
# REPORT

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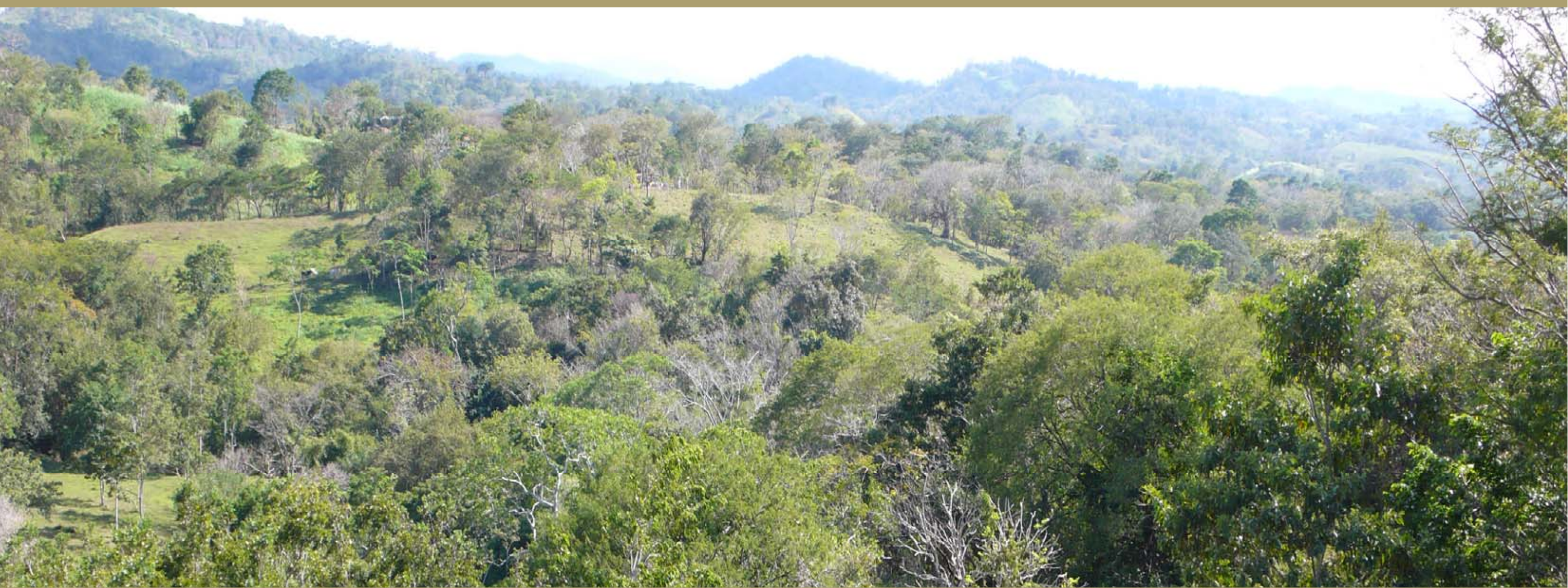

# Adoption and non-adoption of agroforestry practices II – Rivas, Nicaragua

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Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)

LIST OF CONTRIBUTORS:
Tamara Benjamín
Adriana Chacón
Isabel Gutiérrez
Muhammad Ibrahim
Chloé Marie
Ditter Mosquera
Dalia Sánchez
Nicole Sibelet
Cristóbal Villanueva

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Graciela M. Rusch

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CONTACT INFORMATION
Fabrice DeClerck
fdeclerck@catie.ac.cr

# Adoption and non-adoption of agroforestry practices II - Central America

**Fabrice DeClerck**

# Contents

# 1 Objectives

The objectives of workpackage 2 (WP2) are to:

- Identify farmers production goals and priorities
- Establish current agroforestry functions at various scales (farm, regional and across continents).
- Identifying factors that might increase adoption rates or could pose barriers for adoption across regions.
- Establish the relationship between the adoption or lack of adoption of AFS and the functional capacity of these systems to meet farmer priorities across regions.

The activities reported here refer to the tasks described below and correspond to the research in the Nicaraguan site, at Rivas.

