**	**100**	**100**	**300**

4.2.4 Plantation crop combination – perennial cultivates (PCCPC)

Total number of identified species: 18

Total number of identified native species: 14 (78%)

Total number of identified exotic species: 4 (22%)

The Important species components in the agroforestry system and their main use are Coffee (*Coffea arabica*) with an IV of 54 as main perennial cultivate in this system. Cachichín (*Oecopetalum mexicanum*) with an IV of ≈ 46 is considered to be an important food tree and provides additional income by selling the fruits of the tree. Jonote (*Heliocarpus appendiculatus)* has an IV of ≈ 29 and is generally used as construction material for houses. Chalauite peludo (*Inga vera*) has an IV of ≈ 24 and is regularly planted to optimize the growth conditions for Coffee (*Coffea arabica*).

The importance value of the 10 most common species is ≈ 261, which indicates a moderate till low complexity and variety of ligneous plant species composition is this agroforestry system.

Table 8: IV Plantation crop combination – perennial cultivates

Name	**Density**	**Frequency**	**Ba m²**	**DR**	**FR**	**BaR**	**IV**
Coffea arabica	42	6	0,63	32,8	17,6	3,8	54,3
Oecopetalum mexicanum	31	2	2,62	24,2	5,9	16,0	46,1
Heliocarpus appendiculatus	6	2	2,94	4,7	5,9	17,9	28,5
Inga vera	8	3	2,03	6,3	8,8	12,4	27,5
Ardisia compressa	16	4	0,28	12,5	11,8	1,7	26,0
Mangifera indica	1	1	2,89	0,8	2,9	17,7	21,4
Cedrela oderata	3	2	1,40	2,3	5,9	8,5	16,7
Swietenia macrophylla	3	2	1,27	2,3	5,9	7,7	16,0
Citrus aurantifolia	7	2	0,69	5,5	5,9	4,2	15,6
Pouteria sapota	1	1	0,94	0,8	2,9	5,7	9,5
Other species (8)	10	9	0,71	7,81	26,47	4,32	38,6
Total	**128**	**34**	**16,4**	**100**	**100**	**100**	**300**

4.2.5 Trees on Pastures (TP)

Total number of identified species: 20

Total number of identified native species: 18 (90%)

Total number of identified exotic species: 2 (10%)

The important species components in this agroforestry system and their main use is Cedro (*Cedrela oderata*) with an IV of 65 as main perennial cultivate in this system. Zapote Mamey (*Pouteria sapota*) has an IV of ≈ 33, its fruits are used for personal consumption or sold for cash income. Aguacatillo (*Ocotea* sp) has an IV of ≈ 23 and is a timber source for the construction of sheds and houses. Guayaba (*Psidium guajava*) has an IV of ≈ 17 and is an important shadow tree for cattle, and is also used for firewood and fruit collection

The importance value of the 10 most common species is ≈ 222, which indicates that - despite a low tree density - a relative high variety of ligneous plant species is being planted or left over after exploitation of former forests in is this agroforestry system.

Table 9: IV Trees on Pastures

Name	Density	Frequency	Ba m²	DR	FR	BaR	IV
Cedrela oderata	5	5	3,52	14,7	17,2	32,6	64,6
Pouteria sapota	3	1	2,21	8,8	3,4	20,5	32,8
Octea sp.	1	1	1,77	2,9	3,4	16,4	22,8
Psidium guajava	2	2	0,40	5,9	6,9	3,7	16,5
Croton drago	2	2	0,29	5,9	6,9	2,7	15,5
Guarea glabra	1	1	0,97	2,9	3,4	9,0	15,4
Citrus sinensis	2	2	0,24	5,9	6,9	2,2	15,0
Xantoxilum sp.	2	2	0,11	5,9	6,9	1,0	13,8
Inga jinicuil	1	1	0,63	2,9	3,4	5,8	12,2
Inga vera	2	2	0,07	5,9	6,9	0,6	13,4
Other species (10)	13	10	0,6	38,2	34,5	5,3	78,0
Total	**34**	**29**	**10,8**	**100**	**100**	**100**	**300**

5 Results - Subquestion 3

This chapter describes and analyses the results of the quantitative interviews which have been held with the ejiditarios to answer sub question 3: "To what extent do provisional and cultural services derived from agroforestry systems contribute to the subsistence security and cultural identity of surrounding rural household's?".

5.1 Interviewed target group

Eventually 10 of the 14 ejidatrios were available for the interview. Three other farmers which owned and actively managed a (non-certified) land parcel were interviewed upon the recommendations of ejiditario Juan Carrera and based on their extensive traditional knowledge about (local) cultivates, tree and shrub species. Twelve masculine farmers and one female farmer were interviewed. Farmers had an average age of 66 and a family size of approximately 3 members. The number of applied land use systems per farmer varied between 1 and 6. On average, farmers actively manage 3 different types of land use systems at the same time.

5.2 Possession rates

Table 10 summarizes the different land use types found in the ejido and to which agroforestry system it belongs to. The third and last row defines how often this land use type is possessed within the interviewed group. Evidently pasturelands both with as well without trees is the most common applied land use system in Los Ídolos and 12 (93%) of the 13 farmers are in possession of a pastureland. After pasturelands, coffee under shadow plantations is with a possession rate of 62% popular among the farmers. Maize cultivations and home gardens are with a possession rate of both 54% relatively often applied as land use system. Less common are plantations of citrus fruits, since only 5 of the 13 farmers actively cultivate and produce citrus fruits in plantations. The traditional and local production of cachichín nuts derived from 'cachichínales', is a rare land use system within the ejido and only applied by 2 farmers, having a possession rate of only 15%. The relicts of natural forest in the ejido (classified as Forest gardens) are only sporadically and spontaneous used for the collection of all sorts of subsistence products such as fruits, medicinal plants, poles and firewood. Nobody of the target group has these isolated parts of natural forest under active management or in possession.

Table 10: Possession rates of identified land use

Land use - local name	Agroforestry system – classification name	Possession (nr of ejiditarios)	Possession rate %
Monte alto	Forest garden	0	0%
Cafetal	Plantation crop combination - perennial cultivates	8	62%
Cachichínal	Plantation crop combination - perennial cultivates	2	15%
Huerto familiar	Homegarden	7	54%
Milpa	Plantation crop combination - annual cultivates	7	54%
Citrico	Plantation crop combination - perennial cultivates	5	38%
Portrero con arboles	Trees on Pastures	10	77%
Portrero sin arboles	Pastures without trees*	2	15%

* Pastures without trees are not considered as an agroforestry system.

5.3 Perceived value of ecosystem goods and services from agroforestry systems

Table 11 shows the perceived cultural identity; commercial and subsistence mean value of the present agroforestry systems in ejido Los Ídolos. The last column sums the 3 relative values to give a mean perceived value, in order to show the general importance of an agroforestry system. Below the perceived values of every agroforestry system are explained. In the case of this exercise, the PCCPCC systems in ejido are sub divided into 3 local examples: Cafetales (coffee plantations), Cachichínales (forests exclusively enriched with *Oecopetalum mexicanum* for generating extra cash income) and Citrico's (plantations of citrus fruits). This choice has been made to give a more complete overview of the importance of PCCPCC systems.

Table 11: Perceived cultural, commercial and subsistence value of agroforestry systems in Los Ídolos

Land use - local name	Agroforestry system	Cultural identity value	Commercial value	Subsistence value	Mean
Monte Alto	Forest garden(FG)	6,8	3,5	5,8	**5,4**
Cafetal	Plantation crop combination - perennial cultivates (PCCPC)*	7,8	5,5	7,5	**6,9**
Cachichínal	Plantation crop combination - perennial cultivates (PCCPC)*	7,8	7,7	6,5	**7,3**
Citrico	Plantation crop combination - perennial cultivates (PCCPC)*	7,6	6,3	6,8	**6,9**
Huerto familiar	Homegarden (HG)	8,3	4,0	8,1	**6,8**
Milpa	Plantation crop combination - annual cultivates (PCCAC)	8,8	4,4	8,6	**7,3**
Portrero con arboles	Trees on Pastures (TP)	7,9	7,8	4,9	**6,9**

** The mean value of al PCCPC systems together is ≈ 7,0*

5.3.1 Monte Alto - Forest garden

From table 11 it can be seen that this agroforestry scores on average a 5,4 which can be explained trough the low commercial value of the system (3,5) since only a few timber species are used in this small agroforestry system which grow on steep hills and are difficult to exploit. The subsistence value of this system is with 5,8 moderate.

Farmers sometimes go to these isolated patches of fallow land to collect fruits, medicinal plants and some firewood; however younger peasants have less interest in this system because they lack the knowledge of usable plant species.

The cultural identity value of this agroforestry system is relatively high with a 6,8 because most of the farmers recognize that fallow lands contains the highest (medicinal) plant diversity and seed trees for regeneration, compared to elsewhere in the ejido. Mostly the older farmers of the target group recognize this high plant diversity and occasionally collect woody plants which are specifically used for local crafts and handwork. Besides a potentially high amount of useable products within the fallow lands, its distinctive appearance reminds farmers about a more natural landscape with unexploited forests which originally covered the hills in the ejido.

5.3.2 Cafetal/Plantation crop combination – perennial cultivates

Coffee under shadow plantation scores relatively high with 6,9 as mean. Especially cultivation practices of coffee under shadow are considered as an important aspect of the cultural identity for most of the farmers since it grows in the ejido for many generations (up till 70 years of active cultivation). Therefore the culture identity of these "cafetales" scores a 7,8.

