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Are we learning? : strengthening local people's capacities to facilitate the recuperation of degraded pasture lands in Central America

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"Are we learning?" Strengthening local people's capacities to facilitate the recuperation of degraded pasture lands in Central America

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A thesis submitted to the joint program for the degree of Doctor of Philosophy

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Dedication

With love to my daughter Nelli and my wife Dyanna. Sorry for all the moments that I missed; and also for the limitation of material resources. I cannot say that I will be able to pay you back but at least my promise is to try. This thesis is another of our achievements as a family. I hope we continue learning together and expect to have the opportunity to support your own personal and professional aims.

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Abstract

This thesis describes and assesses the impact of a participatory learning and experimentation process based on the livestock Farmer Field Schools (FFS) approach in Central America. Several organizations have devoted efforts to generating technological improvements for livestock production, such as the implementation of silvopastoral systems (SPS) and intensive livestock practices including silage and hay. However, despite material investments in research and extension for promoting their use, the adoption of those technologies remains limited. In consequence, the livelihoods of farmers and the environmental sustainability of cattle production are compromised, causing negative effects such as contamination of water, degradation of pastures and soils, and poverty. From 2003 to 2008 farmers, local organizations related to livestock production and CATIE formed an alliance and participated in a regional Degraded Pastures Programme (DEPAPRO). The aim of DEPAPRO was to strengthen livestock stakeholders' capacities for implementing environmentally beneficial livestock production. Mixed methods (quantitative, qualitative and participatory) were combined in three main research stages during fieldwork: (i) FFS documentation; (ii) participatory technology analysis; and (iii) FFS impact assessment. Most of results were structured using the Sustainable Livelihood Approach (SLA); and Community Capitals Framework (CCF). The main effect of DEPAPRO for the stakeholders that participated in the FFS was the strengthening of human capital. Specifically, the stakeholders displayed greater technical knowledge about some intensive and silvopastoral technologies; and methodological skills for organizing FFS. Farmers preferred practices such as improved pastures and live fences because they provided several beneficial impacts, require simple management and were more adaptable to their livelihoods. Analyses showed that further efforts for facilitating the implementation of sustainable livestock production systems are needed. The latter should include the strengthening of assets that have not usually been addressed in agroforestry and rural development projects: namely social and political capitals. Moreover, a search of strategies for creating a supportive policy environment; and mechanisms for funding FFS and the establishment of better practices are also necessary.

Keywords: Farmer field schools, documentation, participatory technology evaluation, impact assessment, adoption, silvopastoral systems, cattle, Central America.

Resumen

Esta tesis describe y evalúa el impacto de un proceso participativo de aprendizaje y experimentación, basado en el enfoque de Escuelas de Campo (FFS) para ganaderos en Centro América. Organizaciones han dedicado esfuerzos para generar mejoras tecnológicas en la producción ganadera como la implementación de sistemas silvopastoriles (SPS) y prácticas intensivas como silos y heno. Sin embargo, a pesar de la inversión material en investigación y extensión para promover su uso, la adopción de dichas tecnologías permanece limitada. Por ende, los medios de vida y la sostenibilidad ambiental de la producción ganadera son comprometidos, causando efectos negativos como la contaminación de fuentes de agua, degradación de pasturas-suelos y pobreza. De 2003 a 2008 productores, organizaciones locales vinculadas a la producción ganadera y CATIE formaron una alianza, participando en una iniciativa regional: el Programa Pasturas Degradadas (DEPAPRO). El objetivo de DEPAPRO era fortalecer las capacidades de los actores ganaderos para implementar una ganadería amigable con el ambiente. Métodos mixtos (cuantitativos, cualitativos y participativos) fueron combinados en tres fases de trabajo de campo: (i) Documentación de las FFS; (ii) análisis participativo de tecnologías; y (iii) evaluación del impacto FFS. La mayoría de los resultados fueron estructurados usando el Enfoque de Medios de Vida Sostenibles (SLA); y el Marco de Capitales de la Comunidad (CCF). El principal efecto de DEPAPRO en los actores que participaron en la FFS fue el fortalecimiento de su capital humano. Específicamente, los actores demostraron mayor conocimiento técnico sobre algunas tecnologías intensivas y silvopastoriles; y habilidades metodológicas para la organización de FFS. Los productores prefirieron prácticas como pasturas mejoradas y cercas vivas porque estas brindan múltiples impactos positivos, requieren un manejo simple y se adaptan mejor a sus medios de vida. El análisis demostró que son necesarios más esfuerzos para facilitar la implementación de sistemas de producción ganadera sostenibles. Estos pueden incluir el fortalecimiento de bienes que usualmente no son considerados en proyectos de desarrollo agroforestal o rural: los capitales social y político. Además, es necesaria la búsqueda de estrategias para un ambiente de políticas favorable; mecanismos para el financiamiento de FFS y el establecimiento de mejores prácticas.

Palabras clave: escuelas de campo, sistematización, evaluación participativa de tecnologías, evaluación de impacto, adopción, sistemas silvopastoriles, ganado, América Central.

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Abbreviations, acronyms and units

Item	Description
$\bar{x}$	Mean
$\tilde{x}$	Median
%	Percent sign
’	Minutes
º	Grades
ACIAR	Australian Centre for International Agricultural Research
AGRECOLANDES	AGRECOL ANDES Foundation
AIAEE	The Association for International Agricultural and Extension Education
AIDS	Acquired immunodeficiency syndrome
ASTI	The Advanced Science and Technology Institute
AU	Animal units
CABI	Centre For Agriculture And Biosciences International
CAFTA	Central American Free Trade Agreement
CAPRO	Cristianos Asociados para la Educación
CARE	Cooperative for Assistance and Relief Everywhere
CASREN	Crop-animal Systems Research Network
CATIE	Tropical Agricultural Research and Higher Education Center
CCF	Community Capitals Framework
CD	Compact Disc
CETA	Centro de Estudios Técnico Agropecuarios, NI
CIAT	International Center for Tropical Agriculture
CIFOR	The Center for International Forestry Research
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CIPAV	Centro para la Investigación en sistemas sostenibles de producción agropecuaria, CO
CMD	Consejo Municipal de Desarrollo, GT
COLCAPRO	Colegio de Profesionales en Ciencias Agrícolas de Honduras
CONABIO	Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, MX
CONALFA	National Committee of Literacy, GT
CRELS	Milk Colection Centers, HN
CUDEP-USAC	Centro Universitario de Petén, GT
CURN-UNAH	Centro universitario Regional del Norte- Universidad Nacional Autónoma de Honduras
DANIDA	Danish International Development Assistance
DEPAPRO	Multi-stakeholder Participatory Development of Sustainable Land Use Alternatives for Degraded Pasture Lands in Central America Project
DF	Dead fences
DFID	Department For International Development, UK
DICTA	Dirección de Ciencia y Tecnología Agropecuaria, HN
DP	Degraded pastures
DPA-UNAG	Departamento de Producción animal-Universidad Nacional de Agricultura, HN

EAP-Zamorano	Pan-American Agricultural School, HN
Ed	Editor
Eds	Editors
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária
EPTD	Environment and Production Technology Division
ESNACIFOR	Escuela Nacional de Ciencias Forestales, HN
EUNED	Editorial Universidad Estatal a Distancia, CR
FACA-UNA	Facultad de Ciencia Animal-Universidad Nacional Agraria, NI
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO Statistics Division
FA-USAC	Facultad de Agronomía-Universidad de San Carlos de Guatemala
FCE-UNAN-MANAGUA	Facultad de Ciencias Económicas-Universidad Nacional Autónoma de Nicaragua
FEDECOAG	Federación de Cooperativas Agrícolas de Guatemala
FFM	Farmer First Model
FFS	Farmer Field Schools
FGD	Focus Groups Discussions
FIDA (IFAD)	International Fund for Agricultural Development
FIDAMERICA	FIDA's network
FITTACORI	Fundación para el Fomento y Promoción de la Investigación y Transferencia de Tecnología Agropecuaria en Costa Rica
FMVZ-USAC	Facultad de Medicina Veterinaria y Zootecnia-Universidad de San Carlos de Guatemala
FONDEAGRO	Fondo de Desarrollo Agropecuario, NI
FUBNAPIB	Fundación Parque Nacional Pico Bonito, HN
FUNDEBASE	Fundación para el Desarrollo y Fortalecimiento de las Organizaciones de Base, GT
FYDEP	Empresa de Fomento y Desarrollo de Petén, GT
GIS	Geographic Information System
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
Ha	Hectares
HIV	Human immunodeficiency virus
ICTA	Instituto de Ciencia y Tecnología Agrícolas, GT
IDB	Inter-American Development Bank
IDR	Instituto de Desarrollo Rural, NI
IDRC	International Development Research Centre
IFPRI	International Food Policy Research Institute
IGER	Instituto Guatemalteco de Educación Radiofónica
IICA	Inter-American Institute for Cooperation on Agriculture
IIED	International Institute for Environment and Development
IITA	International Institute of Tropical Agriculture
ILEIA	Centre for Learning on Sustainable Agriculture
ILRI	International Livestock Research Institute
IMF	International Monetary Fund
INE	Instituto Nacional de Estadística, GT
INE	Instituto Nacional de Estadística, HN
INEC	Instituto Nacional de Estadísticas y Censos, CR
INETER	Instituto Nicaragüense de Estudios Territoriales

INFO@GRO	Red Social de Conocimientos al Servicio de la Agricultura Cubana
INFOP	Instituto Nacional de Formación Profesional, HN
INI	Informal interviewing
INIAP	Instituto Nacional Autónomo de Investigaciones Agropecuarias, EC
INIFOM	Instituto Nicaragüense de Fomento Municipal
INSIVUMEH	Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología, GT
INTA	Instituto Nicaragüense de Tecnología Agropecuaria
INTA	Instituto Nacional de Tecnología Agropecuaria, AR
ITDG	Practical Action Publishing
KARI	Kenya Agricultural Research Institute
Kg	Kilograms
kgDM	Dry matter kilograms
km^2	Square kilometres
KVL	The Royal Veterinary and Agricultural University
L	Litres
LEAD	Livestock, Environment and Development
LF	Live fences
M&E	Monitoring and Evaluation
MAG	Ministerio de Agricultura y Ganadería, CR
MAGA	Ministerio de Agricultura, Ganadería y Alimentación, GT
MANMUNISURP	Mancomunidad de Municipalidades del Sur de Petén
Masl	Meters above sea level
MCTR	Medium control farmers
MFFS	Medium FFS farmers
MINAET	Ministerio del Ambiente, Energía y Telecomunicaciones
NAFTA	North American Free Trade Agreement
NGO	Non-Governmental Organization
NITLAPAN	Instituto de Investigación Aplicada y Promoción del Desarrollo Local, NI
NORAD	Norwegian Agency for Development Cooperation
ODESAR	Organización para el Desarrollo Económico y Social para el Área Urbana y Rural, NI
ODI	Overseas Development Institute
OECD	Organisation for economic Co-operation and Development
PACTA	Programa de Acceso a la Tierra, HN
PD	Pasture Degradation
PDS	Proyecto de Desarrollo Sostenible del Petén
PES	Payment for Environmental Services (PSA in Spanish)
PETENLAC	Livestock cooperative from El Chal Guatemala
pH	Potentiometric hydrogen ion concentration
PLA	Participatory Learning and Action
PR	Participatory Research
PRA	Participatory Rural Appraisal
PREVAL	Monitoring and Evaluation for Rural Development
PROMIPAC	Programa de Manejo Integrado de Plagas de América Central
PROPETÉN	ProPetén Foundation