## 1.1 Task 2.1 - Identify farmers production goals and understand their priorities

This task will develop a unified survey to be carried out in the three field sites to understand what stakeholder priorities exist. The surveys have focused in understand farmers' priorities and assessing human, cultural and financial strengths and opportunities as well as weaknesses and threats. This task has mapped farmer-producer assets (existing and needed) to analyze the role of AFS in their livelihoods, and taking gender aspects, social and age-based differences into account.

## 1.2 Task 2.2 – Survey of regional agroforestry systems and their functions at the farm, regional and global scales.

This task has conducted an inventory to show what AFS are practiced in the Rivas case study, both those systems that are commonly adopted, and those that have received less success. Interviews will reveal what functions these different AFS play in the farmer's point of view.

## 1.3 Task 2.3 – Cross regional analysis of AFS functions and Adoption

The design of AFS must take into consideration cultural, social, economical, as well as biophysical factors in order to increase adoption rates, which are highly dependent upon whether the system is feasible, superior, simple to implement, the results are observable, and it is compatible with other systems on the farm (Somarriba 2007). Adoption rates of some technologies have not been high because they require large up-front investments or because they are new to farmers. These factors were assessed in Rivas.

# 2 List of farmer priorities and limitations. What AFS functions are local management priorities?

The majority of farmers in the region have livelihoods that are dependent on extensive livestock production (Gómez et al. 2004). According to data from the Municipality, there are 350 farmers found within the region. These farmers can roughly be classified as (1) farmers who are associated with small properties; (2) farms with mixed management types associated with the agrarian reform characterized as having obtained their land in the 1980's; (3) Private landowners with mixed management types who can be classified as being the children of traditional property holders whom have managed to accumulate lands through the purchase of adjacent lands (often held by poor landowners) or through the sale of livestock and musaceas (Gómez et al. 2004). All of the farms that have livestock, have pasture comprised of jaragua (*Hyparrhenia rufa*) and to a lesser extent, cut and carry pasture comprised of Taiwan (*Pennisetum purpureum*).

## 2.1 Characterization of Silvopastoral Systems

Silvopastoral systems include the combinations of trees, pasture, and livestock. Several types of silvopastoral systems can be found in Rivas (Table 2) amongst which the most common are dispersed trees in pastures, live fences, and windbreaks (López et al. 2004, Harvey et al. 2006). These three types of silvopastoral systems do no represent new adoptions of for the Rivas area since they are considered traditional practices that have been adopted for quite some time and which are culturally ingrained. These systems however can be improved through better species selection, and management whose adoption to date has been slow.

**Table 2**. Potential uses of trees found in pastures and live fences of Rivas, Nicaragua. Data are taken from Mosquera (2010).

| Use | Number of Species |
|---|---|
| Shade for Livestock | 20 |
| Shade for pasture | 12 |
| Forages | 41 |
| Fruit consumed by livestock | 41 |
| Windbreaks | 10 |
| Protecting water sources | 27 |
| Erosion Control | 8 |
| Soil Improvement | 8 |
| Biodiversity Protection | 16 |
| Drought Resistance | 7 |
| Live Fences | 21 |
| Fuelwood | 41 |
| Medicinal | 15 |
| Timber | 35 |
| Fruit for Human Consumption | 28 |

**Dispersed trees in pastures**

Dispersed trees in pastures are most commonly originated from relictual forest cover, or are comprised of species that are capable of germinating in pasture systems and surviving to adulthood. These can also include species that are retained by the farmer during weeding in recognition of the contributions that the species makes to farm management (Pezo e Ibrahim 1998, Harvey y Haber 1999). In Rivas, trees in pastures are dominated by five species including: *Cordia alliodora, Guazuma ulmifolia, Tabebuia rosea,* *Byrsonima crassifolia y Gliricidia sepium* which can represent up to 58% of the individuals found in pastures (Harvey et al. 2010).

**Live Fences**

In Rivas, live fences can serve multiple roles including serving as sources of fuelwood, timber, fruit and fodder production in addition to the primary role of demarcating pasture boundaries and serving as support for fence lines. In some cases they can serve as the primary source of shade in the pasture. The trees that are found in live fences primarily originate from the natural sources, including adjacent live fences or farms. The five most common live fence species in the region include *Guazuma ulmifolia, Cordia dentata, Acacia collinsii, Myrospermum frutescens* y *Simarouba amara*. Live fence management, including pruning, is rather uncommon (Harvey et al. 2006).