However the commercial value of Coffee (*Coffea Arabica*) has been decreasing since the economic crisis of the 80's (Sánchez y Gándara, 2012), and many families in the region of Misantla had to abandon their coffee plantations because the harvest and production proved to be not profitable anymore, resulting in a score of 5,5.

Although the commercial value of coffee plantations under shadow is not very high, the subsistence value scores higher with a 7,5, which can be explained by the abundance of a high variety of timber species for construction, fruit trees and species which generate firewood.

5.3.3 Cachichínal/ Plantation crop combination – perennial cultivates

The Cachichín (*Oecopetalum mexicanum*) is a tree which locally represents the identity of the misantecos (inhabitants of the Sierra de Misantla) and explains the high mean score of 7,3. The seeds of the cachíchin are consumed raw or toasted and have a bitter taste. The reproduction, collection, processing and personal consumption of cachichines has an important cultural value (Lacurain 2011, López 2012) in La Sierra de Misantla, which explains the high cultural identity score of 7,8.

In contrast to coffee plantation under shadow, the collection and selling of (raw) cachichín seeds is a relatively valuable product. According to one of the interviewed farmers 1 kg of cachichín seeds can be sold between $30 up till $50 mexican pesos (€1,70 - €2,80) which is quiet high for a primary agricultural product, especially in comparison to a kg of raw coffee (€0,15 – €0,30 per kg) . This explains that the commercial value of cachíchnales with a score of 7,7 is one of the highest of all agroforestry systems in the ejido.

The subsistence value is with a score of 6,5 lower than coffee plantations under shadow because the amount and variety of intercropped cultivates with cachichín trees is limited. Cachichínales are mainly intercropped with Coffee (*Coffea arabica*) and Capulín (*Ardissia compressa*), and sporadically with trees such as Mango (*Mangifera indicia*) or Jonote (*Heliocarpus appendiculatus*).

5.3.4 Citrico/Plantation crop combination – perennial cultivates

Inhabitants of the region of la sierra de Misantla have been important producers of citrus fruits and still a decent amount of orange, lemons and mandarin plantations can be found in the ejido of Los Ídolos (Sánchez y Gándara). Therefore the cultural identity of citrus fruit plantations scores a 7,6.

The commercial value is with a 6,3 somewhat higher than that of coffee under shadow plantation. Whereas the production of lemons is locally relatively profitable, the production of oranges is often not considered as profitable by the interviewed farmer. Still most of farmers recognize citrus fruits as an important source of alimentation for personal consumption, while the leaves, flowers and juice of the fruit is used against flu and obesities (website Ecocrop ,FAO) . The multifunctional character of citrus fruits resulted into a subsistence value of 6,8. The cultural identity, commercial and subsistence value together account for a mean score 6,9.

5.3.5 Huerto familiar/Home garden

Differences in plant diversity and vegetation strata between Home gardens and other agroforestry systems are not easy to distinguish and therefore the following definition is used: "home gardens represent intimate, multi-story combinations of various trees and crops, sometimes in association with domestic animals, around the homestead*".* (Wiersum, 1982; Brownrigg, 1985; Soemarwoto, 1987).
This agroforestry system receives with an 8,3 a high score for cultural identity of the farmers in Los Ídolos.
As is stated in *Tropical Home gardens - A Time-Tested Example of Sustainable Agroforestry* (P.K.R. Nair , B.M Kumar, 2006) the name "Huerto familiar" almost literally explains the high subsistence value of 8.1. The family decides which herbs, crops, trees have the highest utilitarian value for the family its subsistence and thus should be cultivated. The high plant diversity can be maintained because the garden is around the homestead and in generally only needs to produce enough products for the consumption of the family who maintains the home garden. Logically the high personal consumption results into a low commercial value of 4,0. Summing up all scores of the three categories Home gardens receive a mean ranking of 6,8.

5.3.6 Milpa's/Plantation crop combination – annual cultivates

PCCA systems are closely related to home gardens since its main components Maiz and Beans are also often planted in Home gardens. However milpa's[5] are originally considered as a shifting agricultural system that provides fewer forest products. According to Steinberg this development resulted in a less diverse agricultural and biological landscape, because of a shorter fallow period which prevented the regeneration of tree species. (Steinberg 1998, F.Montagini, 2006). This assumption is clearly evident in section 4.2.C which shows that lowest tree diversity is found in milpa's.

Milpa management in Los Ídolos distinguishes itself from home gardens because management is focused on a more commercially oriented intensified production of staple crops such Maiz (*Zea maiz*), Black Beans (*Phaceolus vulgaris*) and Cassava (*Manihot esculenta*) than in home gardens. Furthermore milpa's cultivate diversity is complemented by other popular vegetables such Cucurbita spp. and Capsicum spp. With an 8,8 and 8,6 Milpa's are assessed with the highest cultural identity and subsistence value of all land use systems present in Los Ídolos. This score is explained because these agroforestry systems provide staple crops for the daily diet of the framers in Los Ídolos: "<u>Tortillas de Maiz con frijoles enchililados</u>".

Despite these high scores, the commercial value of milpa's is with a 4,4 very low. Since the NAFTA free trade agreement in 1992 the Mexican state is able to import cheap Maize from the United States and Canada (E. Perramond 2008, USAID 2011). Due to this international free market the price of Maize declined. Also in Los Ídolos farmers are often obliged to sell Maiz for a price which is unprofitable, however indispensable in order to prevent that the complete harvest will rot in storage rooms. Eventually the low commercial value results into a 7,3 as mean score for milpa's.

5.3.7 Trees on Pastures

This agroforestry system has become increasingly important for farmers in Los Ídolos, since the market value of coffee and citrus fruits collapsed and many farmers in the region of Misantla started to breed cattle. At this moment meat production is one of principal incomes within the agricultural sector due to subsidies and help from local government policies, and an increasing

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[5] Land use system consisted of 2 to 5 ha plots that were cut and burnt, and cultivated mainly with maize (*Zea mays*). In the traditional system, after a few harvests the plots were left to regenerate with a long fallow cycle, leaving tree species time to mature and bear fruits (15 to 40 years) (Steinberg,1998).

demand for beef from cities such as México City, Puebla, Veracruz and Xalapa. Also farmers recognize the increased popularity and rank the cultural identity value with a 7,9.
Trees on Pasture systems are former "Selvas medianas sub perrenifolias" which have been cleared for cattle breeding and sometimes for the establishment of timber plantations which mainly contain Cedro (*Cedrela oderata*) and Caoba (*Swietenia macrophylla*). This activities are strongly market oriented which explain the commercial value of 7,8.
The amount of edible woody plant products depends strongly on the tree density and vegetation cover which is in Trees on Pastures evidently the lowest of all agroforestry systems in Los Ídolos (see section 4.2E). In contrast to cafetales, citrico's, huertos familiars and milpa's, trees on pasture systems received a low subsistence value of 4,9. On average Trees on Pasture systems scored a 6,9.

5.4 Subsistence proportion per agroforestry system.

This paragraph describes which agroforestry is perceived by the interviewed farmers as being most appropriate for the extraction of utile ligneous plant species, which were subdivided among the 9 pre-determined categories of provisional ecosystem services (see 2.4.3 C). The results of the interviews and ranking exercise are shown in table 12 and 13.

In total 84 different species with in total 212 uses were identified in the 13 interviews. Table 12 sums up how many species per provisional category were identified. Note that some species have more than one single use. A full overview of all the 84 species is shown in appendix 7.

Table 12: Number of utile ligneous plant species per provisional ecosystem service

Provisional service	Number of utile species
Artisanal products	15
Food products	28
Construction wood/timber	21
Fence/Shadow trees*	30 (22)
Firewood	30
Fodder	5
Medicinal products	25
Ornamental plants	33
Reforestation	25
Total number of used species	**84**

** Eight tree species are used for fencing terrains, 22 of the species are considered as important shadow trees for people and cattle*

To indicate which agroforestry system has potentially the highest subsistence value and serves the best to secure subsistence needs, table 13 summarizes the different provisional services per agroforestry system. In the second column it is counted how many times plant individuals have been perceived as important by farmers for a specific use in a specific agroforestry system. In the third column the actual number of different species per provisional category is displayed.

Subsequently the forth column visualizes how many different species are considered as useful per agroforestry system. The fifth column displays sub percentages which indicate the relative socially perceived importance for every provisional ecosystem service within a specific agroforestry system. After summing up the secondary percentages, a primary percentage is presented in **bold** which shows the general subsistence value of the agroforestry system.

The relative subsistence value rates of agroforestry systems are calculated on the basis of data from the second row in table 13 and are expressed as a relative percentage of the total number of all plant individuals recorded during the interviews .

Table 13: Agroforestry with the highest rate of provisional ecosystem services.

Provisional ecosystem services per Agroforestry System	Times species are perceived as useful (D)	Number of different used species per category (F)	Number of total used species in system	SP%
Fences	**37**		**8**	**6,8**
1 Fences	37	8		6,8
Forest garden total	**20**		**12**	**3,7**
1 Artisanal	4	4		0,7
2 Food	3	2		0,6
3 Construction	6	5		1,1
4 Firewood	1	1		0,2
5 Fodder	1	1		0,2
6 Medicinal	5	4		0,9
Home garden total	**99**		**58**	**18,2**
1 Food	31	13		5,7
2 Construction	2	2		0,4
3 Shadow	2	2		0,4
4 Firewood	2	2		0,4
5 Medicinal	19	12		3,5
6 Ornamental	43	27		7,9
Plantation crop combination - perennial cultivates total	**191**		**30**	**35,0**
1 Artisanal	29	11		5,3
2 Food	51	14		9,4
3 Construction	35	14		6,4
4 Firewood	35	14		6,4
5 Medicinal	13	7		2,4
6 Reforestation	28	18		5,1
Trees on Pastures total	**198**		**46**	**36,3**
1 Artisanal	14	7		2,6
2 Food	23	11		4,2
3 Construction	25	13		4,6
4 Shadow	44	22		8,1
5 Firewood	36	18		6,6
6 Fodder	9	4		1,7
7 Medicinal	17	7		3,1
8 Ornamental	7	7		1,3
9 Reforestation	23	14		4,2
Total useful	**545**			**100**

* Trees used for "living" fences are found in every agroforestry system since these species are used to border the land parcels in ejido Los Ídolos.