R&D	Research & Development
RAAKS	Rapid Appraisal of Agricultural Knowledge Systems
RD	Rural Development
SAG	Secretaría de Agricultura y Ganadería, HN
SAGE	Publishers
SAR	Sección de Agricultura de las Municipalidades, GT
SCTR	Small control farmers
SE	Standard error
SFFS	Small FFS farmers
SIM	Sistema de Información de Mercados, GT
SLA	Sustainable Livelihoods Approach
SO	Systematic observation
SPS	Silvopastoral Systems
SPSS	Statistical Package for the Social Sciences
SSI	Semi-structured interviews
STI	Structured interviews
T&V	Training & Visit Extension
TECHNOSERVE	NGO, NI
TOT	Transfer of Technology
UCA	Universidad Centroamericana, NI
UNAM	Universidad Nacional Autónoma de México
UNEPET	Consejo Unido de Las Áreas Protegidas del Petén, GT
UNI	Unstructured interviews
UPWARD	Users' Perspectives with Agricultural Research and Development
USD	United States of America Dollars
UTJ-PROTIERRA	Unidad Técnico Jurídica de la Comisión Institucional para el Desarrollo y Fortalecimiento de la Propiedad de la Tierra, GT
UTM	Unidad Técnica Municipal, GT
VC	Vulnerability context

Chapter 1. General introduction

1.1. The research issue

In Central America one of the most important land use changes observed during the last forty years has been the reduction of forest area to implement agriculture and livestock production (Buschbacher 1986, Pezo and Ibrahim 2002, Steinfeld 2002). In 2003, arable land was one of the largest land uses in this region comprising 42.1% of the total land area[1], of which 11.6% was temporary crops, 3.8% with permanent crops, and 26.7% permanent pastures and meadows (FAO 2010). In 2005 the forest cover was estimated to be around 43.9%, and other wooded land uses covered 9.9%[2] (FAO 2006). Pastures in Central America are used as one of the main feed sources for feeding cattle. Thus, deforestation and pasture expansion have been linked to the development of the cattle livestock industry in this region, as well as in the rest of the Latin American tropics (Kamaljit and Dayanandan 1997).

Most of the cattle production systems in the region are under extensive grazing management (Haan *et al.* 1997). Farmers commonly use natural pastures[3] because they require minimum labour and external inputs, however, their productivity expressed in the quantity of meat or milk per unit area is low as well (Sánchez and Gaviria 2002, Steinfeld 2002). For example, in La Fortuna de San Carlos, Costa Rica dual-purpose (milk and beef) extensive livestock systems were characterized for having bigger farms and more total milk production than systems specialized in milk, and mixed systems (crops and milk) (Souza *et al.* 2000). However, milk and mixed systems had better production per unit of land (Table 1.1). Livestock production systems therefore face several reinforcing constraints including poor economic returns, increasingly negative environmental impacts; and continuing degradation of pastures and soils that eventually result to less profitable and non-sustainable production systems (Buschbacher 1986).

It has been estimated that more than 40% of Central America's pastures are degraded (Agostini *et al.* 2003). A degraded pasture can be defined as deterioration in the pasture condition or quality, associated with negative ecological and environmental changes

[1] Excluding area under inland water bodies the total land area of Central America is 510,740 km^2.
[2] Land use data for the same year were not found.
[3] Natural pastures can be defined whether as native pastures of a certain geographic region or ecosystem; or pastures that were introduced long time ago to a given area and that now are considered as naturalized.

(Szott *et al.* 2000). The causes of degradation in natural or human established pastures have been discussed in the literature. Factors identified include the use of landscapes or soils that are inappropriate for cattle and sensitive to overstocking, inadequate establishment and management of pastures and grazing systems, pest and disease damage, soil erosion, soil chemical and physical characteristics decline, and inefficient nutrient recycling (Buschbacher 1986, Hecht 1993, Boddey *et al.* 2004, Alves *et al.* 2005, Dias-Filho 2005, Zhou *et al.* 2005, Feigl *et al.* 2006, Gómez *et al.* 2006).

Table 1.1. Land use and milk yield from livestock farms in La Fortuna, Costa Rica.

Productive system	Farm area (ha)	Pasture (ha)	Pasture with trees (%)	Total milk production (kg/farm/day)	Milk production (kg/ha^{-1}/day)
Dairy	50[b]	46[b]	27[b]	651[b]	14.2[b]
Mixed	44[b]	35[b]	16[b]	442[b]	12.6[b]
Dual-purpose	327[a]	273[a]	74[a]	1188[a]	4.3[a]

Source: (Souza *et al.* 2000). Different letters indicate statistically significant differences ($P<0.05$). N=35.

Additionally, livestock production systems on degraded pastures are more likely to produce significant negative environmental impacts such as soil erosion, decreased soil fertility and water infiltration, loss of organic matter, the reduction of biodiversity and global warming. (Haan *et al.* 1997, Müller *et al.* 2001, Boddey *et al.* 2004). There are also important socio-economic impacts. Degraded pastures can foster declining grass and animal productivity by reducing either profits or livelihood assets, whilst increasing production costs through greater dependence on feed sources that are not produced on the farm (Holmann *et al.* 2004c, Oliveira *et al.* 2004, Betancourt 2006), all of which can affect local farming economies (Bouman *et al.* 1999). For example, Betancourt (2006) working in El Chal, Petén, Guatemala, estimated that a reduction in the net income/cattle head/year of US$158 dollars for dairy systems and US$144 dollars in beef systems was incurred as consequence of degraded pastures.

The environmental impacts of livestock production can be alleviated and even reversed (Abarca 1997). In trying to reduce negative effects of degraded pastures, the design and implementation of alternative production systems, such as silvopastoral systems (SPS) has been suggested (Pezo *et al.* 1999). In SPS, trees are used in addition to the livestock traditional components i.e. grasses and cattle (Pezo and Ibrahim 2002). The stream of benefits from trees includes the diversification of farm products, the provision of services and the improvement of soil fertility. Trees produce multiple goods like fruits, fodder, wood, timber, and poles. These can be used for increasing the income sources of rural households due to commercialization of surpluses, or produce assets for self-consumption that contribute to food security and the improvement of other assets or capitals (DFID 1999, Flora *et al.* 2004). Moreover, trees provide shade to the cattle which help to reduce stress induced by high temperatures (Souza 2002). The soil productivity can be improved by planting or selecting leguminous tree species that are able to fix atmospheric nitrogen (Torres 1983, Franke 1999, Franke and Furtado 2001).

Besides, in regional terms, increased numbers of trees within a landscape can help diminish important environmental problems by providing niches for biodiversity and by capturing and storing carbon dioxide (Harvey 2003, Ibrahim and Mora-Delgado 2003, Harvey *et al.* 2004, Soto-Pinto *et al.* 2010). However, a supportive policy and institutional context is needed to help farmers move towards implementing or increasing such alternative production systems. Included here are measures such as adequate governmental policies, appropriate environmental education, practical technical support, economic incentives and even assistance for commercializing their products. Therefore enhancing their capacity of providing such environmental services and the sustainability of their production systems is crucial.

Implementing SPS is not always an easy task (Dagang and Nair 2003). Like any other agricultural technology, farmers normally encounter constraints and barriers that may not have been appreciated by technology developers and promoters. In the past many agricultural technologies were generated and introduced using top-down schemes of technology transfer, often ignoring or overlooking farmer's needs (Probst *et al.* 2005). Without an appreciation of the farmers own situation, many of these technologies were not adopted and had little impact on the field, especially for poor farmers located in remote areas (Keulen 2007). There has therefore been a growing understanding that different approaches of technology development and transfer are needed to enhance SPS adoption (Denning 2001, Dagang and Nair 2003) and help make farming systems more sustainable (Abarca 1997).

Agricultural and agroforestry development projects have traditionally oriented their efforts to strengthen and investigating material assets such as crops management. This has hindered the effect of exogenous factors including important historical shocks such as the civil war in the case of Central America. Civil war had drastic effects in the human assets of Central American population, especially in Guatemala where social capital effects have been reported in post-conflict areas. For example, a study in urban communities from Guatemala identified the fear produced by the violence as a cause of lack of trust in the authorities, mistrust and lack of solidarity (Moser and McIlwaine 2001). Moreover, effects to the human and social capitals have been also reported in post-conflict rural areas of Guatemala (Nesheim *et al.* 2006, Taylor 2007, Chamarbagwala and Morán 2011). On the other hand, livestock production areas in Central America are located in former agricultural frontier areas (Szott *et al.* 2000, Yamamoto *et al.* 2007), which face issues such as inequalities in land distribution, insecurity, lack of access to services such as education or health. All those factors create a social complexity that is usually not considered when explaining the results of rural development programmes.

In response to the situation described, a multidisciplinary team from CATIE (Tropical Agricultural Research and Higher Education Centre) and other local institutions developed and implemented a project called "The multi-stakeholder participatory development of sustainable land use alternatives for degraded pasture lands in Central America Project" (hereafter referred as DEPAPRO). DEPAPRO was established in 2003 and dealt with the problem of degraded pasture lands, taking into consideration the several dimensions of its causes and impacts (CATIE 2002, 2003a). DEPAPRO tried to encourage producers to shift from unsustainable practices that led to degraded pastures to more sustainable sound land uses including SPS implementation in livestock farms in Guatemala, Honduras and Nicaragua. One of the distinctive characteristics of DEPAPRO is that it used a participatory approach based on Farmer Field Schools (FFS), promoting the participation of the farmers into the process of planning and implementation of training activities. Given that DEPAPRO encouraged this approach, the question is how FFS impacted on different stakeholders. This research evaluated, using qualitative and quantitative research methods, how the participatory learning and experimentation approach based on FFS influenced the development and strengthening of local capacities for developing and using a more environmentally sound livestock productions systems in Central America.

1.2. Objectives of the study

There are general and specific objectives to this thesis as follows.

1.2.1. General objective

- To describe and evaluate the impact of the Farmer Field Schools approach encouraged by DEPAPRO in strengthening capacities for managing environmentally friendly livestock production in Central America.

1.2.2. Specific objectives

i. To describe the DEPAPRO process and the opinion of the stakeholders about it.

ii. To investigate farmers' opinions and preferences about the silvopastoral system and intensive technologies tested.

iii. To assess the impact of DEPAPRO intervention on farmers' human assets.

1.3. Research questions

1.3.1. General research question

The broader research question being asked by this thesis is:

- Did the Farmer Field School approach strengthen the local capacities for developing and using a more environmentally friendly livestock production in Central America?

1.3.2. The specific research questions

This generates a number of specific research questions that are associated with each of the objectives as follows:

1.3.2.1. Specific objective I

- What was the institutional context influencing the livestock activity in the pilot areas where DEPAPRO worked?

- What is the opinion of the different stakeholders about DEPAPRO?

- What were the immediate effects of the activities promoted by DEPAPRO?

1.3.2.2. Specific objective II

- What were the technologies tested in Central Petén Guatemala's pilot?

- What were the farmers' opinions and preference about the technologies being tested?

- What opinions influenced the preference for certain technologies rather than others?

- What factors influenced the decision to test *Leucaena leucocephala* plots?

1.3.2.3. Specific objective III

- What external factors influenced the way cattle production is done and the FFS approach in Central Petén, Guatemala?

- What were the effects of the participatory learning and experimentation intervention on human assets of farmers?

- What effects on human capital affected to other human and material assets?