**Windbreaks**

Windbreaks are commonly established in pastures to reduce wind speeds, provide shade for livestock, to reduce desiccation of the pasture, and to reduce wind erosion (Harvey y Haber 1999). In Rivas, these systems can also be used to protect row crops from desiccation, and it is not uncommon to see farmers rotate a parcel between pasture and crop production (bananas, plantains, and papaya). Windbreaks are not common throughout the region, but have a greater adoption rate in Rivas where high winds between December and April can have a significant impact on crop production. The area is also Nicaragua's primary source of wind energy as it is located on a narrow isthmus between two large bodies of water.

**Silvopastoral Systems as indicators of adoption**

Protein banks comprised of *Gliricidia sepium*, improved pasture with dispersed trees and multistrata live fences can be consider as non-traditional systems that are commonly adopted (Table 3). In the case o the adoption of *G. sepium* based protein banks, these were initially introduced into the area in 2001 as a pilot project in 15 farms. Since these were experimental at the time, plots were limited to 1.5 ha in each farm (López et al. 2005).

In addition, other protein banks were sown with *Erythrina poeppigiana* in live fence as an addition source of fodder for livestock. Initiatives that promoted pasture improvement with dispersed trees in pastures have had greater adoption rates in part because of their direct impacts on sustaining meat and milk production during the dry season, and extension work supported by industry.

**Table 3**: Silovpastoral sytems found in the Department of Rivas and its adoption or lack thereof.

| Silvopastoral System | Not Adopted | Adopted | Indicator |
|---|---|---|---|
| Dispersed Trees and Shrubs in Pastures | X | | Traditional method, widely adopted. |
| Simple Live Fences | X | | |
| Wind Breaks | X | | |
| Protein Banks of *Gliricidia sepium* | | X | Reduced production cost in the dry season. |
| Multistrata live fences | | X | More species for fruit, posts, timber and fuelwood production |
| Improved pastures with dispersed trees | | X | Reduction of production costs through increased production. |

Chloe Marie, a CIRAD master's student who worked in the region adds that she identified six types of farmers in the region. These groups represent distinct management capacities, strategies, and priorities (Table 4). Each of the groups was identified according to seven variables: (1) production type, (2) end point of production, (3) employment, (4) size of farm, (5) investments, (6) management practices, and (7) land use. The first two types of farmers (1 and 2) have good investment abilities. However, they are distinguished by their end goals and the types of investments they make. The first type considered their landholdings as speculative capital. The farm is not the primary source of income for the family. In contrast the second type directly depends on the income generated by the farm which is sold at the market rather than consumed on-farm. Farmer type 3 and 4 have intermediate investment capabilities. The type three farmer is more market oriented and is constantly seeking to improve his income. This type tends to make greater investment in production and labor. In contract, the type 4 farmer is self-sufficient, and less market oriented. Labor comes from the family. His primary objective is to maintain his current status and to protect his children's inheritance. The type 5 farmer does not have investment capabilities, and the size of his farm is not large enough to provide self-sufficiency for his family. He needs to work outside of the farm in order to support the family. Finally, the type 6 farmer represents the labor source of the other farmer types. He may be the farm manager for a farm with an absentee owner (type 1), or he may provide seasonal or contract work for other farmers such as weeding pastures.

## 2.2 Inventory of local AFS and the functions they play on farms from the farmer's perspective in relation to management priorities

Dalia Sanchez conducted the initial inventory of agroforestry systems of the region in 2005 (Sanchez et al. 2005) and provides a list of 146 species found in the region (Sanchez database of species found in Rivas is included in Appendix 1). The database assembled by Ditter Mosquera completes this deliverable. Mosquera inventoried four agroforestry systems, and found 109 species of trees and shrubs within these systems. Mosquera used farmer interviews to identify those species that were selected in these systems for their capacity to provide specific ecosystem services.