5.4.1 Fences

This section only assesses an agroforestry system component, which are ligneous plants perceived as useful for fences. Since these trees are used to fence and bound borders for all land parcels in Los Ídolos, fence trees belong to all identified agroforestry systems. In total 8 different trees are used for fence planting, and account together for a subsistence value of 6,8%.

5.4.2 Forest gardens

In total 6 of the 8 provisional services are used in this system. However, with a SP of 3,7%, Forest gardens have the lowest subsistence proportion of all systems. A few farmers extract medicinal woody plant species (5 species), construction wood (4 species) or artisanal products (4 species) from this system. The farmers use in total 12 species from fallow lands.

5.4.3 Home garden

Home gardens contained 58 species, the highest amount of different used species belonging to 6 provisional services which together account for a SP of 18,2%. The subsistence value is mainly determined because of the high amount of used food (13), medicinal (12) and ornamental cultivates, shrubs and trees (27). Benefits of both medicinal and ornamental plants are socially perceived to be the most abundant in home gardens.

5.4.4 Plantation crop combination – annual cultivates

With respect to the benefits of provisional services extracted from woody plant this type of agroforestry system was not perceived to be important. This general opinion of the farmers can simply be explained since plantation crop combinations with annual cultivates only serve the objective of increased and efficient food production for their family subsistence. The utile trees and shrubs resources which remain in these agricultural fields are occasionally collected and consumed spontaneously, rather than on a regular basis.

5.4.5 Plantation crop combination - perennial cultivates

Plantation crop combination with perennial cultivates is a comprehensive concept for agroforestry system which includes local site specific examples such as cafetales, citrico's and cachichínales (see paragraph 5.2). Although farmers don't recognize every provisional ecosystem service from the agroforestry system the available provided goods and services are frequently benefited for by the interviewed farmers. This explains its high SP% rate of 35%, which is mainly based on the highly preferred extraction of a diverse range of artisanal products (11 species), food products (14 species), construction wood (14 species) and firewood (14 species). The farmers preferred to promote 18 different species for reforestation purposes planted in plantation crop combination – perennial cultivate systems, which underlines its perceived importance within the ejido. In total, PCCPCC contain 30 utile species.

5.4.6 Trees on Pastures

TP systems receive an SP of 36,3% because every provisional ecosystem service is occasionally of beneficial use for the majority of the interviewed farmers. Especially the provision of shadow (22), construction wood (13) and firewood (18) species are generally enjoyed and extracted in Trees on Pasture systems. Also artisanal, food, fodder and medicinal goods are occasionally collected. With 46 species the silvopastoral agroforestry system contains the second highest amount of utile species. Like plantation crop combinations with perennial cultivates, also trees on pasture systems enjoy a relatively high support to be promoted as key land use system within the ejido. Six of the thirteen farmers (46%) would like to reforest bare pasture lands with 14 different tree species in silvopastoral agroforestry systems.

5.5 Species perceived as important for subsistence needs

Besides measuring the subsistence proportion (SP) of agroforestry systems, a subsistence importance value (SIV) was identified on species level. In table 14, the ten species with the highest subsistence importance value are presented. This SIV value is a result of the relative FR value, which is based on the number of times a particular species is perceived as useful for providing any provisional ecosystem service. The other relative value which determines the SIV is the UR value which indicates the number of different uses of a particular species as a percentage of the total number of uses/provisional services of all species. An "R" is put between brackets after the species scientific name and refers to its potential as reforestation species. Ligneous plants with highest subsistence value are briefly explained below.

As is visible in table 14, the ten species with the highest subsistence importance value (SIV) account for 66.3 (≈ one third) of the total perceived utility of the total number of recognized plants in the ejido. The Chinine or Pagua is with IV of 10,3 the most important tree species.

According to the interviewed farmers, the Chinine (*Persea schiedeana*) is popular due to its multifunctional character: the tree provides high quality timber for construction, avocado's for consumption, firewood and it is the preferred tree for its shadow function and ornamental value. (M. Lascurain, S. Avedaño, S. del Amo, A. Niembro, 2010)

Despite the low market value of Oranges (*Citrus sinensis*), this species is still favored for personal consumption, medicinal use and firewood, besides the fact that it is used as ornamental shadow tree and occasionally for construction (website Ecocrop, FAO).
Cedro which scores a SIV of 7,9 is one of the most precious timber species of México and widely used for the construction of ornaments, furniture and general construction.
Chaka (*Bursera simaruba*) is often mentioned as important because it is the most popular tree for fencing land parcels, besides its function to clarify terrain borders, while the leaves of the *Bursera simaruba* are used as medicinal product.

Table 14: Subsistence importance value of species identified in the interviews

Scientific name	Times perceived as useful (FR)	Number of uses (UR)	FR	UR	SIV
1 Persea schiedeana (R)	38	7	7,0	3,3	10,3
2 Citrus sinensis (R)	29	7	5,3	3,3	8,6
3 Cedrela odorata (R)	30	5	5,5	2,4	7,9
4 Bursera simaruba	27	5	5,0	2,4	7,3
5 Inga vera (R)	25	4	4,6	1,9	6,5
6 Psidium guajava	17	5	3,1	2,4	5,5
7 Gliricidia sepium	16	5	2,9	2,4	5,3
8 Oecopetalum mexicanum (R)	12	6	2,2	2,8	5,0
9 Beilschmiedia anay (R)	17	4	3,1	1,9	5,0
10 Nectranda sp. (Lauracea) (R)	19	3	3,5	1,4	4,9
Subtotal					*66,3*
Other species (74)	315	161	57,8	75,9	133,7
Total	**545**	**212**	**100**	**100**	**200**

6. RESULTS – SUB QUESTION 4

In order to answer sub question 4 "To what extent do agroforestry systems differ in relation to the number of useful introduced and native ligneous plants species?" it is first of all important to check the diversity of native and exotic plant species within the ejido and its agroforestry systems.

In chapter 4 the results of the transects indicated 71 species of which 11% (8 species) are exotic and 89% (63 species) are native. During the interviews, which are described in chapter five, 84 species were registered of which 29% (24 species) were introduced, while 71% were native ones. However, these differences between introduced and exotic species do not indicate their absolute ecological and social/subsistence importance. In order to describe a more nuanced picture of the extent of native and exotic plant species, importance values of all these species were summed up and the relative share for each different agroforestry systems in the ejido was calculated (figure 7). The third category in figure 10 represents the relative IV of species without a specific use.

Figure 10 shows that on ejido level the IV of **all native species** accounts for 82% of the total IV (300). Only ≈ 15% of the all species is exotic and ≈ 3% of the IV contains species with no recognized use.

On a systems level, the IV of native **FG systems** is with 100% the highest of all systems. 6% of the IV value is dominated by other native species without a perceived use for subsistence needs. More than a quarter (26%) of the IV in **HO systems** accounts for exotic species, ≈ 73% of the IV exists of native species and only 1% of the IV contains species without specific use. More or less the same pattern is observed in **PCCA systems**, with a slightly higher IV of ≈ 75% for native species and a little lower IV ≈ 23% which refers to exotic species. Around ≈ 2% of the IV in PCCA systems contains species which are not identified as useful. **PCCPC systems** contain with 32% of the total IV the largest share of exotic species and the lowest IV for native species ≈ 68%, and all the species found in this system are actively used by the farmers. Despite its low tree density **TP systems** account with an IV of 85% for the second highest IV of native species. The extent of exotic species in this system is with ≈ 13% relatively low. Only ≈ 2% of the species IV in TP systems is not actively used.