Chapter 2. Conceptual framework

2.1. Abstract

Some silvopastoral systems (SPS) such as live fences and scattered trees are common in most of the Central American livestock landscapes. In contrast, and despite the efforts of several research and development (R&D) projects and programs, other SPS such as fodder banks and trees/pastures in alleys are not being widely practiced by farmers. This chapter comprises a literature review of the main concepts that have a direct bearing on silvopastoral technology practice with the aim to answer the following questions: (1) is the current practice of SPS reflective of inappropriate strategies of the dominant model for generating and transferring technologies in Central America? (2) Is it a consequence of disadvantages associated to features of the SPS technologies? The sustainable livelihoods approach (SLA) and the community capitals frameworks (CCF) were used as a platform in the analysis described in this thesis. Previous research suggests that the current paradigm of agricultural policies, extension and R&D in Central America have influenced the diffusion of SPS practices. SPS simple practices tested and adapted by farmers or by events from nature are more used than practices originated by R&D.

2.2. Introduction

The main external factors linked to the concepts and ideologies of rural development (RD) are relevant for explaining the current practice of silvopastoral systems (SPS) in Central America. The top-down rural development (RD) ideology, the transfer of technology model (TOT), and the diffusion of innovations theory have been the predominant paradigm used in the world and in Central America (Rogers 1995, Sánchez de Puerta 2004, Staver 2005). All those use a vertical approach, where farmers are considered as clients or receptors of technology packages and not as genuine innovators. Thus, agroforestry, SPS, and RD projects have been frequently biased towards the imposition of technical knowledge, creating a lack of communication and understanding between farmers and development professionals that limited SPS practice. Furthermore, other external processes and elements of the vulnerability context such as inadequate policies, markets, and economic trends have played major roles in the SPS limited practice, and have aggravated environmental degradation as well.

Conversely, bottom-up RD ideology and farmers participatory approaches encourage farmers involvement, learning, and the use of local knowledge in all the stages of the R&D process (Biggs 1990, Douthwaite *et al.* 2009). This has shown better results to farmers coping with limited assets (Ashby *et al.* 2000). Special attention in this review was given to Farmer Field Schools (FFS), because it was the participatory approach used by the project being studied. Vast information about the application of FFS approaches in integrated pest and crop management was found. However, there were fewer reports on its use with livestock systems in Central America, suggesting that documenting such experiences is necessary.

The main local factors influencing the practice of SPS are related to the features of pastures degradation (PD) problem, alternative solutions to PD, and the lack of farmers' assets. Current pasture degradation in Central America implies a reduction of palatable forage species and eventually soil degradation processes. All these result in a decline in milk or beef, particularly because farmers make a limited use of external inputs, and other alternatives to intensify production including SPS. The most frequently employed SPS in Central America are relatively simple practices originated from farmers' innovations, natural ecosystems and their interaction. SPS options generated by research centres are rarely implemented by farmers. The lack of financial assets is probably the most investigated influencing factor; however it is not the only one, and even when there is a lack of research addressing this matter in Central America several issues related to the other factors were identified in this review.

2.3. Development and rural development

The word "development" is used with different meanings and in different contexts, thus, it is difficult to have a single general definition (Singh 1999). According to Esteva (1993) the concept is political and originated in 1949, after a declaration of the former president of United States of America Harry S. Truman, who suggested the existence of "underdeveloped areas" and people with necessity of being "developed". However, such concept has been considered an invention, as people were never asked if they perceived the necessity of being developed (Esteva 1993). The definition of development has changed and with it the policies and actions encouraged to achieve its goals. First, it was considered as interventions that were intended to change the livelihoods of people in

Asia, Africa, and Latin America towards more western, industrialized, and urban practices (Escobar 1997). Later, it was suggested that development was an external imposition and that the participation of the people was necessary to achieve changes (Escobar 1997).

The history of development started around the 1950s when the first assistance agencies and programs were established for political interests. The United Nations declared the 1960s as the development decade; and the 1970s became the second development decade (Burkey 1993). Since then, several approaches and schools of thinking on how to achieve development or to explain the causes of underdevelopment were theorized and tried to be applied. Among those theories Burkey (1993) described the following: modernization; dependency or underdevelopment; global interdependence; basic needs; eco-development; and people first.

According to Jazairy *et al.* (1992) development approaches can be summarized into two main categories: (1) the dominant and old development approach, which states that growth of the overall economy leads to wealth; and (2) a paradigm centered on poverty alleviation, which proposes a participatory and environmentally sustainable growth based on poverty alleviation; and an integration of the poor into the process of growth (participation). In the latter approach poor people are not seen as passive beneficiaries, instead, they are considered partners in the growth process, interventions are supposed to consider an equitable allocation of resources and the design of poverty-alleviating policies and institutions (Jazairy *et al.* 1992).

RD was defined by Chambers (1996a) as: "a strategy to enable a specific group of people, i.e., poor rural women and men, to gain for themselves and their children more of what they want and need. It involves helping the poorest among those who seek a livelihood in rural areas to demand and control more of the benefits of development. The group includes small-scale farmers, tenants, and the landless". RD was focused on helping poor people in rural areas, because the majority of rural people and especially small tenants have limited assets (Hazell *et al.* 2007). Rural areas were identified by three main features: (1) a relative abundance of land which is usually cheaper than in urban areas; (2) long distances and adverse topographic and road conditions between rural settlements and cities; and (3) the poverty of the inhabitants (Wiggins and Proctor

2001). However, economic development policies in Latin America and other regions have changed the distribution of population, favouring migration of rural people to periurban and urban areas (Madaleno and Gurovich 2004). Such spaces are now referred to as the rural-urban interface and are important for RD initiatives, because their main productive activities are agricultural and may contribute to food security (Madaleno and Gurovich 2004, Leal 2008).

The RD implementation is usually carried out through the implementation of one or more of the following initiatives: strategies, policies, programs and projects (Moris 1981). Initiatives have to be adapted to the dynamic reality of rural people and their environment. Thus, through RD history several approaches have been suggested such as: community development, integrated rural development, agricultural development, among others (Ashley and Maxwell 2001). Relatively recent approaches for rural development like "reaching the rural poor" proposed by the World Bank (Csaki 2001), are trying to consider and foster a diversified rural growth, an improvement in social well-being, a better management of the risks, a reduction of the vulnerability factors and processes affecting rural people's livelihoods and the enhancement of sustainable management in natural resources. This should imply acknowledging the different realities of the rural people and considering non-traditional rural activities as means for the creation of livelihoods in less remote rural areas (Ellis and Biggs 2001, Wiggins and Proctor 2001).

2.3.1. Rural development ideologies

Development ideologies imply different concepts and actions such as the type of planning, approaches to action, organizational methodologies and financing (Moris 1981). Actors participating in the development initiatives are different and their organization also differs. These characteristics might influence both the overall operation of the intervention and the outputs of its application. Four main types of ideologies or approaches commonly used in rural development projects are: (a) the top-down or bureaucratic approach; (b) the outside-in or commercial approach; (c) the bottom-up or participatory approach; and (d) the inside-out or mobilization approach (Singh 1999). The characteristics of those four types are summarized in Table 2.1. Some years ago the ideologies used to be considered as different and irreconcilable approaches to achieve rural development. However, this has started to change and now there are guidelines promoting to take the best of each ideology for success, based on the specific context for each situation (Heck 2003).

Table 2.1. Characteristics of the main rural development approaches.

Characteristic	Top-down	Outside-in	Bottom-up	Inside-out
Aim	Penetration	Commercialization	Participation	Mobilization
Agency	Bureaucracy	Companies	Community	Party
Level of interest	Nation	Market demand	Village	Class
Goal definition	Material well-being	Profit and client satisfaction	Social well-being	Group consciousness
Rationale	Economic development	Microeconomics and innovation theory	Community development	Underdevelopment theory
Starting point	Planning	Market survey	Need identification	Class analysis
Approach	Funding request to the center	Organize company in district	Organize groups in locality	Organize cells in localities
Personnel	Outside experts, some locals	Local entrepreneurs, some help	Local leaders, some help	Local party cadres and sympathizers
Role of outsiders	Formulate request	Start-up loan	Serve as catalyst	Safeguard purity
Major aim	Implement programs	Offer services	Solve problems	Raise consciousness
Financing	Credit from center, start-up grant	Self-financing from fees	Self-help raising of local funds	Party funds and brotherly regimes
Project emphasis	Infrastructure & production projects	Equipment, new crops and inputs	Social service facilities	Production co-ops and group organization
Evaluation criteria	Targets achieved	Innovations spread	Problems solved	Regime changed
Targeted capitals	Built, natural and financial	Built, natural and financial	Human, social	Social and political
Time horizon	Short-medium term 2-5 years	Short term 1-3 years	Medium-long term 3-10 years	Long term: 5-50 years

Source: (Moris 1981).

Most of the development projects and programs in developing countries have been based on the top-down ideology, characterized by policy formulation made by bureaucrats, centralized decision-making, one-way communication, authoritarian leadership and undemocratic and hierarchical organizational structures (Raintree 1983, Burkey 1993). Conversely, the outside-in ideology is also known as “the commercialization approach”. This is based on innovation theory and microeconomics, which consider farmers to be rational, but their decisions affected by market imperfections (Moris 1981).

The bottom-up ideology is the opposite of the top-down approach, and is also known as the grassroots approach. This ideology emphasises that people will only be participating if there are good reasons for it. Thus the role of outsiders is to facilitate and work with what is already constructed, rather than impose solutions (Moris 1981). Finally, the inside-out ideology also known as the mobilization approach is related to the Marxist theory and hence antagonist from the outside-in ideology. It argues that small farmers who compete with others in a free market economy will deteriorate over time (Moris 1981).

2.3.2. Technology diffusion or local innovation?

Rural activities are now more diversified than in the past and frequently include non-agricultural income sources, including remittances from other countries. Nevertheless, rural livelihoods are still strongly linked to farming activities (Ashley and Maxwell 2001). Hence, farming technologies still play an important role in alleviating poverty and fostering agricultural development (Tripp 2001). Experiences showed that several characteristics have influenced the success of research and development programmes, including those focused in agroforestry or SPS. Among them, the theoretical basis of generation of innovations is a key issue.

Three main models for the generation of agricultural technology innovations are distinguished in the literature (Prins 2005). The first is when innovation is generated by farmers, there is no participation of external stakeholders, or it was minimal and farmers led the innovation generation and use (Prins 2005). Since pre-Columbian times farmers in Mesoamerica have developed agricultural technologies such as the “*chinampas*”, “*terrazas*”, and “ancient live fences” which allowed crop production on apparently less favoured lands (Mountjoy and Gliessman 1988, Puig 1994, Angel-Pérez and Mendoza

2004, Zuria and Gates 2006). Moreover, ancient farmers domesticated crops and created varieties or cultivars through their selection, notable examples from Latin America include: maize, tomatoes, and potatoes. Regarding SPS, in modern times farmers in Central America have created “contemporary live fences” and scattered trees in pastures (Sauer 1979, Budowski 1993). Thus, creativity, curiosity and vocation for experimentation have always been intrinsic characteristics of farmers; unfortunately, external factors such as lack of financial assets and dominance of non-traditional paradigms have restricted and ignored those qualities (Rölling and Fliert 1994).

The second model is the Everett Rogers diffusion of innovations approach which considers a centralized process, in which innovations are mainly developed at research stations (Rogers 1995). According to Rogers, the innovation process has six steps: (1) identification of needs or problems, (2) research, (3) development, (4) commercialization, (5) diffusion and adoption, and (6) impact or consequences (Rogers 1995). Farmers are considered as technology end-users or adopters in a one way process of technology transfer, and they are likely to be involved only when the technology has reached the diffusion and adoption stage (Biggs 1990, Rogers 1995, Prins 2005). This model produced three main issues that affected mainly to less wealthy farmers: (a) innovation bias, or the perception that technologies must be adopted because they are necessary and perfect; (b) individual-blame bias, where failed attempts in adoption were attributed to farmers’ negative attributes, instead of observing issues in the whole system of innovation generation; (c) inequalities in the diffusion model development and technology generation models, hence wealthy farmers are benefited by expanding the lack of equity in the rural area (Rogers 1995).