Chloe Marie adds that trees in the area have multiple functions within production systems of the area. They have symbolic, economic and ecological value (Appendix 2: Local Knowledge collected by Chloe Marie). Trees can be conserved or retained according to different strategies and in different production systems including: secondary forests, live fences, dispersed trees in pastures, reforested areas, protein banks, riparian forests, and home gardens.

The type of agroforestry systems implemented depends on the social standing (typology) of the farmer, as well as their capabilities. Livestock farmers value tree species that have nutritional values, whereas those farmers that have diversified production systems trees that serve as a savings (high timber value for sale on special occasions), or for on-farm use (fence posts, fuelwood, or timber for home construction). We noted that these farmers have a preference of multifunctional species, and madero negro (*Gliricidia sepium*) is a perennial favorite.

**Table 4**: Typology of farmers found in Rivas, Nicaragua

| Farmer Type | Production | Market Source | Labor | Farm Size | Investment | Technologies | Representations |
|---|---|---|---|---|---|---|---|
| Absentee, large landowner (1) | Meat cows, maybe a couple dairy. | Off-Farm Sale only | Salaried only. | > 70 ha | Low: naturalized pastures, few direct investments made. | Little mechanization | Land as capital |
| Agricultural Businessman (2) | Milk and meat cows. Commercial crops including timber. | Off-Farm Sale only | Permanent and temporal salaried staff, occasional use of family labor | >35 ha | Strong: Forage crops included, improved pastures, includes silo and chopper. | Mechanized with tractor | Land as a production system |
| Family farm, mixed production, market oriented (3) | Basic grains and some milk/meat cows. | Sale and autoconsumption | Family labor complemented with permanent and temporary salaried | 14-45 ha | Medium: small annual increased in forage banks, naturalized pasture. | Mechanized with rented tractor and plow | Land as a production and reproduction system |
| Autosufficient Family Farm (4) | Mixed: Basic grains + couple head of cattle | Autoconsumption and sale of surplus | Primarily family labor with occasional temporary salaried | 7 – 30 ha | Medium: may have a couple fields with forage banks | Mostly manual, occasional use of plow | Land as patrimony |
| Proletarized Family Farm (5) | Mixed: Basic grains + couple head of cattle | Autoconsumption and sale when necessary | Family labor, with members also working off farm | 3.5 – 10 ha | Low: Naturalized pastures. | Manual | Land as a reproduction system |
| Small Landowner (6) | Basic grains | Autoconsumption | Family with strong additional income off farm | <3.5 ha | None | Manual | Land as insurance |

## 2.3 Report on the understanding of which AFS are being adopted or not and the ecological (not suited to the environment), social (question of perception), economic (too expensive to implement or maintain), or agricultural (conflicts with production goals) drivers of adoption. Definition of why the AFS is not being adopted based on the function it is or is not providing to the farm, region, or at the global scale

**Barriers to adoption**

**Economic Barriers:** The Rivas region has highly diversified production systems with banana, sugar cane production drawing much of the labor force as well as a significant rural migration to Costa Rica (located less than 1 hour away by bus). Finding manual labor to work on some of these improvements can be limiting. High we intervention costs have also been mentioned as a limiting factor, particularly for farmers that have little access to credit. These systems are also high risk, and farmers cite that they are not willing to risk losing their farm to the back should they not be able to make payments. It is also worth mentioning that the unstable, and often low market costs of livestock also makes farmers leery of taking on interventions that they might not be able to afford.

**Social Barriers:** Many farmers restrict themselves to management techniques passed on from their parents, there is also a general lack of local organization, low scholastic levels, new lands available, and many farmer with relatively few years of experience working with livestock. Lopez et al (2005) mentions other factors such as inadequate extension and diffusion mechanisms, and the lack of technical assistance in the region. This may be somewhat exacerbated by the rather disperse locations of individual homes, lack of regional center, and low access to transportation.

**Ecological Barriers:** The soils of the region are very clayey (vertisols) and species that have been widely promoted for agroforestry systems such as mulberry (*Moringa oleifera*) is not well suited to these soils. The significant variation between the rain season and the dry season, availability of water for the dry season, and the broken topography can all complicate the adoption of more intensive technologies. The lack of access to water in particular is of vital importance, and often is the primary management priority of farmers in the region. Other interventions often take a back seat.