Figure 10: Extent of useful native and exotic species found in each agroforestry system

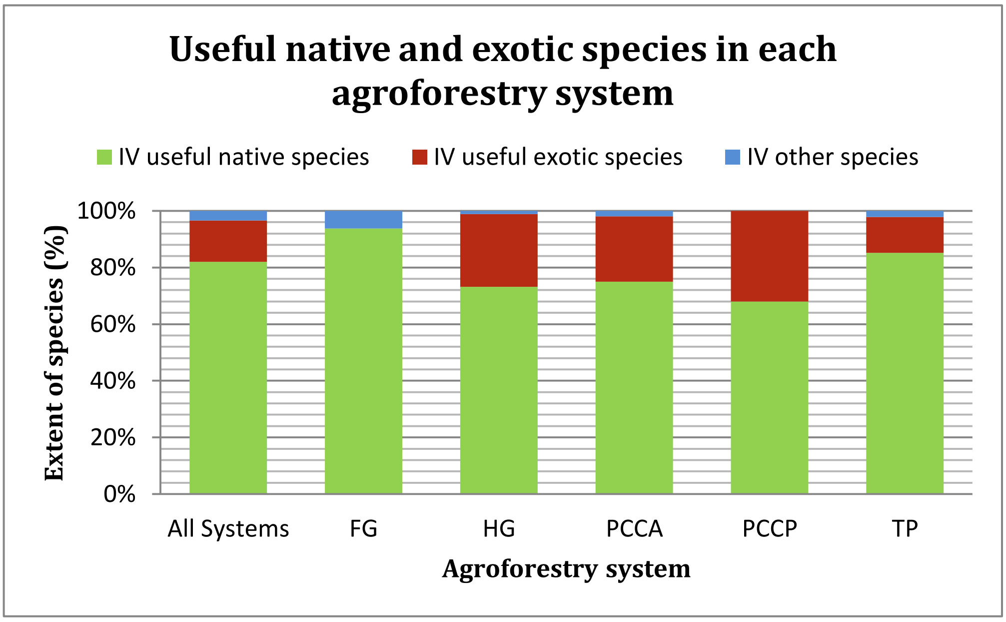
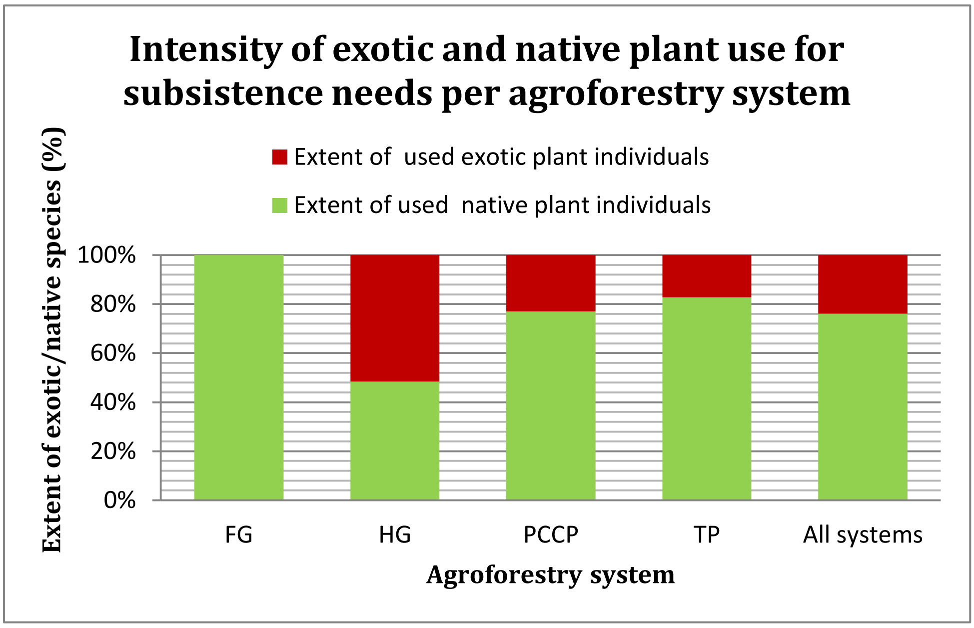


Figure 11 presents to what extent native and exotic species are actually used for subsistence needs. The results presented in figure 11 are based on interview data on plant species. The difference between the data shown in figure 10 is that during the interviews only records about utilized plants were collected, which explains the absence of the category "other species". Another difference with figure 10 is that figure 11 does not show the IV of exotic and native species in PCCA systems because none of the interviewed farmers designated these systems as useful. Figure11 shows that on ejido level 76% of the species which are used for subsistence needs are native and 24% exotic.

On system level FG systems are solely used (100%) for the extraction of native species. In contrast to HG systems where less than half - 48% - of all native species is used for securing subsistence needs while exotic species represent 52% of the total amount of used plants. The results of PCCPC systems are in line with the outcomes on ejido level: 77% of the plants extracted from these systems are native, 23% exotic. In TP systems 83% of the species used is native and 17% exotic.

Figure 11: Intensity of exotic and native plant use by the interviewed target group



7 Discussion

The chapter discusses and reflects on the applied methodology, its outcome and the limitations of the study results. Besides these critical reflections, also the strong points of the research methodology and the results obtained in a relatively short time span will be addressed.

The findings of the study address that ligneous plant diversity in all identified agroforestry systems with different practices and species compositions contribute in varying extents to the cultural identity of the interviewed target group.

First result of this study was a practically useable map was prepared in a relatively short time which clearly displayed the location and proportion of each identified agroforestry system. This map appeared to be <u>the second map of the area made since the period of agrarian reforms in the 1920's</u> (Vásquez Zarate, 2012) and may help future assessments and the planning of new land uses and/or reforestation activities. Individual landowners were registered as GPS points only as - due to time limitations - insufficient GPS points could be collected to elaborate a map which shows the borders of each specific land parcel. With such information, the map would have been even more useful for the farmers in the ejido for making decisions about e.g. landownership and/or inheritance.

For determining the answer on the second sub question, the concept "floristic plant diversity" was introduced through identifying the presence of species providing (potentially) useful ecosystem services. Ligneous plants could only be identified using rather small transects of 2*25 due to their specific growing arrangement on steep limestone hills as well as for time constraints given the size of the investigated area. As a result, only 0,03 ha of each agroforestry system was determined in detail (total 0,15 ha for all agroforestry systems). For follow-up research it is envisioned that 10 plots of 20*50 m (1000 m^2), accounting for approximately 1 ha of vegetation sampling, would definitely give a more representative view of plant diversity in the identified agroforestry systems and this would lead to a dataset on which meaningful statistical analysis could be carried out. Nevertheless, all transects which were carried out to assess the location of the agroforestry systems present and valuable data were obtained on the most commonly observed plant species. These observations seemed to correspond well with the analyzed importance values of the vegetation sampling transects and the results from the interviews, and the applied methodology thus seemed to work very well for the initial spatial assessment, the aim of this study.

Demmer and Overman (2001) stated that an index for total use of forest resources by converting values into rank scores theoretically allows the calculation of a 'total score,' (see chapter 4 and 5) for (potential) agroforestry system resource use. These scores could also be weighed against each other to evaluate the relative importance of a specific ecosystem service or species in a particular agroforestry system. However, the writers assume that: "any decision on the weighing of scores relative to each other would raise more controversy than would be gained from additional insights". For example, it became clear in this study that FG systems, which contain the highest species densities and the highest number of total identified species (40), appeared to have the lowest subsistence share (3,7%) within the total subsistence proportion (SP) of all agroforestry systems. On the other hand, TP systems which contain a lower species diversity (20) and tree density. However, TP systems are perceived as the most important agroforestry systems by having a subsistence share of 36,3%. This illustrates that a potentially important agroforestry system is influenced significantly by the social perception of farmers about tree use.

The forest resource index allows at the same time to make interesting observations about what is "observed in the agroforestry system" versus "what is perceived to be useful in the agroforestry system". For instance, species such as Coffee (*Coffea arabica*) and Capulín (*Ardisia compressa*) scored respectively an IV of 19,4 and 15,7 and appeared to be two of the most common ligneous plants in the study area. However after identifying the trees with the highest subsistence importance value (table 14 and appendix 7) *Coffea arabica* (SIV 3,5) and *Ardisia compressa* (SIV 2,0) scored much lower.

Despite the fact that socially more valuable ligneous plant species are qualified in a clear ascending order (see appendix 7) this validation remains relative. A similar pattern is also visible after presenting the results of sub question 4 which indicated the differences between exotic and native plant presence in agroforestry systems. As is shown in figure 10 that HG systems consisted for 73% about native species and for 26% exotic species. In contrast figure 11 showed that 52% of the actual used species is exotic and while 48% is native. This result is however predictable since introduced ornamental plants were taken into account, as these type of plants are considered as a provisional ecosystem service. However ornamental species are - despite their beauty - not critical for subsistence security and bias the actual importance of exotic ligneous plants species and their role in sustaining economic and subsistence needs of farmers. To overcome these limitations some recommendations on the research methodology are presented in chapter 9.

8 Conclusions

This chapter evaluates the results of the sub questions in a descending order to answer the main research question: "To what extent does the floristic diversity of agroforestry systems in ejido Los Ídolos contribute to the cultural identity and economical/subsistence security of local farmers?" in order to show whether traditional knowledge of usable plant species is still maintained and recognized as socially important in ejido Los Ídolos, Veracruz, México.

In this study different agroforestry systems and associated practices in ejido Los Ídolos were identified and mapped by using ARC GIS. The floristic diversity of (edible) ligneous plants in each identified agroforestry system was analyzed in order to validate the potential of agroforestry systems to secure the farmer's subsistence needs. From the point of view of local farmers, the actual role of agroforestry systems for securing subsistence needs was indicated trough measuring the perceived subsistence value of each system. The total share of exotic and native species in the different agroforestry systems was assessed. Finally, the extent of used exotic and native species for the subsistence need of farmers was identified.

In total 5 agroforestry systems were identified. During the transect walks and interviews a total of 110 ligneous plants species were identified. In the subsequent section, for each agroforestry systems the conclusions for the 4 sub questions are described.

8.1 Forest garden (FG)

With 5 ha, the FG system covers 2% of the investigated area, the smallest proportion in the ejido. Despite this small area, transect data showed that IF systems have the highest floristic diversity of all studied systems and are the habitat for at least 40 different species. Also the number of recorded plant individuals (239) and the corresponding basal area (49,2 m^2) are the highest in the FG. However, interview data indicated that this agroforestry system, despite its species richness and density, is actually the least recognized as potentially useful by the interviewed farmers. The cultural identity, commercial and subsistence value respectively received 6.8, 3.5 and 5.8, giving a mean value of 5.4 which may also explain its relatively low area coverage. This low perceived importance of the FG is confirmed by the low user's intensity. Only 20 times an interviewed farmer preferred to collect a certain tree/shrub product in the FG which corresponds to a total subsistence proportion (SP) of 3.7%. Regarding native plant use and protection the system is considered to be very important as all species found and used are indigenous. Potentially the system may thus be very important as 94% of the identified species are useable.