The third source of innovations is a “multisource” model in which innovations are originated by several stakeholders including farmers, practitioners, technicians, researchers, NGO’s staff, and private corporations, among others (Biggs 1990). In this case innovations are considered the results from learning and cooperation processes of several actors (Prins 2005). Rölling and Fliert (1994) described a successful experience of the application of this model in Indonesia, where farmers, extension staff, facilitators, and government policy makers joined efforts for improving rice management practices by encouraging integrated pest management. Another example from Central America is the use of *Mucuna* spp. as a cover crop. This was first introduced by the United Fruit

Company to Guatemala, and then it was used by Q'eqchi' farmers as an intercrop with maize (Buckles 1995). The latter practice was communicated from farmer to farmer to other regions in Guatemala and Central America first without participation of extension services; but later extension services and researchers were also involved in the adaptation of management practices and promotion of its use (Buckles 1995).

On the other hand, agroforestry and development programmes have used different models for encouraging the use of innovations. These are influenced by the ideologies of development and the models of generation of innovations. The models included different sets of strategies, thus it is expected to find differences in the results obtained from their implementation according to the context of each locality. Probst *et al.* (2005) identified three main models that have been used for transferring agricultural technologies: (1) Transfer of Technology (TOT); (2) Farmers First Model (FFM) and (3) Participatory Learning and Action Research (PLA). The first model considers that only researchers and extension staff professionals are responsible for the communication of innovations; whilst the latter two approaches involve the participation of farmers in such process.

The TOT model was influenced by the first perspectives of development which were based on the positivism paradigm, used a top-down ideology and the diffusion of innovations theory (Chambers 1999, Prins 2005, Probst *et al.* 2005). Same authors pointed out that this model is linear and considers three main actors: formal researchers, extension staff, and farmers. Technologies disseminated under this model had major success in the context of the Green Revolution and in relatively homogeneous lands under favourable conditions. However, TOT failed to support asset poor farmers who have a diversity of conditions and problems (Sanders and Lynam 1981, Schweigert 1994, Probst *et al.* 2005). Despite of the criticisms, most of the international and national research institutions have used TOT as their institutional model for transferring technology. Even CATIE promoted the use of such approach in some of its technical cooperation projects carried out in Central America (Staver 2005).

The FFM is focused on farmers' needs, and it is based on the bottom-up ideology. Farmers are encouraged to innovate and do experimentation, and the complementation of technical and indigenous knowledge is promoted (He *et al.* 2009). There are four principal approaches summarized under this model: (1) Farmer-Back-to-Farmer; (2) Farmer First and Last; (3) Farmer Participatory Research; and (4) Participatory Technology Development (PTD) (Probst *et al.* 2005). The latter approaches pioneered the shift to participatory strategies, and have been accepted by poor farmers. For example, Clarke (1991) described the use of PTD in agroforestry initiatives in Zimbabwe. Confronted by a first round of negative results using agroforestry trials designed by researchers and managed by farmers, the Zimbabwe project decided to shift and involved farmers from the planning stage, including the selection of tree species and agroforestry systems to be tested (Clarke 1991). In China the PTD model encouraged farmers to identify and apply agroforestry options in steep lands (He *et al.* 2009).

The PLA concept has been suggested as an evolution from Participatory Rural Appraisal (PRA) (Kumar 2002, Laws *et al.* 2003). PRA practice was being implemented not only in rural areas, and not just to extract information for diagnostic purposes (Mikkelsen 1995). Moreover, PRA practitioners were experimenting with new techniques and applications, therefore it was suggested that PRA was not anymore adequate for describing the latter (Chambers 1999). The PLA model is based on the bottom-up ideology of development; considers several stakeholders and actors, and promotes collaborative work, dialogue, negotiation and conflict mediation between interest groups (Probst *et al.* 2005). PLA helped to identify gender issues in land endowment and trees' preference that influenced the practice of agroforestry in Cameroon (Vabi 1996). In Brazil, PLA was used for facilitating a shared learning process on agroforestry systems (Cardoso *et al.* 2001).

2.3.3. The effects of structural adjustment on agricultural extension services in Central America

One of the underlying factors affecting the status of agricultural R&D and extension services are the macro policies reforms adopted by governments in Central America since the 1980s (Sain and López-Pereira 1999). Few studies evaluated the impact of such reforms in rural development and agricultural extension, perhaps because of the difficulties for estimating such scenarios as all the countries in the region have implemented such reforms. Macro policies reforms comprised three main strategies: stabilisation, adjustment and reform (Ellis 2000), from which the first two have produced the most notable implications for agricultural R&D and extension organizations. On the other hand, reform strategies are considered as beneficial, since it has promoted transparency and more equitable rules in organizations and the state (Ellis 2000). Furthermore, structural adjustment has been associated with a recovery of forest cover and the conservation of natural resources in El Salvador (Hecht *et al.* 2006).

Stabilisation reforms reduced public expenditure in governments, which was translated in a reduction of budget assigned to public agricultural R&D and extension agencies, lack of credit opportunities for farmers, and more expensive imported inputs because of the devaluation of the local currencies (Sain and López-Pereira 1999, Enríquez 2000). Moreover, adjustment reforms favoured the privatisation of extension services. This eventually ended in the involvement of other actors such as NGOs and education organizations in extension services, but also many rural areas were left unsupported because of the lack of financial resources for extension services. The liberalization of agricultural markets has propitiated the competence of small farmers from Central America with those of developed, subsidized and more technically supported economies such as the USA.

2.4. Participatory research

The approaches comprised in the Farmers First and PLA models are considered as participatory research. These modified technology generation and diffusion paradigms by encouraging active involvement of farmers in on-farm research activities. Many definitions of participation have been used, and its meaning has become difficult to describe (Mikkelsen 1995). This can be explained by the fact that the concept has been used under different circumstances and contexts. For example, Uphoff (1982) described that participation could be conceived by economists and planners as related to benefits; by project managers and public administrators as related to implementation; and finally, by political scientists and politicians as related to the decision making process. However, for the present research, Tikare *et al.* (2002) definition of participation "the process by which stakeholders influence and share control over priority setting, policymaking, resource allocations, and program implementation" is accepted.

Then, what is participatory research (PR)? Thiele *et al*. (2001) defined PR as a: research "where technology users are actively involved with scientist in developing the new technology". These authors clarified that PR is not synonymous with research done with partners, because research carried out with institutional partners is not necessarily participatory. According to Cornwall and Jewkes (1995): "PR is about respecting and understanding the people with and for whom researchers work". This implies the recognition that local people are knowledgeable of their reality and can make their own analyses and solutions. CIP-UPWARD and IDRC (2005) pointed out that: "PR is not a single approach, but rather cuts across a broad collection of approaches intended to enable participants to develop their own understanding and control of the process and phenomena being investigated". In fact, many of the methods used in PR were drawn from conventional research. However, what is distinctive about PR is the methodological context of its application, considering the attitudes and roles of researchers, farmers and any other stakeholder involved in the research process (Cornwall and Jewkes 1995).

2.4.1. Farmer Field Schools (FFS)

One of the participatory approaches widely used is FFS, which is based on principles of adult education, local organization, alliance building and stakeholders active participation (Pontius *et al.* 2002). This implies that farmers are encouraged to observe, suggest alternatives of solution, measure, analyse and experiment in their farms to facilitate their understanding, learning and informed management decisions (Braun *et al.* 2006). FFS were first promoted by FAO in Southeast Asia, specifically in Indonesia during the rice season 1989-1990 (Scarborough *et al.* 1997, Pontius *et al.* 2002). The approach emerged from a problem related to the excessive use of biocide products in rice that were threatening the health, natural resources and economy of rice farmers (Scarborough *et al.* 1997, Braun *et al.* 2006). In the beginning FFS were focused on Integrated Pest Management (IPM) of single crops. However, soon after the approach was carried out with farming systems, livestock production, water resources management, forestry, HIV/AIDS, malaria and other health issues, democracy and empowerment (Pontius *et al.* 2002, Berg and Knols 2006, Braun *et al.* 2006).

An extensive review of the dissemination of the FFS was performed by Braun *et al.* (2006). According to such report, the first experience with FFS in America was carried out by CIP (International Potato Center) in Bolivia and Peru by 1997. Braun describes that CIP first started to adopt some principles of FFS for its implementation of participatory research, however, did not include Agro-ecosystem Analysis. The latter has been pointed out as a distinctive feature of IPM oriented FFS. The first proper FFS are considered to have been carried out in 1999 in Bolivia, Ecuador and Peru (Braun *et al.* 2006).

In Central America (Nicaragua, Honduras and El Salvador) the pioneering institution working with FFS was the Pan-American Agricultural School, EAP-Zamorano, leading the implementation of the approach with IPM, under the framework of PROMIPAC[4] in 2000 (López Montes *et al.* 2003). The use of the FFS methodologies in Central and South America responded to failures in previous models for technology generation and transfer like the TOT or the training and visit extension models (T&V) (Rölling 2002), which is a top-down oriented model. Agricultural technologies were generated in research stations and they omitted consideration of necessities of farmers located in poorer or remote areas with limited assets for implementing agriculture. The alternative was the incorporation of participatory approaches and stakeholders considered atypical in agricultural research centres such as sociologists and anthropologists (Goodell *et al.* 1990).

The FFS are not a written recipe. However, previous experiences have shown valuable lessons that can be described as principles leading the approach, these are:

i. Farmers are not considered as users or objects. Rather they are considered as partners and experts (subjects) whose knowledge and active participation through the entire process of encountering alternatives of innovation is fundamental (Rölling 2002).

ii. The agenda of the FFS is not limited to agricultural technology issues. Instead, FFS curriculum usually includes themes related to organizational, health and administrative issues among others. The aim is to use an holistic approach (Rölling 2002, Hughes and Venema 2005).

[4] Integrated Pest Management Programme in Central America. http://www.promipac.org/promipaczamo/index.php?option=com_frontpage&Itemid=28

iii. The sessions of the FFS are not lectured in a top-down manner or with technical language that might difficult or impede the understanding and learning of farmers. In its place, knowledge is revealed through practical discovery learning exercises or experimentation (Tripp *et al.* 2005).

iv. The school is facilitated by an extension agent, NGO staff or graduated farmers from FFS (Tripp *et al.* 2005). The role of the facilitator is not to lecture the farmers, but to ease the process of learning (Hughes and Venema 2005). Agricultural scientists provide feedback about technical aspects acting more as colleagues.

v. The school is carried out in the field (Hughes and Venema 2005). The field in this case corresponds to the land available in the farms of the FFS group members. This is the "classroom" where the farmers are encouraged to assess their own problems, propose alternatives of solution, observe, experiment and learn (Gallagher 2003).

vi. FFS works with groups of farmers that have periodical/regular sessions (Tripp *et al.* 2005). As some farmers can observe or have different aspects in the field, the interaction in the group is intended to ease the generation of knowledge and empowerment. The groups can be formed by and for the purpose of attending the FFS, or it can be existent groups (Gallagher 2003).

2.5. Agroforestry adoption or practice studies?

The interest in conducting technology adoption studies emerged from the necessity for improving the scale of positive impacts intended by such technologies or actions. Initially, adoption studies were addressed in a similar way to those performed with agricultural technologies. However, later it was recognized that adoption studies in agroforestry technology required a different approach, because agroforestry technology is complex, knowledge intensive and its effects are likely to be appreciated in a medium or long term period (Mercer 2004). This author identified two main perspectives for adoption studies: (a) at the individual household level, where the factors influencing the adoption are investigated using statistic models or through qualitative work based on experiences; and (b) at the macro-level, where the general trends of the dynamic of adoption is addressed in a broader way, longer periods of time and larger scale (Mercer 2004).