**Conflicts between multiple agricultural production goals:** The farmers may be more inclined to invest in silvopastoral systems if and when cattle production is the primary production activity they engage in. When the farmer has multiple production goals, and land is shared between different crops, farmers are frequently disinclined to establish agroforestry systems with perennials.

**Availability of Materials:** Some agroforestry interventions are not adopted simply because there is a lack of the needed raw materials – such as seeds or posts for live fences.

**Prioritizing functions of silvopastoral systems for local management.**

According to Mosquera's study (see below), we find ample evidence that silvopastoral systems contribute to the local and farm economy through the productions of good and services distinct from milk and meat production. These goods and services include timber, fuelwood, fence posts, and fruit for human and livestock consumption. In addition, farmers recognize the contributions of these trees to protecting water sources and providing shade for livestock. When farmers select species to include or to retain on farm, frequently take into consideration economic benefits, such as timber and fruit production, and the multifunctionality of the species such as its contribution to other goods and services. In the database assembled by Mosquera (Appendix 3) we present a summary of local knowledge in the Rivas area with the different uses identified and the number of species that provide those services.

Addition barriers were identified by Chloe Marie who suggests that the adoption, or lack thereof, of a certain agroforestry system depends on a combinations of variables mentioned above. It is possible to demonstrate the relationship between production strategies, and agroforestry strategies (Table 5).

The adoption of an agroforestry system depends on:

- The farmers global strategy and their social goals. For example, although the absentee farmer has access to funds for investment, they most likely will not invest in fodder banks that require significant initial investment, and manual labor for maintenance.
- The investment capabilities and access to production means (economic resources). For example it would be difficult to convince a small landowner to set aside land for reforestation that would reduce the land available to subsistence cropping.
- Management of production systems: Conserving isolated trees in pastures is often a balance between different production and conservation objectives. For example, trees are typically removed from fields dedicated to row crops. Only occasionally are high value trees such as Caoba, Cedro or Pachira are conserved the majority o the time. In pastures, trees may be retained based on their nutritional value when livestock production is the primary goal, or dor their commercial value for the mixed production systems.

Based on the agro-ecological knowledge of the farmers: For example, Tigüilote is valued for live fences because of its capacity to rapidly re-sprout.

# 3 Student theses WP 2

Marie, Chloe. (2010) Of trees and pastures – management of woody resources and the social dynamics in La Chocolata, Rivas Nicaragua. Committee Members: Sibolet, N., I. Gutiérrez. CIRAD Master's Thesis.

Mosquera Andrade, Ditter Horacio. (2010). Local Knowledge on the goods and services provided by trees and shrubs in cattle production systems of Rivas, Nicaragua. Committee Members: Villanueva, C., I, Gutierrez, M. Ibrahim, and C. Cerdán. CATIE Master's Thesis.