8.2 Home garden (HF)

Home gardens are situated around the homesteads of farmers and with 11 ha this system accounts for 4,7% of the investigated area. Next to FG, home gardens have the highest diversity with at least 32 identified ligneous plant species. With 96 measured individuals with a basal area of 12 m^2 the system appears less densely covered than the FG. The HG is important for the cultural identity of farmers and scores an average of 8.3 by the interviewed target group. Regarding the small size of the HG and high number of species, the system is important for subsistence needs (8.1), but not important with respect to economic needs (4.0). 18.2% of the harvested and collected goods are derived from HG, with food, medicinal products and ornamental trees as main ecosystem service. The difference between actually used exotic and native ligneous plants is small at first sight: transect data display a relative IV of 26% for exotic plants and 73% for natives. However if we look at the interview data, 52% of the derived plant products in the HG are exotic, while 48% is native. This difference is explained because of the high amount of used exotic ornamental plants.

8.3 Plantation crop combination – annual cultivates (PCCA)

The land parcels in this agroforestry system have a size of 16 ha and cover 6,8% of the total studied area. With 13 identified species, the PCCAC system has the lowest floristic diversity. The 53 recorded individuals correspond to a basal area of 11 m^2. This means that the ligneous plant species are less abundant compared to the other agroforestry systems: the collection of woody plant products is often spontaneously and incidental. This observation is confirmed by the interviews: none of the interviewed farmers visits the PCCAC for the collection of products. Despite the fact that farmers indicate to have little interest in cultivating and using trees or shrubs in the PCCAC, the agroforestry system scores a high cultural identity value (8,8) and subsistence value (8,6), because these agroforestry systems also provide staple crops which are being eaten daily by both livestock as well as the inhabitants of the community. With regard to the economic value, the PCCAC scores a 4,4 because staple crops have a low market value. The different in the extent of extracted exotic and native ligneous plants couldn't be measured since the farmers didn't use the system. Records from the transect data showed that a third (75%) of the plants are native and 25% is exotic.

8.4 Plantation crop combination – perennial cultivates (PCCPC)

PCCPC systems have a size of 49 ha and thus represent 20,6% of the ejido. Although their relatively large land coverage and a tree density of 128 measured individuals (accounting for a basal area of 16 m^2), the floristic diversity is with 18 different species relatively low in comparison to HG and FG. The absence of a wide range of species is explained by the fact that most of PCCPC systems are dominated by introduced perennial cash (tree) crops such as Coffee (Coffea arabica), Lemon (Citrus aurantifolia), Orange (Citrus sinensis) as well native ones like Cachíchin (Oecopetalum mexicanum) and Capulín (Ardisia compressa). Different local examples of PCCPC systems (Cáchichin, Coffee and Citrus plantations) scored generally a high cultural identity value of 7,7 on average. Despite these plantations are partly commercially oriented, the perceived commercial value of 6,5 is rather low as a result of the low market prices of Coffee and Oranges. The mean subsistence value is 6,9, which is not that high since harvests of collected goods are only partly sold. Taken the mean of the tree measured values, PCCPC systems score on average 7,0 for their provided cultural, economic and subsistence goods. After analyzing the proportion of extracted goods for subsistence needs it appeared that PCCPC systems account for 35% of the total amount of derived ligneous plant products, which underlines this systems importance for securing local subsistence needs. With regard to the difference between exotic and native species, the transect data indicated that 32% of the present plants is exotic and 67% is native. The actual amount of extracted exotic ligneous plants by farmers is however less with 23%, whereas 77% of the collected ecosystem goods are derived from native woody plants.

8.5 Trees on pastures (TP)

TP are the most widespread of all identified agroforestry system in ejido Los Ídolos. This system covers 143 ha and represents 60% of the total surface. The TP has the lowest tree density of all systems and only 34 individuals were identified during the transects, corresponding to a basal area 11 m^2. However, floristic diversity can be considered as relatively high with 20 species recorded in total. Especially the cultural and commercial value of TP systems is high with respectively 7,9 and 7,8, since cattle ranching became in the 80's a profitable and more secure source of income. The subsistence value is with 4,9 significantly lower, which may be explained by the low tree density in pasture fields. TP systems are at the same time favored by farmers for extraction of tree products. Based on the interviews, TP accounts for 36% of the total amount of products subtracted from this agroforestry system. Especially firewood collection (6.6%) , shadow trees for cattle (8.1%), and to lesser extent construction timber (4.6%) and food products (4.2%) are derived from TP systems. Despite low tree densities, importance values of trees measured in this system are dominated by useful native species (85% of the IV), while 13% is exotic and 2% by unusable native shrub and trees. The actual amounts of extracted exotic and native species are quiet similar: 83% are native and 17% exotic.

6.6 Final conclusion

This study revealed that the diversity in an agroforestry system corresponds well with the diversity of needed goods for specific cultural, ecological, economical and subsistence purposes.

With regard to land use planning, landowners in Los Ídolos are obligated to make a trade off: Would farmers choose agroforestry systems such as the IF, HG and PCCPC to fulfil a subsistence security? Or would they, rather prefer a more economic oriented destination of the land by choosing for a TP system, which generates more financial outcomes trough selling timber and allows for keeping livestock, despite the lower abundance of useful ligneous plants.

Pasture lands for cattle ranching is evidently the most popular among the interviewed farmers and cover the largest area due to a growing market for cattle derived products, such as meat and dairy (Lascurain 2011 and Sánchez y Gánadara 2012). However, this study clearly indicated that the maintenance of a high (indigenous) species diversity (managed in diverse agroforestry systems) serves as an important safety-net. Especially when production of (exotic) cash crops suffer low market prices or are influenced by political choices, the importance of locally sustaining traditionally managed agroforestry systems should be underlined (NOM 059ECOL 2010, SEMNARAT, 2010).

9 Recommendations

9.1 Recommendations for further research coordinated by CITRO

9.1.1 Study the floristic diversity and species composition in all vegetation strata

To create a complete overview of the subsistence potential of a particular agroforestry system, it is recommended to investigate species density, frequency and basal area in other vegetation layers such as the lower shrub and herbaceous strata. Important species such as Banana (*Musa sp.*) Vanilla (*Vanilla planifolia*), Chiles (*Capsiucm sp.)* are examples of species with an important commercial and subsistence value on (inter)national level for México (Vavilov, 1951; Fujigaka Cruz, 2004). Due to the fact that this study focused only on ligneous plants which mainly grow in the tree strata, the full economical and subsistence potential of the studied agroforestry systems was not fully taken into account. Based on own observations, especially FG and HG systems contain dense vegetation layers with high numbers of herbaceous plant species and it would be recommended to study this in more detail.

9.1.2 Measuring seasonal activities of farmers during the year

It is also recommended to measure the time allocation by farmers for specific ligneous plant species collection during the year, in order to obtain data about frequency (how often), intensity (how much) and seasonal variations (when). With such data, it could become clear when which agroforestry system and its resources are optimally able to secure cultural, economic and subsistence needs.

The livelihood analysis which is stated in the SEAGA handbook (Socio Economic and Gender Analysis Programme, FAO, 2001) summarizes various tools which help to understand the seasonal activities of different inhabitants and their relative access to natural resources. Especially the following two methods are recommended to be applied (box 3):

Box 3 Recommendable Livelihood Analysis Tools of the SEAGA handbook (FAO 2001) which could be planned in following of this study with special focus on plant resources from agroforestry systems .

Purpose Daily activity clocks: Daily Activity Clocks illustrate all the kind of activities carried out in one day (or period). They are particularly useful for looking at relative work-loads between different groups of people in the community, e.g women, men, rich, poor, young and old. Comparisons between Daily activity clocks show who works the longest hours, who concentrates on a small number of activities, and who has the most leisure time and sleep. They can also illustrate seasonal varieties.

Purpose Seasonal Calendars: Seasonal Calendars are tools that help us to explore changes in livelihood systems taking place over the period of a year. They can be useful in counteracting time biases because they are used to find out which activities and (cultural) events take place during different seasons. Calendars can be used to study many aspects such as how much work people have at different times of year or how their incomes change in different periods. It can also show the seasonanilty and availability of different natural resources

9.1.3 Identifying marketable timbers and NTFP's

Lopez Acosta emphasized in 2012 the importance of tree species of the Lauracea family because these tree species deliver high quality timber and edible fruits which could possibly improve the living situation of farmers in ejido Los Ídolos. This is one of the many examples of potentially profitable and useful natural plant products which could be exploited from the agroforestry systems in Los Ídolos. It is recommended to identify - based on the farmer perception - which ligneous plant products (especially those listed in table 14 and appendix 7) could be promoted as marketable timber or NTFP (Non Timber Forest Products), and whether or not the farmer is able to make changes in his seasonal or daily activities (see recommendation 9.1B).

In addition, it should be investigated which companies are willing to process the product for a fair price. Subsequently, a small orientating research among citizens of surrounding bigger cities such as Misantla and Xalapa is recommended to check a product for its market potential.

9.1.4 Studying physical properties and phenology of useful ligneous plants

The last and fourth recommendation is to investigate the phenology and physical properties of the trees and shrubs which are preferred for reforestation, promotion in specific agroforestry systems or as marketable product. Aspects such as flowering, fructification and period of product harvesting/collection are very useful data which can be combined with recommendation 9.1.B and 9.1.C.