One of the most important studies about agroforestry adoption in Central America was published by the World Bank (Current *et al.* 1995a). Based on information from 21 agroforestry programs from Central America and the Caribbean, the study produced important findings for understanding agroforestry adoption. Current (1997) stated that most of the agroforestry options analyzed in the study were profitable in economic terms. However, farmers were not considering this as the most important factor for establishing agroforestry practices. Instead, adoption was influenced by local biophysical and socioeconomic features. This included the household feasibility for investing in agroforestry, their capability to provide the labour required and cultural issues that could interfere with the process of adoption (Current 1997). The author also argued that farmers were more likely to plant trees, when their use was meant to produce benefits for the household. Many times such benefits were noticed to be related to household needs (self-consumption); and later related to the marketing of products. Regarding technical assistance, such report pointed out that programmes offering several strategies of extension and incentives (mainly agricultural inputs) to farmers were more likely to encourage agroforestry practice (Current 1997).

2.5.1. Factors influencing the adoption of agroforestry practices

The factors influencing agroforestry adoption are quite specific and influenced by the local context that the farmers and their families face. In following paragraphs are reviewed the main results from two studies (further discussion on this factors is available in Chapter Five). In Senegal, Caveness and Kurtz (1993) determined that land ownership and labour availability were the two most significant factors influencing the adoption of agroforestry practices. The study argued that agroforestry adoption was facilitated by greater availability of land and labour which contributed to increase the perceived security and consequently reduced the perception of risk.

In another study from India, Sood and Mitchell (2009) used logistic regression to identify biophysical and social variables influencing farmers' willingness to grow trees.

Their results showed that a combination of social (mobility of head of the household and importance of tree growing); and biophysical variables (farm size, agroclimatic zone, soil fertility) explained better why farmers grew trees in their farms. The authors explained that: (i) farmers with more land are likely to take more risks; (ii) that the agroclimatic zone was related to better assets availability such as radiation and temperature, soil fertility favoured natural regeneration; (iii) social mobility facilitated the access to new agricultural practices; (iv) and the value of trees for future generations was related to increasing assets in the medium and long term (Sood and Mitchell 2009).

2.5.2. Perception and technology practice

Farmer's perception has been used with the aim of eliciting the local perspective to understand the present status of both production systems and rural livelihoods. This can help empower farmers, create user oriented initiatives, and to identify and promote alternative management strategies or measures for achieving sustainability. Studies from several fields have employed perception in their conceptual and methodological frameworks. For example, it was used: for the characterization of plant species and their properties such as cassava in Nigeria and Tanzania (Oluwole *et al.* 2007); for identifying the local image of an ideal farm in Kenya (Waithaka *et al.* 2006); for explaining the implementation of bio-security measures for swine production in Spain (Casal *et al.* 2007); for modifying rice insect pest control measures in the Philippines (Palis 1998); and for prioritizing weed control needs in Africa (Chikoye *et al.* 2000).

Nevertheless, it is in agroforestry adoption studies where perceptions are considered an essential element, because it has been suggested that farmers' decision making of practicing a certain technology is related with their perception and attitudes about it (Adesina and Zinnah 1993, Palis 1998, Abadi Ghadim and Pannell 1999, Anfinnsen 2005). Farmers' behaviour is a consequence of their perception or understanding of the reality (cognized model), this determines farmers' reaction to opportunities and constraints (Nazarea-Sandoval 1995). For example, Franzel (1999) used "acceptability" as one of the three main factors considered by farmers for practicing agroforestry. Acceptability is defined as the perception farmers have about advantages and disadvantages of a given technology, which in Franzel (1999) study was the perception that farmers have on fertility issues as the most relevant criteria to adopt improved fallows.

2.5.3. Impact monitoring and assessment

Impact evaluation of development programmes emerged from the aim of donors and organizations to probe that the work was performed as agreed, that resources were allocated properly and the investment was worthy, and to evaluate their potential scaling up or creation of policies supporting it (Guijt 1998, Gertier *et al.* 2011). Impact evaluation was not usually undertaken in rural development initiatives because of the lack of experience in conducting such evaluations, the pressures for accomplishing technical tasks and the lack of budget needed for its implementation among other reasons (Scherr and Müller 1991). However, at present it is difficult to find a project without at least some degree of evaluation.

Project evaluation has been defined as “the systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfilment of objectives, development efficiency, effectiveness, impact and sustainability” (OECD 2002: 21-22). Most impact evaluations are performed at a specific time of the lifespan of the project, i.e., medium term or *ex posts* evaluations. This implies that the observations obtained in evaluations are just from a specific time of the project, thus making more difficult the use of findings for improving the success of the initiative. As a result, the project monitoring concept was suggested. In project monitoring the evaluation is a continuous task along the project implementation (Abbot and Guijt 1998). Hence, there is more opportunity to use the findings from monitoring for correcting or improving the implementation and encouraging the intended impacts.

The impact can be defined as the consequences or changes that the actions carried out by a certain project created. It has been argued that such impact can be classified according to when those changes are likely to be observed. For example, short term (immediate), medium term and long term impacts (Herweg and Steiner 2002). Conversely, hand impact can as well be classified using categories of the nature of such changes. Most of the development initiatives aim to produce good results for improving people's livelihoods. These can be classified as "wished", "expected" or "positive" impacts. However, it has been observed that even when projects have the best intentions (or not), its actions most of the times produce "non-wished", "non-expected" or negative consequences as well. In the past, impact evaluation targeted positive impacts only. The impacts of agricultural development projects on farmers measured impact by using economic (income) and productive (yield) indicators. However, traditional impact evaluation missed approaching both: consequences for other aspects of people's livelihoods and negative impacts. Therefore, holistic approaches for impact evaluation and monitoring have been suggested.

2.6. Degraded pastures

Pasture degradation (PD) can be defined as the deterioration in pasture condition, associated with negative ecological and environmental changes (Szott *et al.* 2000, Dias-Filho 2005). The decline in pasture condition can be expressed as the presence of less palatable forage species (Müller *et al.* 2004). However, while pasture degradation advances, the decline of the soil chemical, physical and biological properties can also be observed (Rasiah *et al.* 2004) resulting in soil degradation. Based on this, Dias-Filho (2005) distinguishes between agricultural and biological degradation. The former implies a process of natural succession where sown or natural pastures are gradually replaced by other vegetation, but soil properties are not compromised; whilst in the latter, the soil may not sustain acceptable productivity of pastures or natural vegetation (Dias-Filho 2005).

In Central America PD are the main agricultural degradation type observed, and in 2007 threatened the sustainability of at least 5.5 million of hectares[5] (ha) (FAO 2010). Reduced leaf area of pastures is unable to provide enough quantity and quality of feed for cattle, and may cause a reduction in the yields of cattle products. Estimations of PD's impact in economic terms were limited by the variation of its occurrence, and due to the lack of models for predicting yields in dual-purpose systems (Betancourt 2006). Nevertheless, some estimates of its impact in Guatemala and Honduras have been made. Holman *et al*. (2004a) estimated yield reductions with a value between US$63 to 94

[5] The area corresponds to the 50% of the total area with pastures. Total pasture area in Central America was 11,138,000 ha in 2007. Pasture degradation in the region have been estimated between 50 to 90%.

million dollars per year for milk, and US$48 to 66 million dollars per year for beef in Honduras. Betancourt *et al*. (2007) valued income reductions of US$3.4 million dollars for milk and beef for an area of 720 km^2, with more than 46,000 ha of pastures in Petén, Guatemala.

Several causes of PD have been discussed in the literature which include those related to natural capital: the use of landscapes or soils that are inappropriate for cattle production (Holmann *et al.* 2004a), for example, use of acid soils common in the tropics (Carvalho *et al.* 2003); or relatively nutrient poor soils like Oxisols (Numata *et al*. 2007); the inappropriate selection of grass species (Peralta and Toledo 1991); the unavailability of phosphorus and nitrogen (Müller *et al.* 2004, Rasiah *et al.* 2004, Bach 2005); soil compaction (Martínez and Zinck 2004); and the inadequate management of pastures and grazing systems that leads to overgrazing of pastures (Buschbacher 1986, Hecht 1993, Bach 2005).

On the other hand, PD has been pushed by inconsistent policies, cultural values and issues with social and financial assets linked to the drivers of deforestation such as: agricultural production tax exemption, low agricultural land or products taxation; land speculation; laws conceding land endowment to squatters; subsidized agricultural credits; colonization and development projects; agricultural development projects; lack of alternative economic activities; low labour required for extensive livestock production; demand of livestock products; loss of traditional production and land regulation systems; cultural prestige of livestock activity; stability of prices for cattle products in regional markets (Binswanger 1991, Nicholson *et al.* 1995, Walker and Moran 2000, Durand and Lazos 2004, Grandia 2009, Roebeling and Hendrix 2010). Hence, PD is not a consequence of only one factor but of a complex number of interacting factors (Figure 2.1) (Martínez and Zinck 2004).

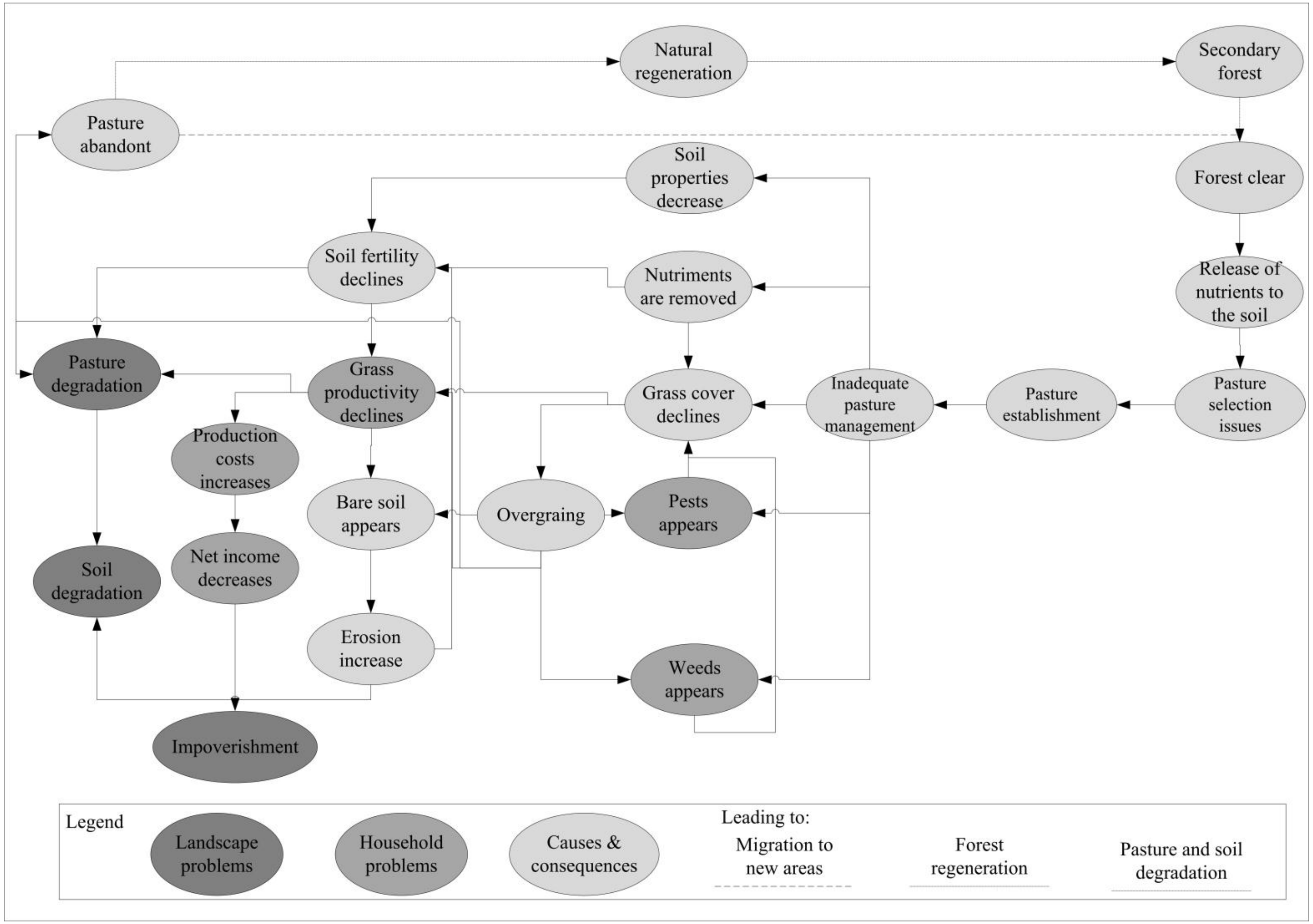

Figure 2.1. Pasture degradation chain of causes and issues by scale of occurrence (Based on: Martínez and Zinck 2004).