**Table 5:** Production and agroforestry strategies of farmers in Rivas, Nicaragua

| Typology | Production Strategy | Goals | Agroforestry Strategy | Species of Interest | Function of the AFS | Possibilities and Limitations |
|---|---|---|---|---|---|---|
| 1 | Availability of large land holdings; extensive systems; little investment; natural or naturalized pastures. | Speculation, maintain lands, political influence | Secondary forests as sources of forage; High Value species in the pasture | High Value Species:<br>Pochote, Caoba, Cedro | Dry season forage; Natural Capital | Little interest in investing in the farm despite capacity; primarily seeks to conserve holding; farm is not principle source of income. |
| 2 | Significant investments; intensive systems; open to adopting new technologies and seeking better forage strategies; improved pastures and forage banks. | Increase revenue<br>Increase landholdings | Protein Banks; Forage Banks; Live Fences; Riparian Forests | Forage Species:<br>Madero Negro, Guácimo, Guanacaste. | Forage for livestock | Focus on farm production; primary interest in forage species; little interest in increasing tree density in pastures for competition with pasture. |
| 3 | Mixed intensive production system; livestock is occasionally destined fro market. Seeks to invest, but little available resources; naturalized pastures and some forage banks. | Maintain or improve social status<br>Schooling of children and improving social status. | Isolated trees for farm use; savings; Homegardens; Live Fences | Species of interest to livestock:<br>Madero Negro, Guácimo, Guanacaste.<br>Trees for farm use, savings:<br>Madero Negro, Tigüilote, Arboles de frutas | Forage for livestock; Farm Supply (posts, timber, etc.) | Little investment capability for protein bank; little interest in increasing tree density in pastures for competition with pasture. |
| 4 | Mixed cropping system with livestock used for autoconsumption; little investment in production system; family labor; naturalized pastures. | Maintain social status and insure inheritance children | Reforestation; Homegardens; Riparian Forests | High Value Species:<br>Pochote, Cedro, Caoba, Roble<br>Trees for Farm Use:<br>Madero Negro, Jocote, Aceituno, | Farm Supply (posts, timber, etc.) Autoconsumo; Saving and Inheritance; Monetary value (sale of timber; fuelwood and charcoal). | Limited investment capability; primary drive for self-sufficiency; trees are source of savings and household goods; interested in silvopastoral systems for confronting dry season. |
| 5 | Mixed cropping system with livestock used for autoconsumption; time divided between seasons for salaried work and family farm work. | Maintain land and improve production for self sufficiency | Isolated trees in pasture; Homegardens; Riparian Forests<br>Live Fences | High Value Species: Pochote, Cedro, caoba, Roble<br>Fruit trees | Savings and Insurance; Autoconsumption; Farm Supply (posts, timber, etc.); Monetary value (sale of timber, fuelwood and charcoal). | No investment capacity; goal of ensuring sufficiency; not enough land holding for dedicated conservation strategies; trees can not reduce crop production. |
| 6 | Salaried work; buys and sells fuelwood for subsistence. | Obtain landholdings | Homegardens | Fruit Trees.<br>High value species for fuelwood: Madero y el Guácimo | Autoconsumption<br>Monetary value (sale of timber, fuelwood and charcoal). | No landholdings. |

# Appendix 1

Extract of data retrieved from the literature – Rivas site

| Species_code | Family | Genus | Species | Jan(FR) | Feb(FR) | Mar(FR) | Abr(FR) | May(FR) | Jun(FR) | Julio(FR) | Agosto(FR) | Sept(FR) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACACOL | FABACEAE | Acacia | collinsii | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| ACADIV | EUPHORBIACEAE | Acalypha | diversifolia | | | | 1 | 1 | 1 | | | |
| ACAFAR | FABACEAE | Acacia | farnesiana | | | | | | | | | |
| ACAPEN | FABACEAE | Acacia | pennatula | 1 | 1 | | | | | | 1 | 1 |
| ACRMEX | ARECACEAE | Acrocomia | mexicana | | | 1 | 1 | 1 | 1 | | | |
| ADETRI | EUPHORBIACEAE | Adelia | triloba | | 1 | 1 | 1 | | | | | |
| AEGPAN | VERBENACEAE | Aegiphila | panamensis | 1 | 1 | | | | | | | 1 |
| ALBADI | FABACEAE | Albizia | adinocephala | 1 | 1 | 1 | 1 | | | | | 1 |
| ALBGUA | FABACEAE | Albizia | guachapele | 1 | 1 | 1 | 1 | 1 | | | | |
| ALBNIO | FABACEAE | Albizia | niopoides | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| ALBSAM | FABACEAE | Albizia | saman | 1 | 1 | | | | | | | |
| ALCLAT | EUPHORBIACEAE | Alchornea | latifolia | | 1 | 1 | 1 | | | | | |
| ALLRAC | SAPINDACEAE | Allophylus | racemosus | | | | | 1 | 1 | | | |
| ANAEXC | ANACARDIACEAE | Anacardium | excelsum | | | 1 | 1 | 1 | 1 | 1 | | |
| ANDINE | FABACEAE | Andira | inermis | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ANNGLA | ANNONACEAE | Annona | glabra | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ANNHOL | ANNONACEAE | Annona | holosericea | | | | | | | | 1 | 1 |
| ANNMUR | ANNONACEAE | Annona | muricata | | | | | | | | | |
| ANNPUR | ANNONACEAE | Annona | purpurea | | | | | | | | 1 | 1 |
| ANNRET | ANNONACEAE | Annona | reticulata | 1 | | | | | | | | 1 |
| APETIB | TILIACEAE | Apeiba | tibourbou | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| APHSCA | ACANTHACEAE | Aphelandra | scabra | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| APOPAN | FABACEAE | Apoplanesia | paniculata | | | | | | | | 1 | 1 |
| ARDREV | MYRSINACEAE | Ardisia | revoluta | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ASTGRA | ANACARDIACEAE | Astronium | graveolens | 1 | 1 | | | | | | | |
| BACMAJ | ARECACEAE | Bactris | major | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| BALREC | ASTERACEAE | Baltimora | recta | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| BAUDIV | FABACEAE | Bauhinia | divaricata | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| BAUMON | FABACEAE | Bauhinia | monandra | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| BAUPAU | FABACEAE | Bauhinia | pauletia | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| BAUUNG | FABACEAE | Bauhinia | ungulata | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| BIXORE | BIXACEAE | Bixa | orellana | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| BRAINT | ACANTHACEAE | Bravaisia | integerrima | 1 | 1 | 1 | 1 | 1 | 1 | | | |