9.2 RECOMMENDATIONS FOR THE INTERVIEWED FARMERS IN EJIDO LOS ÍDOLOS.

9.2.1 Identifying which agroforestry system, associated practices and corresponding ligneous plant species may be promoted in the ejido

After carrying out this research it became clear that most of the interviewed farmers in Los Ídolos are interested to promote species diverse agroforestry systems (figure 12). It is therefore recommended to organize a village meeting with all interviewed farmers and ejiditarios where the following may be discussed:

The (summarized) findings of this study and the potential use of the prepared map.
- Which agroforestry system and associated practices could be promoted?
- Which cultivates, shrubs and trees could be planted (table 14 and appendix 7).
- Where specific agroforestry systems should be promoted in the ejido, using the prepared map.

Based on the proportions of subsistence providing agroforestry systems listed in table 13, a multifunctional land use system, which involves all 5 agroforestry systems, may be implemented. When rounding up the subsistence proportion of each agroforestry system, an open pasture land of 1 hectare could be arranged in the proportions listed in table 15.

- Prepare a plan for the design and planting of these agroforestry systems using the proportions of the agroforestry system design in table 15.

Table 15: New land use planning per ha of bare pasture lands based on interview and transect data.

Agroforestry system	Proportion of land area	Local name	Trees and shrub species	Cultivates	Main objectives
Forest garden	10% 0,1 ha	Monte alto	See table 5 chapter 4	-	Biological conservation, source of medicinal plants and genetic seed material bank
Home garden	20% 0,2 ha	Huerto familiar	See table 6 chapter 4	Maize, Beans, Cassave, Banana, Coffee, Gourds	Food security, source of medicinal plants
Plantation crop combination – dominance of annual or perennial cultivates	35% 0,35 ha	Cachichínal, Citríco, Cafetal, Milpa	See table 7 and 8 chapter 4 and appendix…(trees species list preferred for reforestation)	Oranges, Limes, Coffee, Maize, Beans, Banana, Cassave, Gourds	Food security, firewood collection, commercial artisanal timber and food production
Trees on pastures	35% 0,35 ha	Potreros con maderables, frutales	See table 9 chapter 4 and appendix 7	-	Cattle ranching, food security, firewood collection, commercial artisanal timber and food production

Figure 12: Overview of landscape in the study area: agroforestry systems of ejido Los Ídolos (Photo Sjoerd Pietersen)

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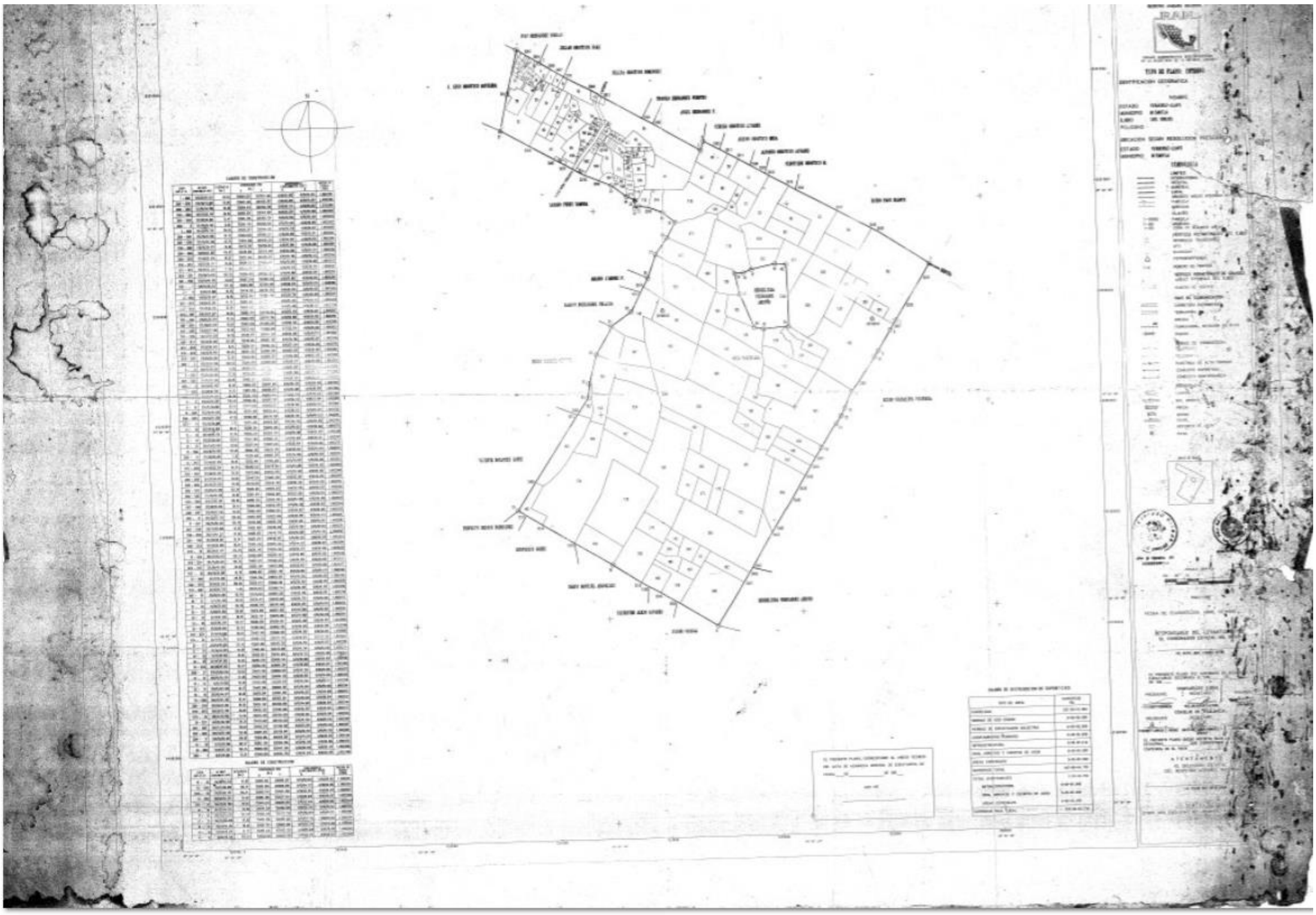
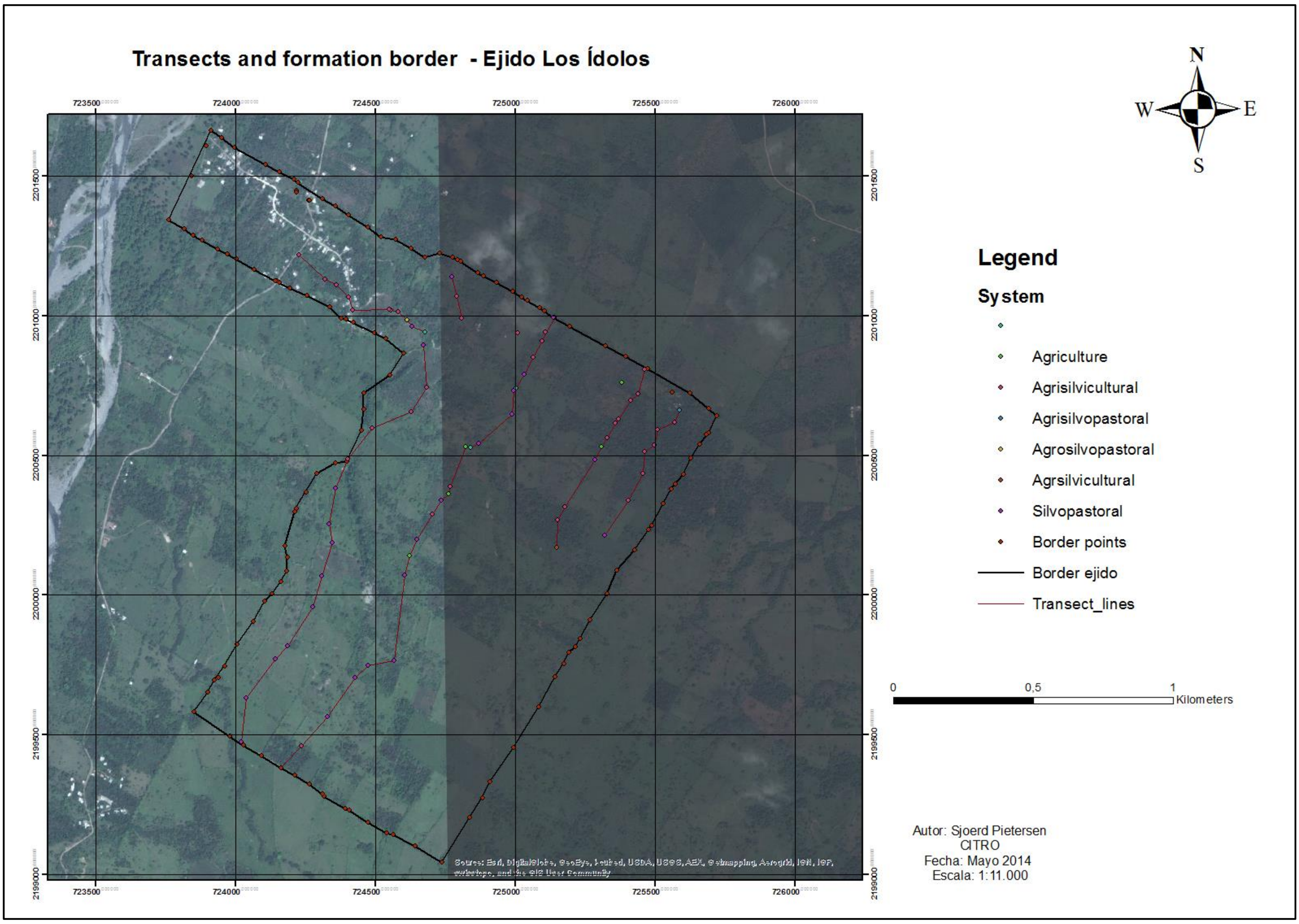
APPENDIX 1- FIRST RETRIEVED EJIDO MAP AFTER THE MEXICAN CONSTITUTION IN 1917