2.6.1. Alternatives for the rehabilitation of degraded pastures

The alternative solutions to pasture degradation can be classified into strategies, techniques or practices with the aim of regenerating agroecosystems: crops, pastures and leguminous forages (Bouman *et al.* 1999, Almeida 2000, Trejos 2006); or those with the aim of re-establishing trees and natural ecosystems such as forests (Carpenter *et al.* 2004, Zahawi 2005, Zahawi and Augspurger 2006). This review is based on the alternatives for agroecosystems. Preventive and remediation measures were distinguished. The former include evaluating the land suitability for establishing pastures. If pastures are to be established in land with adequate characteristics for their development, the risk of degradation may be reduced (Bautista-Solis 2005). Other preventive practices include the implementation of soil and water conservation practices, selecting fodder sources –grasses, leguminous, shrubs and trees- more adapted to the local conditions (Holmann *et al.* 2004c). Hence, selecting and breeding fodder species to obtain characteristics that allow a better adaptation to low fertility soils, water stresses and resistance to pests or diseases is recommended as well.

Remediation practices for pasture degradation can be classified into three main categories: (1) the recovery; (2) reform; and (3) renewal of pastures (Lucena *et al.* 2006). The differences among these approaches could be difficult to identify as their associated practices may be similar (Lucena *et al.* 2006). Over-sowing bare soil spaces in the paddocks where grass cover has decreased or renovating the pasture are practices suggested in technical guidelines (Trejos 2006). These actions can be performed with or without tillage practices. Nonetheless, faster and more stable results have been reported with tillage (Silva-Acuña *et al.* 2005, Sanabria *et al.* 2006). Another practice for alleviating pasture degradation is to apply phosphorous and nitrogen fertilizers (Soares *et al.* 1992, Soares *et al.* 2000, Silva *et al.* 2004, Moreira *et al.* 2005, Oliveira *et al.* 2005, Trejos 2006). Soil analysis and pH treatments are recommended so that appropriate sources and techniques for fertilization can be selected (Evangelista and Lima 2001). However, many farmers in Tropical America lack financial capital, therefore, chemical fertilization is not a common practice in pastures. In this way, adding manure, compost, using herbaceous leguminous such as *Arachis pintoi*, and woody perennials with high rates of nutrient cycling and other resources produced in the farm could be more feasible options (Torres 1983, Carvalho *et al.* 1990, Thomas 1995, Carvalho *et al.* 2001, Evangelista and Lima 2001).

Weed control is a recommended practice for avoiding pasture degradation (Trejos 2006). Weeding in Central America is usually done manually through "*chapias*[6]" and using herbicides. This practice should be performed selectively, because some of the so-called "weeds" are important feed resources for cattle (Yamamoto 2004, Pineda *et al.* 2009, Velásquez-Vélez *et al.* 2009) and have a role in the nutriment flow of agroecosystems. Controlling pests is a key practice recommended by Trejos (2006) to prevent PD. For example, in Petén, Guatemala, Castillo (2006) reported declines in pasture production and persistence, as well as protein content and digestibility, in *Brachiaria decumbens* attacked by spittlebugs (*Aeneolamia albofasciata* and *Prosapia simulans*). Consequently, even when the so-called improved pastures are grown because of their high productivity and adaptation to adverse conditions, pest management - including the use of germplasm which is tolerant or resistant to specific pests should be considered. Finally regulating the stocking rate and the use of a proper grazing management system is necessary. One of the most cited drivers of PD is overgrazing. This could be avoided by reducing the size of paddocks, adjusting the length of the occupation and resting periods, and more importantly regulating the grazing pressure (Trejos 2006).

2.6.2. Silvopastoral systems in Central America

Agroforestry and specifically silvopastoral systems (SPS) have been pointed out as an alternative for preventing and remediating pasture degradation (Pezo *et al.* 1999, Carvalho *et al.* 2001). In the SPS, trees, shrubs, or both are used in addition to grasses and livestock (Pezo and Ibrahim 2002). Tree benefits include improvement of local economic indicators by diversifying farm products –wood, fuel wood, posts, fruits, fodder- and improving soil fertility (Franke 1999, Franke and Furtado 2001). On the other hand, SPS can help diminish global environmental problems by providing niches for biodiversity and by capturing and storing carbon dioxide (Ibrahim and Mora-Delgado 2003, Harvey *et al.* 2004, Harvey *et al.* 2005, Harvey *et al.* 2006).

[6] Common term used in some areas of Central America for hand weeding that involves removing undesirable plant species using a machete.

Furthermore, SPS have shown additional benefits such as: improvement of physical and chemical soil properties (Villanueva and Ibrahim 2002), provision of feed in the dry season (Zamora *et al.* 2001, Esquivel *et al.* 2003), the reduction of damages from strong winds (Prins 1999), decrease the stress generated by high temperatures under the canopy of scattered trees in pastures (Souza 2002), among others.

The main components of the SPS: woody perennials, pastures and animals can be arranged in many ways (Pezo and Ibrahim 2002). Thus, several types of SPS have been identified. Dagang and Nair (2003) stated that SPS were not being adopted at a wide scale in Central America. However, other literature and personal field observations suggest that some SPS are widely distributed in Central and Tropical America (Kass *et al.* 1992, Abarca 1997, Pezo and Ibrahim 2002, Pagiola *et al.* 2007). In these regions live fences and windbreaks are frequently used (Holmann *et al.* 1992, Current *et al.* 1995a, Ibrahim *et al.* 1999), as well as scattered trees in pastures (Lobo and Diaz 2001, Ibrahim *et al.* 2005, Love and Spaner 2005). Such options are recognized as "traditional agroforestry or silvopastoral practices" (Current *et al.* 1995b, Scherr 1999).

Nevertheless, there are other SPS options less frequently implemented such as fodder banks (Alonzo *et al.* 2001, Holguin and Ibrahim 2005, Orozco 2005) and trees/pastures in alleys (Ibrahim *et al.* 1997, Arias 1998, Cruz and Nieuwenhuyse 2008). Only a few tree species such as *Leucaena leucocephala*, *Gliricidia sepium*, *Erythrina* spp. and *Cratylia argentea* have been widely studied in Latin America. Many local and introduced tree species with potential use in SPS or other agroforestry system still wait for assessment. The consequence of this is that knowledge about the practice of some SPS is not yet available to farmers, nor to local organizations involved in agricultural research and extension services. Hence the possible contribution of SPS to mitigate degraded pastures is still limited.

2.6.2.1. Scattered trees

Scattered trees in pastures is one of the most frequent SPS option in Central America (Harvey *et al.* 1999). It is recognized as a key element in conservation, because of the local and landscape ecological functions it can provide (Manning *et al.* 2006). In Central America, scattered trees are found in natural savannas as well as in established pastures. This SPS option has been reported from Belize to Panamá (Vieto 1995, Michmerhuizen 1997, Souza *et al.* 2000, Alonzo *et al.* 2001, Casasola *et al.* 2001, Zamora *et al.* 2001, Barrance *et al.* 2003, Esquivel *et al.* 2003, Villacís *et al.* 2003, Anfinnsen 2005, Love and Spaner 2005, Horgan 2007, Trautman-Richers 2007, Villanueva *et al.* 2007, Yamamoto *et al.* 2007, Esquivel *et al.* 2008, Decker 2009). Most of the latter studies were focused on surveying trees on pastures, describing their uses and abundance to understand the potential of their ecological and economical contribution. However, few studies were focused on understanding why these practices were originated, disseminated and used by farmers.

The origin of scattered trees and shrubs is linked to the existence of natural savannas and anthropogenic activities (Pezo and Ibrahim 2002, Harvey *et al.* 2004). Central America has two zones where savannas naturally occur (Furley 1999), including Petén in Northern Guatemala. In these areas, the vegetation was determined by severe climatic changes that occurred since the last glacial event (Furley 1999); and is likely to include a combination of pastures, shrubs and scattered trees (Pezo and Ibrahim 2002). Other areas in Latin America with similar ecosystems are the Matorral in North Mexico, the Llanos in Colombia and Venezuela; and the Cerrados in Brazil (San José *et al.* 1991, Furley 1999, Pezo and Ibrahim 2002).

On the other hand, farmers select valuable trees to be conserved in the agroecosystems they manage (Pezo and Ibrahim 2002, Harvey *et al.* 2004). Old trees are forest remnants, or early colonizers that persisted under grazing conditions (Harvey *et al.* 1999, Esquivel *et al.* 2008); while young trees emerged mostly from natural regeneration, and relatively few trees have been planted by farmers that participated in reforestation or agroforestry projects (Esquivel *et al.* 2003, Villacís 2003, Villanueva *et al.* 2003). Therefore, the scattered trees option is mostly an innovation led by farmers, rather than the result of research interventions or R&D initiatives.

The uses of scattered trees are diverse, and usually linked to the local context and farmers' livelihoods. For example, in rural areas of Guatemala and Nicaragua its use is related to the provision of firewood as the main source of energy for cooking (Casasola *et al.* 2001, Sánchez Merlo *et al.* 2004, López *et al.* 2007a, Anfinnsen *et al.* 2009). In Costa Rica, where only 13.2% of the population use firewood for cooking, its main use is for wood extraction (Harvey *et al.* 1999, INEC 2002, Esquivel *et al.* 2003, Villacís 2003, Villanueva *et al.* 2007). In contrast, Alonzo (2000) stated that in Cayo, Belize wood was not the main reason for implementing this SPS option because the country has large forest reserves. Livestock farmers in sub-humid areas of Nicaragua and Belize use scattered trees as source of fodder for cattle (Alonzo *et al.* 2001, Casasola *et al.* 2001, Zamora *et al.* 2001, Barrance *et al.* 2003). Fruits and forage from scattered trees are available during the dry season, when the grass is scarce; and with the increase in the prices of concentrates it has become an alternative for cattle supplementation (Casasola *et al.* 2001, Zamora *et al.* 2001, Restrepo-Sáenz *et al.* 2004). Moreover, farmers recognize the provision of shade for cattle as a major use, especially in areas where projects have encouraged the use of SPS (Alonzo *et al.* 2001, Love and Spaner 2005, Yamamoto *et al.* 2007, Anfinnsen *et al.* 2009).