# Appendix 2

Extract of database on agroforestry tree uses in Rivas, Nicaragua

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | Economic | Economic | Economic | Economic | Economic | Economic | Economic | Economic | Economic | Ecological | Ecological |
| 2 | **English** | | | **Fruit** | **Medicine** | **Domestic Timber** | **Fence Posts** | **Forrage** | **Fuelwood** | **Other** | **Charcoal** | **Commercial Timber** | **Browsing** | **Live Fence** |
| 3 | **Espanol** | **Genus** | **Species** | **Frutas** | **Medicinas** | **Madera de construcción** | **Postes** | **Forraje** | **Leña** | **Otros usos: insecticidas, artesanías** | **Carbón** | **Madera comercial** | **Ramoneo** | **Cercas Vivas** |
| 4 | **Aceituno** | | | | | 1 | 1 | | | | | | | 1 |
| 5 | **Almendro** | | | | | 1 | | | | | | | | |
| 6 | **Arco** | | | | | 1 | 1 | | 1 | | | 1 | | |
| 7 | **Caoba** | | | | | 1 | | | | | | 1 | | |
| 8 | **Carao** | | | 1 | 1 | | 1 | | 1 | | | | | |
| 9 | **Carbón** | | | | | | | | 1 | | | | | |
| 10 | **Cedro** | | | | 1 | 1 | 1 | | | | | 1 | | 1 |
| 11 | **Ceiba** | | | | | | | | | | | | 1 | |
| 12 | **Cenicero** | | | | | 1 | | 1 | | | 1 | 1 | 1 | |
| 13 | **Chiquirín** | | | | | | 1 | | | | | 1 | 1 | |
| 14 | **Cortes** | | | | | 1 | 1 | | | | | | | |
| 15 | **Espavel** | | | | | | | | | | | | | |
| 16 | **Guachipilín** | | | | 1 | 1 | 1 | | 1 | | | | | |
| 17 | **Guácimo** | | | | 1 | | 1 | 1 | 1 | | 1 | | 1 | |
| 18 | **Guanacaste** | | | | | 1 | | | | | 1 | 1 | 1 | |
| 19 | **Guapinol** | | | | 1 | 1 | | | | | | 1 | | |
| 20 | **Guayacán** | | | | | | | | | 1 | | 1 | 1 | |
| 21 | **Javillo** | | | | | | | | | | | | | |
| 22 | **Jícaro** | | | 1 | 1 | | | 1 | | | | | 1 | 1 |
| 23 | **Jocote** | | | 1 | | | | | | | | | 1 | |
| 24 | **Jocote macho** | | | | | | | | | | | | | 1 |
| 25 | **Laurel** | | | | | 1 | 1 | | 1 | | | 1 | | |
| 26 | **Limón** | | | 1 | 1 | | | | | | | | | |
| 27 | **Madero** | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | |
| 28 | **Madroño** | | | | | 1 | | | 1 | | 1 | | | 1 |
| 29 | **Malinche** | | | | | 1 | | | 1 | | | | | |
| 30 | **Mango** | | | 1 | | | | | | | 1 | | 1 | |
| 31 | **Marañón** | | | 1 | | | | | | | | | | |
| 32 | **Mora** | | | | | | 1 | | 1 | | | 1 | | |
| 33 | **Muñeco** | | | | | | | | | | | | | |
| 34 | **Nancite** | | | 1 | | | | | | | | | | |
| 35 | **Naranja** | | | 1 | 1 | | | | | | | | | |
| 36 | **Neem** | | | | | | | | | 1 | | | 1 | 1 |