APPENDIX 2 - FORMATION BORDERS AND SHAPE EJIDO AND WALKED TRANSECTS



Appendix 3 – Field form for identifying agroforestry systems

Punto GPS	(Systema)(Agro)forestal	Uso de Suelo/ Arrangement C	Quien es manejando	Terreno vecinos	Arboles indicativos/dominantes

Aceso de terreno	Practicas de manejo	Major Components w = woody; h = herbaceous; f = fodder for grazing; and a = animals.	Range of management zone units (ha) (socio economic)	Market Orientation (socio economic)	**Exploitation phase of field and tree crops (Harris 1989 and Wiersum 1997) Table 2***

APPENDIX 4 – PHASING OF FIELD CROPS (HARRIS 1989) AND TREE CROPS (WIERSUM 1997) EXPLOITATION AND EXAMPLES OF INDIGENOUS AGROFORESTRY SYSTEMS IN TROPICAL REGIONS (WIERSUM 1997).

Table 2. Comparison of phases in the exploitation of field crops and tree crops

	Field crops (Harris, 1989)	Tree crops (Wiersum, 1997)
Phase 1	Procurement of wild-food by gathering/collection	Uncontrolled, open-access gathering of forest products
		Controlled gathering of wild tree products
Phase 2	Production of wild-food with small-scale clearance of vegetation and minimal tillage	Systematic collection of wild tree products with protective tending of valued tree species
		Selective cultivation of valued trees by artificial in-situ regeneration of native trees
Phase 3	Cultivation of native food plants with larger-scale land clearance and systematic tillage	Cultivation of selected native tree species in artificially established plantations
Phase 4	Cultivation of domesticated crop plants	Cultivation of domesticated tree crops in intensively managed plantations

Table 4. Examples of indigenous (agro)forestry management systems in tropical regions (after Wiersum, 1997)

Intensity of forest manipulation	Forest/tree crop management		
	Protection of forest resources	Cultivation of native trees and palms	Cultivation of genetically selected trees
Forest conservation	Sacred/temple forests Spring forests		
Modification of forest	Village forests Grazed woodlands Protected forest belts	Enriched natural forests e.g. with native fruit trees	Forest gardens with exotic tree species, e.g. jungle rubber gardens in Indonesia
		Enriched fallows, e.g. Casuarina fallows Rattan-enriched fallows Tree-crops enriched fallows: oilpalm, damar gum	
Forest transformation (= reconstructed forest)		Planted temple forest	Plantations of selected & improved cultivars – smallholder plantations – (mixed) fruit orchards
		Multistoreyed tree cropping systems, e.g. homegardens	
Scattered tree growing	Individual trees on agricultural fields	Growing of genetically modified trees on cropland	

APPENDIX 5 – QUANTITATIVE INTERVIEWS FOR TARGET GROUP

Entrevista Campesinos de Los Ídolos   Entrevista#:

Fecha: Nombre: Edad: Género: Tamaño familia:

1 ¿Cuánto tiempo tienes viviendo en Los Ídolos y desde cuándo eres propietario de una parcela?

……….

……….

2 ¿Qué tipo de uso de suelo manejas?

Acahual ( ) Tiempo de manejo: …………..

Cafetal ( ) Tiempo de manejo: …………..

Cachichínal ( ) Tiempo de manejo: …………..

Huertos de traspatio ( ) Tiempo de manejo: …………..

Milpa ( ) Tiempo de manejo: …………..

Citricos ( ) Tiempo de manejo: …………..

Portrero con arbóles ( ) Tiempo de manejo: …………..

Portrero con arbóles ( ) Tiempo de manejo: …………..

3. Cultural and Provisional value and ejiditario's identitiy with land use systems →

Servicio provisional y cultural →	**Valor cultural 1-10**	**Valor comercial 1-10**	**Valor de subsistencia 1-10**	**Total**
Uso de suelo				
Acahual				
Cafetal				
Cachichínal				
Jardines de hogares				
Limónar				
Milpa				
Naranjal				
Portrero con arbóles				
Sitio arqueológico				
TOTAL				

Explicación de los resultados:

……….....
……….....

4 .1 Importancia de los servicios y productos provisionales derivados de los sistemas agroforestales

Artesanal (A)	Especies Sub/Com	Sistema	Comestible (B)	Especies Sub/Com	Sistema	Construcción (C)	Especies Sub/Com	Sistema	Cerca viva / Sombra(D)	Especies Sub/Com	Sistema
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
6			6			6			6		
7			7			7			7		
8			8			8			8		
9			9			9			9		
10			10			10			10		

Explicación de la clasificación:

4 .2 Importancia de los servicios y productos provisionales derivados de los sistemas agroforestales

Forraje (E)	Especies Sub/Com	Sistema	Leña y/o carbón (F)	Especies Sub/Com	Sistema	Medicinal / Ritual (G)	Species Sub/Com	Sistema	Ornamental (H)	Especies Sub/Com	Sistema
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
6			6			6			6		
7			7			7			7		
8			8			8			8		
9			9			9			9		
10			10			10			10		

5 ¿Qué tipo de uso de terreno (cultivos, maderables, frutales) si quieres promover dentro del ejido Los Ídolos y por qué?

……

……

Appendix 6 – Ecological importance values of the in total 71 identified trees

Name	Density	Frequency	Ba m^2	DR	FR	BaR	IV	Exotic
Cedrela oderata	29	15	14,0	5,3	6,7	14,2	26,2	No
Coffea arabica	70	12	1,3	12,7	5,4	1,3	19,4	Yes
Pseudolmedia glabrata	41	5	9,1	7,5	2,2	9,2	18,9	No
Ardisia compressa	46	15	0,6	8,4	6,7	0,7	15,7	No
Eupatorium quadrangulare	44	6	1,3	8,0	2,7	1,3	12,0	No
Pseudolmedia oxphylaria	7	3	8,7	1,3	1,3	8,8	11,4	No
Inga vera	17	11	3,3	3,1	4,9	3,4	11,4	No
Oecopetalum mexicanum	33	4	2,8	6,0	1,8	2,9	10,7	No
Ficus aurea	2	2	8,0	0,4	0,9	8,1	9,4	No
Citrus sinensis	10	8	2,0	1,8	3,6	2,0	7,4	Yes
Urera caracasana	27	2	1,4	4,9	0,9	1,4	7,2	No
Heliocarpus appendiculatus	9	4	3,4	1,6	1,8	3,5	6,9	No
Diospyros digyna	5	4	3,9	0,9	1,8	4,0	6,7	No
Cupania glabra	13	5	1,3	2,4	2,2	1,3	5,9	No
Bernoullia flammea	14	5	0,8	2,5	2,2	0,8	5,6	No
Bunchosea chococa	14	5	0,8	2,5	2,2	0,8	5,6	No
Phoebe paniculata	1	1	4,9	0,2	0,4	4,9	5,5	No
Mangifera indica	2	2	4,0	0,4	0,9	4,0	5,3	Yes
Inga jinicuil	7	5	1,7	1,3	2,2	1,7	5,2	No
Piper amalago	13	5	0,2	2,4	2,2	0,3	4,9	No
Bursera simaruba	6	5	1,5	1,1	2,2	1,5	4,9	No
Pouteria sapota	4	2	3,1	0,7	0,9	3,2	4,8	No
Gliricidia sepium	12	4	0,5	2,2	1,8	0,5	4,5	No
Persea schiedeana	5	4	1,7	0,9	1,8	1,8	4,5	No
Citrus aurantifolia	9	4	0,9	1,6	1,8	0,9	4,3	Yes
Licaria trianda	5	3	1,6	0,9	1,3	1,6	3,8	No
Sapium lateriflorum	7	3	0,9	1,3	1,3	0,9	3,6	No
Guarea glabra	4	4	1,0	0,7	1,8	1,0	3,5	No
Swietenia macrophylla	4	3	1,4	0,7	1,3	1,4	3,5	No
Citrus reticulata	4	3	1,3	0,7	1,3	1,4	3,4	Yes
Octea sp.	3	2	1,8	0,5	0,9	1,8	3,3	No
Cestrum sp. (Solanacea)	6	4	0,3	1,1	1,8	0,3	3,2	No
Pimienta dioica	4	3	1,0	0,7	1,3	1,1	3,1	No
Sapium nitrium	2	1	1,8	0,4	0,4	1,8	2,6	No
Pisonia aculeata	3	3	0,6	0,5	1,3	0,6	2,5	No
Carica papaya	4	3	0,3	0,7	1,3	0,3	2,4	No
Croton drago	3	3	0,5	0,5	1,3	0,5	2,4	No
Jatropha curcas	5	3	0,1	0,9	1,3	0,1	2,3	No
Myconia argenta	3	3	0,1	0,5	1,3	0,1	1,9	No
Beilschmiedia anay	2	2	0,6	0,4	0,9	0,6	1,9	No
Alchornea latifolia	1	1	1,2	0,2	0,4	1,2	1,8	No