All these uses are considered the reason for promoting scattered trees silvopastoral option. Other factor not mentioned by livestock farmers in Central America, yet reported in the literature is the generation of income from payment for environmental services (PES); and the scarcity of tree resources. In Matiguás (Nicaragua) and Esparza (Costa Rica) a pilot project was implemented by giving incentives for the provision of carbon and biodiversity with a payment during two or four years. The PES resulted in increases of the area under improved pastures with trees from 246.5 to 1348.6 ha in Esparza; and from 314.1 to 792.3 ha in Matiguás (Casasola *et al.* 2007, Pagiola *et al.* 2007). The extension of natural pastures with trees reduced from 910.6 to 483.3 ha in Esparza; whereas in Matiguás it increased from 724.4 to 854.7 ha. Those changes were observed in both small and medium scale livestock farms; but the former were more likely to change towards more intensive practices (Casasola *et al.* 2007, Pagiola *et al.* 2007).

Factors limiting the practice of scattered trees in livestock areas of Central America are related to built/physical, cultural, financial, and human assets. Studies in Costa Rica, Guatemala and Honduras reported perceptions related to cultural and human capitals that discouraged the implementation of such SPS option (Souza 2002, Barrance *et al.* 2003, Anfinnsen *et al.* 2009). The main one is the concern farmers have on the potential reduction in growth of pastures due to shade. Moreover farmers also express their concern about potential physical damages from trees on animals, potential damages for thunders on cattle, or the increase in populations of snakes that can damage to the animals and the people (Anfinnsen *et al.* 2009)

Regarding financial and built capital, when farmers harvest scattered trees for their use in cattle feeding the requirement of labour is increased, or could imply acquiring additional infrastructure such as feeding facilities or machines such as a forage chopper (Zamora *et al.* 2001), although the latter is more likely to occur with cut-and-carry systems such as fodder banks. High costs for establishment and eventual protection, long term periods for obtaining benefits, and lack of financial capital, including credits, limit the capacity of farmers to plant scattered trees (Pagiola *et al.* 2007, Trautman-Richers 2007). In Matiguás, Nicaragua reported costs were between US$180/ha^{-1} to US$400/ha^{-1} for planting trees in pastures (Pagiola *et al.* 2007). Those are considered high for small and even medium scale farmers, which have as priority to maintain a family and to increase their herds which are their main assets. Thus, the establishment option is limited to the conservation of remnant trees or to the protection of natural regeneration seedlings. Lack of markets for tree products is another constraint related to financial capital (Barrance *et al.* 2003). Generally, non-timber products are used in farm production and for self-consumption (Anfinnsen 2005). A formal market for such products may enhance farmers' disposition for establishing scattered trees as occurred with fruit trees in Panamá (Cerrud *et al.* 2004).

Policies and legislation are also limiting factors for the establishment of scattered trees in pastures (political capital). For example, before 1992 the law conceded to the government the ownership of trees in Honduras; and even nowadays farmers report difficulties to obtain logging permits (Barrance *et al.* 2003). What incentive can farmers have for retaining trees and investing in its management with such regulations? Moreover, in Central America the law demands a management plan availed by a forest professional for granting logging and transportation permissions (Detlefsen *et al.* 2008), hence such requirement becomes an obstacle for small farmers to harvest and sell wood obtained from scattered trees (Fischer and Vasseur 2002).

Cultural capital expressed as the management practices of pastures; and natural capital factors limited the natural regeneration of seedlings. Weeding has been reported as one of the main practices affecting seedlings survival (Casasola *et al.* 2001, Cerrud *et al.*

2004, López *et al.* 2007a). Seedlings are affected by mechanical or chemical weeding if these are not practiced selectively. High stocking rates have been related to lower density of trees in pastures, because these increase grazing and browsing or cause physical damage to seedlings (Villacís *et al.* 2003).

Despite the observation of scattered trees in pastures in most of the Central American livestock landscapes, the present review of the literature reveals that there are still research opportunities for understanding and encouraging strategies for its wider dissemination, since up to now most of it has been established without the intervention of research institutions. The promotion of livestock intensification strategies such as the use of improved pastures should be reviewed, because improved pastures usually require management practices such as fertilization and chemical weeding (Villanueva *et al.* 2003) which affect seedling survival, and lead to a reduced diversity of trees within pastures. Exceptions to this may occur if improved pastures are located near secondary forest, which year to year provides seeds that enhances natural succession, or if rotational grazing is practiced and pasture is not overgrazed, and if improved pastures are managed with controlled use of herbicides (Esquivel *et al.* 2008).

2.6.2.2. Live fences and windbreaks

Ancient arrangements of live fences and windbreaks were used by farmers in Mesoamerica since pre-Columbian times (Sauer 1979, Budowski 1993, Zuria and Gates 2006). However, some scholars differ and have pointed out that those practices were introduced after the Spanish Conquest (Challenger 1998, Avendaño and Acosta 2000, Angel-Pérez and Mendoza 2004). Sauer (1979) suggests that contemporary live fences were originated in the 20th century following the arrival of barbed wire to Costa Rica, based on the extent of the practice of live fences and windbreaks in such country by non-indigenous farmers. Regardless of the cause, the main purpose of ancient and contemporary live fences and windbreaks is different. Ancient arrangements were intended to prevent soil erosion and to help retain the soil in the *chinampas* (Zuria and Gates 2006); whilst contemporary ones are established to limit properties, agricultural plots and to control the movement of livestock.

Predecessors of contemporary live fences and windbreaks could have been established in Mesoamerica after livestock introduction in 1595 (Ensminger and Perry 1997). Farmers found it necessary to prevent damage by trampling or grazing in agricultural plots (Challenger 1998, Zuria and Gates 2006). In the layout of live fences and windbreaks, farmers included trees, shrubs and even herbaceous plants to restrict livestock mobilization (Zuria and Gates 2006). After the invention of barbed wire in 1874, it was used in fence posts and later in live fences, generating the contemporary layout (Sauer 1979, Budowski and Russo 1993). Nowadays, living fences are more practiced in Central American farms than windbreaks; and both have been studied and promoted in agroforestry projects since the late 1970s (Budowski 1993, Foletti 1994). However, those efforts seem to have less contribution to their innovation process and the widespread of such practice, than those made by the farmers (Reiche 1995, Samayoa 1995).

The use of trees in lines as fences or windbreaks could be considered as SPS options when they are established in pastures (Beer 1994). The difference between live fences and windbreaks lies in the purpose and arrangement of trees. Living fences are meant to delimit properties and divide paddocks to avoid invasion of cattle into plots (Budowski and Russo 1993, Cerrud *et al.* 2004, Harvey *et al.* 2005). Tree species, bushes and herbaceous plants used as windbreaks are left to grow more to form a barrier for the wind, that protects pastures, feedlot facilities and livestock from adverse conditions (Dronen 1988). Moreover, the layout of windbreaks could have more than one row and strata, increasing its density (Dronen 1988, Samayoa 1995). Farmers generally choose native species, with good vegetative propagation, rapid growth, easy to prune or pollard, with tree cortex characteristics that enhance the life of barbed wire and with multipurpose production to be used in live fences (Sauer 1979, Budowski and Russo 1993, Current 1995, Somarriba 1995, Cerrud *et al.* 2004, Villanueva *et al.* 2005, Zahawi 2005). Conversely, when farmers select tree species for windbreaks rapid growth, easiness of propagation, easiness of pruning, capacity to form small but dense crowns, and high or medium heights for forming different strata are considered (Current 1995, Aguirre *et al.* 2001).

The first publications about living fences and windbreaks in Central America were focused on describing the main species used for fencing (Sauer 1979), assessing their productivity (Budowski *et al.* 1985), economic feasibility (Holmann *et al.* 1992), potential use as fodder sources (Pezo *et al.* 1990, Romero *et al.* 1993) and describing its management practices (Budowski and Russo 1993, Beer 1994, Otárola 1995). Recent studies have been directed to the characterization of tree species used (Esquivel *et al.* 2003), assessing its contribution to biodiversity conservation (Harvey *et al.* 2005, Harvey *et al.* 2006) and its role in connectivity of fragmented landscapes (Chacón and Harvey 2006). A brief description of some of the studies about live fences or windbreaks in Central America is presented below. Aspects considered as relevant for understanding what encourages or discourages its practice are prioritized in the discussion.

The main factors encouraging the practice of live fences and windbreaks are related to the natural, cultural, built, human and financial capitals, the vulnerability context affecting the farmers and attributes of the silvopastoral technologies. Farmers preferred fence posts for dividing paddocks, because they could be extracted from forests, and their hard structure granted a life of at least 20 to 30 years (Sauer 1979). However, farmers' preference is not permanent and it has been shifting in areas such as Petén (Guatemala), where the high cost of fence posts of the most preferred tree species (*Manilkara zapota*) for this purpose, encouraged the practice of live fences with species such as "*piñón*" (*Jatropha curcas*) (personal observation). Similar changes in farmers' preference have encouraged the use of live fences in Panamá and Costa Rica (Cerrud *et al.* 2004, Chacón and Harvey 2006).

Natural capital also positively influenced windbreaks practice, because farmers facing problems due to wind in agricultural production established that practice by themselves in Costa Rica (Samayoa 1995, Prins 1999). Small farmers with reduced availability of land in Guatemala and El Salvador preferred the establishment of trees in live fences, windbreaks or bounding agricultural plots, instead of woodlots (Reiche 1995, Samayoa 1995), because those practices do not reduce the agricultural area. Some tree species are frequently used in live fences and windbreaks because their higher capacity for natural regeneration, adaptation to degraded areas, and successful dispersion or propagation methods (Sánchez Merlo *et al.* 2005, Sánchez Merlo *et al.* 2006, Esquivel *et al.* 2008).

Cultural capital factors encouraged the establishment of live fences and windbreaks. For example, in Costa Rica and Nicaragua established live fences and nurseries facilitated expansion in their establishment because local knowledge about tree species and vegetative materials and seeds were available in the area (Samayoa 1995, Pagiola *et al.* 2007). Local knowledge on trees is a key factor in determining species preference, as it has been reported that most of the trees found in live fences and windbreaks are native or naturalized species (Sauer 1979, Harvey *et al.* 2005). This may imply that farmers using such practices have knowledge about the species' advantages and disadvantages in each locality. Farmers use such knowledge to select the trees to be established based on their necessities and the features of trees. For instance, rustic trees that are easily propagated, managed and compatible with cattle are preferred for establishing live fences and windbreaks (Somarriba 1995, Cerrud *et al.* 2004). Also, trees that provide several tangible benefits including firewood, forage, fruit or timber are preferred than those with less perceived benefits (Somarriba 1995, Cerrud *et al.* 2004, Harvey *et al.* 2005, Pagiola *et al.* 2007).

Technical assistance was a factor from human capital that facilitated live fences and windbreaks practice (Current 1995). Experiences from Guatemala and Nicaragua suggest that technical assistance was able to promote their practice. Technical assistance was more efficient when technical staff were local people or farmers who worked as promoters, technical assistance was participative, and farmers were given a chance to select tree species and own the benefits of their use (Samayoa 1995, Vieto 1995). Moreover, observable extension techniques such as field visits and demonstration plots were really appreciated by farmers and showed to be key elements in motivating their decision to establish such agroforestry systems (Rodríguez 1995, Samayoa 1995).

Financial capital was reported to be influencing the establishment of live fences and windbreaks. Farmers perceive that establishing live fences and windbreaks is cheaper than replacing fence posts frequently (Harvey *et al.* 2005). Thus, farmers are increasingly using more living trees in fences because it is more economical (Budowski 1993). Attractive economic features of those practices reported in the literature include: low investment, low labour needed, low opportunity costs, positive returns and increases agricultural production that were tangible in the short term (Reiche 1995, Samayoa 1995, Love *et al.* 2009). Moreover, stakes for fences expansion can be obtained in the farm (Holmann *et al.* 1992). In Costa Rica the cost of establishing one kilometer of *Erythrina berteroana* live fence was 45.9% cheaper than establishing a dead fence (Holmann *et al.* 1992). Recent estimations found that the cost of establishing one kilometer of simple live fence was 11.2% cheaper than establishing one of fence posts (Villanueva *et al.* 2005). If the dead fence is already established and just need to convert it to a live fence the costs were reduced to 57.1% for single strata, and 37.9% for multi-strata live fences[7] (Villanueva *et al.* 2005) (Table 2.2).