# Appendix 3

Extract of database on local knowledge of agroforestry tree in Rivas, Nicaragua

Appendix3(Local_Knowledge).xlsx - Microsoft Excel

**Data collected by Ditter Mosquera; Conocimiento Local Sobre Bienes y Servi**

**Contact:** dmosquera@catie.ac.cr; ditter282@yahoo.es

| | | | Services/*Servicios* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Shade/Sombra | | Nutrition | | | | | |
| Nº | **Nombre común** | **Especie** | **Sombra para el ganado** | **Sombra para el pasto** | **Forraje** | **Frutos al. Animal** | **Rompeviento** | **protec. de fuentes de agua** | **control de erosión** | **Mejoramiento de suelos** |
| Nº | **Common Name** | **Species** | **Shade for Livestock** | **Shade for Pasture** | **Forrage** | **Edible Fruit for Livestock** | **Windbreaks** | **Spring Protection** | **Erosion Control** | **Soil Improvement** |
| 1 | Acacia Amarilla | *Acasia spp.* | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 2 | Acetuno | *Simarouba glauca* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | aguacate | *Persea americana* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 4 | almendro | *Terminalia catappa* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 5 | Almendro de río | *Andira inermis* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 6 | Aromo | *Acacia farnesiana* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 7 | Brasil | *Haematoxilon brassiletto* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 8 | Cachito | *Acacia farnesiana* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 9 | Caimito | *Chrysophillum cainito* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 10 | caoba | *Swietenia humilis* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 11 | Capulin | *Muntingia calabura* | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 12 | Carao | *Cassia grandis* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 13 | carbonero | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 14 | Caucho | *Hevea brasiliensis* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 15 | Cedro | *Cedrela odorata* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 16 | ceibo | *Bombacopsis quinata* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 17 | Chaperno | *Albiziaa adinocephala* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 18 | Chilamate | *Ficus sp* | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 19 | Chipilín | *Crotalaria longirostrata* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 20 | Chiquirín | *Myrospermam frutescens* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 22 | Cóbano | *Swietenia humilis* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 23 | coco | *Cocus nucifera* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 24 | Cornizuelo | *Acacia cornigera* | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 25 | Coyol | *Acrocomia vinifera* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

Servicios y rasgos totales

**Functional Diversity:**
**An ecological framework for sustainable and adaptable agro-forestry systems in landscapes of semi-arid ecoregions.**

Based on the principles of functional ecology, FUNCiTREE addresses the provision of multiple services of silvopastoral systems (SPS) in semi-arid regions in Africa and Central America. FUNCiTREE aims to provide farmers in the regions with a portfolio of regionally suitable tree species that are capable of providing multiple services. The project integrates theories and concepts from agroforestry and ecological science and will provide a scientifically based model for the design of modernized SPS.

NINA (Norway): The leading research center in Norway on applied ecology, emphasizing the interaction between human society, natural resources and biodiversity

CATIE (Costa Rica): A regional research and education centre about agricultural sustainability, environmental protection and poverty eradication

WUR (The Netherlands): Internationally leading university in agricultural Almeria has a focus on organism responses to drought, ecological interactions, biodiversity conservation, desertification, and soil science

**CIRAD** (France): Research on agro-ecosystems for international sustainable development, environmental, and climate research

CSIC (Spain): Research at the Arid Zones Research Station,

ISRA (Senegal): Priority areas relate to agronomic, animal and forest production, and rural economy

IER (Mali): The leading research centre in Mali on agriculture and agro-ecosystems.

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