Wigandia urens	4	2	0,1	0,7	0,9	0,1	1,8	No
Psidium guajava	2	2	0,4	0,4	0,9	0,4	1,7	Yes
Hampea nutricia	3	2	0,1	0,5	0,9	0,1	1,6	No
Manihot esculenta	3	2	0,0	0,5	0,9	0,0	1,5	Yes
Conostegia xalapensis	3	2	0,0	0,5	0,9	0,0	1,5	No
Piper schiedeana	3	2	0,0	0,5	0,9	0,0	1,5	No
Tabernaemontana alba	2	2	0,1	0,4	0,9	0,1	1,4	No
Xantoxilum sp.	2	2	0,1	0,4	0,9	0,1	1,4	No
Erianthuri sp.(Solanacea)	2	2	0,1	0,4	0,9	0,1	1,4	No
Calatola costarisensis	2	2	0,1	0,4	0,9	0,1	1,3	No
Fabaceace	2	2	0,0	0,4	0,9	0,0	1,3	No
Stemandenia littoralis	1	1	0,4	0,2	0,4	0,4	1,1	No
Erytrina folkersii	3	1	0,0	0,5	0,4	0,0	1,0	No
Cecropia obtusifolia	1	1	0,3	0,2	0,4	0,3	0,9	No
Castilla elastica	1	1	0,3	0,2	0,4	0,3	0,9	No
Pleuranthodendron lindenii	1	1	0,2	0,2	0,4	0,2	0,9	No
Inga alata	2	1	0,0	0,4	0,4	0,0	0,8	No
Buddleia cordata	1	1	0,2	0,2	0,4	0,2	0,8	No
Carica vasconceliana	1	1	0,1	0,2	0,4	0,1	0,8	No
Leucaena leocucephala	1	1	0,024	0,2	0,4	0,0	0,7	No
Urera corallina	1	1	0,017	0,2	0,4	0,0	0,6	No
Prunus persica	1	1	0,014	0,2	0,4	0,0	0,6	Yes
Maluauiseus arboreus	1	1	0,012	0,2	0,4	0,0	0,6	No
Cojoba arborea	1	1	0,011	0,2	0,4	0,0	0,6	No
Dendropanax arboreus	1	1	0,009	0,2	0,4	0,0	0,6	No
Guarea spec.	1	1	0,009	0,2	0,4	0,0	0,6	No
Trophis racemosa	1	1	0,009	0,2	0,4	0,0	0,6	No
Trema micranhta	1	1	0,008	0,2	0,4	0,0	0,6	No
Trichillia irca	1	1	0,008	0,2	0,4	0,0	0,6	No
Psychotria sp. (Rubaceace)	1	1	0,003	0,2	0,4	0,0	0,6	No
Total	**550**	**223**	**98,8**	**100**	**100**	**100**	**300**	**8**

APPENDIX 7 – SUBSISTENCE IMPORTANCE VALUES OF THE BY FARMERS 84 IDENTIFIED TREES

Sceintific Name	Times percieved as useful (FR)	Number of uses (UR)	FR	UR	SIV	Exotic?	Perceived as useful for reforestation
Persea schiedeana	38	7	7,0	3,3	10,3	No	Yes
Citrus sinensis	29	7	5,3	3,3	8,6	Yes	Yes
Cedrela odorata	30	5	5,5	2,4	7,9	No	Yes
Bursera simaruba	27	5	5,0	2,4	7,3	No	No
Inga vera	25	4	4,6	1,9	6,5	No	Yes
Psidium guajava	17	5	3,1	2,4	5,5	Yes	No
Gliricidia sepium	16	5	2,9	2,4	5,3	No	No
Oecopetalum mexicanum	12	6	2,2	2,8	5,0	No	Yes
Beilschmiedia anay	17	4	3,1	1,9	5,0	No	Yes
Nectranda sp. (Lauracea)	19	3	3,5	1,4	4,9	No	Yes
Pouteria sapota	13	5	2,4	2,4	4,7	No	Yes
Platanus mexicana	15	4	2,8	1,9	4,6	No	No
Diphysa robiniodes	12	5	2,2	2,4	4,6	No	No
Swietenia macrophylla	17	3	3,1	1,4	4,5	No	Yes
Salix humboldtiana	9	5	1,7	2,4	4,0	No	Yes
Guadua aculeata	11	4	2,0	1,9	3,9	No	No
Wigandia urens	10	4	1,8	1,9	3,7	No	Yes
Coffea arabica	9	4	1,7	1,9	3,5	Yes	No
Persea americana	9	4	1,7	1,9	3,5	No	No
Inga jinicuil	8	4	1,5	1,9	3,4	No	Yes
Annona muricata	10	3	1,8	1,4	3,2	No	No
Prunus persica	10	3	1,8	1,4	3,2	Yes	No
Mangifera indica	7	4	1,3	1,9	3,2	Yes	No
Pimenta dioica	7	4	1,3	1,9	3,2	No	Yes
Diospyros digyna	9	3	1,7	1,4	3,1	No	Yes
Sapium lateriflorum	6	4	1,1	1,9	3,0	No	Yes
Litchi chinensis	8	3	1,5	1,4	2,9	Yes	Yes
Melia azedarach	5	4	0,9	1,9	2,8	Yes	No
Citrus aurantifolia	7	3	1,3	1,4	2,7	Yes	Yes
Croton draco	6	3	1,1	1,4	2,5	No	No
Pseudolmedia glabrata	5	3	0,9	1,4	2,3	No	Yes
Mammea americana	4	3	0,7	1,4	2,1	Yes	Yes

Pseudolmedia oxphylaria	4	3	0,7	1,4	2,1	No	Yes
Xantoxilum sp.	4	3	0,7	1,4	2,1	No	No
Ardisia compressa	6	2	1,1	0,9	2,0	No	No
Dendropanax arboreus	3	3	0,6	1,4	2,0	No	No
Guazuma ulmifolia	3	3	0,6	1,4	2,0	No	Yes
Annona glabra	5	2	0,9	0,9	1,9	No	No
Citrus limetta	4	2	0,7	0,9	1,7	Yes	No
Guarea glabra	4	2	0,7	0,9	1,7	No	No
Manilkara zapota	4	2	0,7	0,9	1,7	No	Yes
Pouteria campechiana	4	2	0,7	0,9	1,7	No	Yes
Terminalia cattapa	4	2	0,7	0,9	1,7	Yes	Yes
Brosimum alicastrum	3	2	0,6	0,9	1,5	No	No
Sambucus nigra	5	1	0,9	0,5	1,4	Yes	No
Astronium gravolens	2	2	0,4	0,9	1,3	No	No
Casimiroa edulis	2	2	0,4	0,9	1,3	No	No
Cecropia obtusifolia	2	2	0,4	0,9	1,3	No	No
Cojoba arborea	2	2	0,4	0,9	1,3	No	No
Erytrina folkersii	2	2	0,4	0,9	1,3	No	No
Heliocarpus appendiculatus	2	2	0,4	0,9	1,3	No	No
Inga alata	2	2	0,4	0,9	1,3	No	No
Jatropha curcas	2	2	0,4	0,9	1,3	No	Yes
Lysiloma acupulensis	2	2	0,4	0,9	1,3	No	No
Trema micrantha	2	2	0,4	0,9	1,3	No	No
Yucca sp.	2	2	0,4	0,9	1,3	No	No
Bougainvillea spectabilis	3	1	0,6	0,5	1,0	Yes	No
Cupania glabra	3	1	0,6	0,5	1,0	No	No
Delonix regia	3	1	0,6	0,5	1,0	Yes	No
Ficus sp.	3	1	0,6	0,5	1,0	Yes	No
Spondias mombin	3	1	0,6	0,5	1,0	No	No
Bocconia frutescens	2	1	0,4	0,5	0,8	No	No
Lagerstroemia indica	2	1	0,4	0,5	0,8	Yes	No
Murraya paniculata	2	1	0,4	0,5	0,8	Yes	No
Pinus spec.	2	1	0,4	0,5	0,8	Yes	No
Schefflera actinophylla	2	1	0,4	0,5	0,8	No	No

Ampelocera hottlei	1	1	0,2	0,5	0,7	No	No
Azadirachta indica	1	1	0,2	0,5	0,7	Yes	No
Buddleia cordata	1	1	0,2	0,5	0,7	No	No
Byrsonima crasiffolia	1	1	0,2	0,5	0,7	No	No
Carica papaya	1	1	0,2	0,5	0,7	No	No
Casuarina cunninghamiana	1	1	0,2	0,5	0,7	Yes	No
Cyathea divergens	1	1	0,2	0,5	0,7	No	No
Eugenia malaccensis	1	1	0,2	0,5	0,7	Yes	No
Jacaranda mimosifolia	1	1	0,2	0,5	0,7	Yes	No
Morinda citrifolia	1	1	0,2	0,5	0,7	Yes	No
Octea sp.	1	1	0,2	0,5	0,7	No	No
Phoenix roebelenii	1	1	0,2	0,5	0,7	Yes	No
Pseudobombax ellipticum	1	1	0,2	0,5	0,7	No	No
Spondias purpurea	1	1	0,2	0,5	0,7	No	No
Tabebuia rosea	1	1	0,2	0,5	0,7	No	No
Tabernaemontana alba	1	1	0,2	0,5	0,7	No	No
Urera caracasana	1	1	0,2	0,5	0,7	No	No
Verbisina sp. (Ateraceace)	1	1	0,2	0,5	0,7	No	No
TOTAL	**545**	**212**	**100**	**100**	**200**	**24**	