Table 2.2. Establishment and transformation costs for fencing one kilometre in Esparza, Puntarenas, Costa Rica.

Fence type	Cost (US$)	Cost (%)	Difference (%)
DF	627.0	100.0	0.0
Simple LF	556.5	88.8	-11.2
Multi-strata LF	663.4	105.8	5.8
DF to simple LF conversion	269.2	42.9	-57.1
DF to multi-strata LF conversion	389.4	62.1	-37.9

Based on (Villanueva *et al.* 2005). US$= Currency United States of America Dollars. DF = Fence posts. LF = Live fence.

Subsidies and PES were reported influencing the establishment of live fences and windbreaks. Current (1995) reported that economic incentives encouraged windbreak establishment to protect pastures, with more than 90% of participant farmers establishing windbreaks. The effect of windbreaks yielded tangible benefits to farmers in a relatively short period of time; whereas combining production and conservation (Current 1995). Pagiola *et al*. (2007) in Nicaragua reported PES increasing the length of living fences from 128.5 km in 2003 to 332.3 km in 2005. The PES accounted for 33 to 40% of the living fence establishment costs (Table 2.3). Similar results by PES were reported in Costa Rica (Casasola *et al.* 2007) and Colombia (Zapata *et al.* 2007).

Market trends were elements of the context of vulnerability that encouraged the establishment of live fences and windbreaks. For example, in Costa Rica it was reported that the fall in beef and coffee prices led farmers to establish more trees in live fences and windbreaks (Current 1995). Market opportunities for tree products are reported as influencing positively the establishment of live fences and windbreaks (Prins 1999,

[7] Multi-strata is referred to the presence of trees with different height in the same live fence. Usually, one strata is lower (2 m), and the other is higher (5m or more).

Cerrud *et al.* 2004). Finally positive features of silvopastoral technologies are likely to influence farmers' willingness to establish those options. This was the case of windbreaks in Nicaragua and Costa Rica that showed high efficiency in protecting agricultural plots, provided tangible benefits, and was compatible with income generating activities such as livestock, agriculture or ecotourism (Current 1995, Vieto 1995, Prins 1999).

Table 2.3. Farmers' response to payment for environmental services in Matiguás, Matagalpa, Nicaragua.

Variable	Baseline	Fist year	Second year
Live fences (km)	128.5	239.0	332.3
Increase/year (km)	-	186.0	139.0
Increase/year (%)	-	144.0	139.0
Total payment (US$)	771.0	4972.5	4198.5
Payment/km (US$)	6.0		45.0
Establishment costs compensation[1] (%)	5.5		40.9
Establishment costs compensation[2] (%)	4.4		33.3
Establishment costs compensation[3] (%)	4.4		28.1

Notes: Based on (Pagiola *et al.* 2007). US$= Currency United States of America Dollars. [1] Total cost US$110/km. [2] Total cost US$135/km. [3] Total cost US$160/km.

There are also some factors discouraging live fences and windbreaks practice related to political, financial, natural, built capitals as well as to the local context. Coercive institutions and policies, or top-down approaches produced discontent in farmers and lack of interest in the management of windbreaks in Nicaragua and of live fences in Panamá (Vieto 1995, Aguirre *et al.* 2001, Fischer and Vasseur 2002). Farmers in Nicaragua were forced to allow the establishment of windbreaks, although not to obtain benefits, instead illegal users and national institutions shared the products obtained (Vieto 1995). In Panamá farmers expressed their disappointment because agroforestry projects did not allow them to express their opinions (Fischer and Vasseur 2002).

Forest regulations could also limit the establishment of live fences and windbreaks. Farmers found little incentives in establishing trees, because permits were required for harvest and transportation of timber (Reiche 1995, Samayoa 1995, Fischer and Vasseur 2000). The latter increased farmer's uncertainty about tree tenure and transaction costs (Current 1995). Institutions' priorities have been reported as another factor constraining live fences and windbreaks practice (Current 1995). This is because the approach more frequently used by institutions has been to encourage the implementation of non-traditional SPS alternatives such as fodder banks, woodlots, or tree/pastures in alleys, instead of the traditional ones that are more accepted by farmers and adapted to their necessities.

Lack of financial capital was reported to constrain the establishment of live fences and windbreaks in Costa Rica, Nicaragua and Panamá (Current 1995, Vieto 1995, Fischer and Vasseur 2002). The investment required for the establishment or management of those options can be considered unaffordable for many small farmers (Aguirre *et al.* 2001, Fischer and Vasseur 2002). Besides, small farmers are likely to prefer short term economic benefits, rather than long term possible ones (Fischer and Vasseur 2002). Live fences and windbreaks produced small financial returns in medium or long term periods, compared to annual crops production with higher profits that could be obtained in a short period (Reiche 1995). Furthermore, the lack of markets for tree products or lack of information about those can discourage the establishment of live fences and windbreaks with timber tree species (Current 1995, Fischer and Vasseur 2002).

Limited natural capital is also a constraint for live fences and windbreaks. Lack of land or land ownership constrained these practices because small farmers fear that live fences and windbreaks reduce the effective area for crops, decrease the production in agricultural areas by competence and shade effects, or by hosting pests that affect crops (Current 1995, Reiche 1995, Samayoa 1995, Fischer and Vasseur 2002). Live fences were less likely to be affected by the latter than windbreaks, because less area is required for its practice. However, issues were reported because live fences are barriers that are difficult to remove or relocate, and farmers need flexibility to change the layouts of crop plots (Harvey *et al.* 2005). On the other hand, lack of road infrastructure is the only factor limiting live fences and windbreaks establishment related to built capital reported in the literature (Fischer and Vasseur 2002). Remote areas near agricultural frontiers are likely to have poor roads for the transportation of timber products and these can affect the willingness of farmers to invest in these options (Fischer and Vasseur 2002).

2.6.2.3. Alley pastures and fodder banks

Alley pastures is the use of shrubs or woody species intercropped in bands within pastures to provide fodder for livestock or improve soil fertility. This SPS option corresponds to a variation of alley farming (Ibrahim *et al.* 1997), a concept generated in Africa in 1976 and promoted as an alternative system to traditional fallows (Kang 1993, Carter 1995, Douthwaite *et al.* 2002, Ogunlana 2004). On the other hand, fodder banks are a SPS option in which woody perennials or herbaceous fodder species are planted in high densities for feeding cattle (Camero 1995, Pezo and Ibrahim 2002, Cruz and Nieuwenhuyse 2008). The simplicity of the latter term has raised criticisms and other names were proposed such as: block fodder banks and cut-and-carry tree fodder (Carlowitz 1989). However, browsing fodder banks are not covered by the latter and longer names are more difficult to be referred. Thus, fodder banks remained as the valid term (Sinclair 1999, Torquebiau 2000).

Alley pastures were designed to obtain benefits from the woody perennials and the pasture in the same area such as nutrient replenishment, water pumping, forage, and soil erosion prevention (Kang 1993, Ibrahim *et al.* 1997, Kang 1997); whilst fodder banks were to maximize the production of high quality forages for feeding cattle (Pezo and Ibrahim 2002, Orozco 2005). Fodder banks can be categorized by their nutrient content as: (1) protein banks, if the fodder provides more than 15% of crude protein; (2) or energetic if they have high content of energy (Pezo and Ibrahim 2002). Alley pastures and fodder banks are classified by their use as: (1) cut-and-carry if fodder is cut and given to the livestock fresh or preserved; (2) or grazing-browsing systems if forage is directly consumed by livestock (Pezo and Ibrahim 2002, Orozco 2005, Cruz and Nieuwenhuyse 2008).

Alley pastures and fodder banks systems managed under browsing are difficult to distinguish in practice (Sánchez 2007), and some authors have used the term fodder banks for designing alley farming systems (Holmann *et al.* 1992, Holguin and Ibrahim 2005). In Petén (Guatemala) a browsing alley pastures system was established at distances of two meters between rows and 0.40 m between plants in single rows; whilst a browsing fodder bank was established at 1.50 m between rows and 0.50 m between plants in double rows (Cruz and Nieuwenhuyse 2008).

Even when alley farming and fodder banks have been related to ancient agroforestry practices as hedgerows and bush fallow systems (Carlowitz 1989, Ogunlana 2004), no references were found about their use in pre-Hispanic agroforestry systems in Mesoamerica. Both practices are induced technologies, designed by researchers and therefore farmers are not familiar with their practices and even with the woody species used in those systems, making their implementation more difficult (Carter 1995). In Costa Rica, pioneering research for using woody perennials for feeding livestock was carried out in the 1980s (Pérez-Guerrero 1985, Abarca 1988, Medina 1988, Tobon 1988). Features of woody species such as: provision of products, adaptability to adverse soil conditions, similar content of nutrients than those of concentrates, good palatability and voluntary intake, and increase or maintenance of milk and beef productivity suggested a promising performance as cattle supplements when established in SPS (Abarca 1988, Pezo *et al.* 1990, Camero 1994, Benavides 1995, Lascano *et al.* 1995, Norton *et al.* 1995, Viquez 1995, Macedo and Palma 1998). However, most of the research was based on experiments designed and conducted by researchers, carried out in research stations, in fertilized paddocks, using pure breed cattle, with full input supply; rather than on-farm conditions (Carter 1995).

In consequence, technologies did not correspond to farmers' objectives and results were not valid for farms with a completely different management, as most of the medium and small farmers in Central America do not apply fertilizers, have mixed breed cattle, and different grazing periods and stocking rates (Jansen *et al.* 1997). Thus, the practice of alley farming and fodder banks was limited by a failure in the technology generation and diffusion model. As result the practice of alley farming and fodder banks is minimal in livestock productions areas of Central America (Pérez-Guerrero 1985, Argel *et al.* 1998, Pezo and Ibrahim 2002, Dagang and Nair 2003). Their presence is always linked to agroforestry or silvopastoral promotion projects or experiments in research stations (Reyes 2006, López *et al.* 2007b, Pagiola *et al.* 2007, Sánchez 2007, Turcios 2008); with little non-induced implementation carried out by farmers (Argel *et al.* 1998). Some of the important information about fodder banks and what factors may have encouraged or limited adoption is reviewed below.

Fewer factors that encouraged alley pastures and fodder banks establishment are reported compared to other SPS. Their practice was related to trends in the prices of commercial concentrates; and to the natural, financial, and human capitals. The price of commercial feed concentrates has increased, limiting its use by small farmers with reduced financial assets. This may encourage an opportunity for using on farm feed sources at cheaper prices, including alley farming and fodder banks (Holmann *et al.* 1992, Benavides 1995).

Financial capital is another factor that encourages alley farming and fodder banks establishment. Several studies have reported positive returns from these SPS options, showing that they could be profitable (Holmann *et al.* 1992, Camero 1994, Sánchez 2007, Turcios 2008). Positive financial returns were related to changes in natural capital such as: higher pasture production and nutrients availability that allowed higher stocking rates. Reports from Costa Rica showed increases in beef cattle production of 20% compared to feeding without supplementation (Ibrahim *et al.* 2000) and up to 10 to 23% of milk production in Costa Rica and Guatemala (Camero 1994, Turcios 2008).

On the other hand, PES and other monetary incentives in Nicaragua managed to encourage the establishment of alley farming and fodder banks (López 2005, Pagiola *et al.* 2007). Poor farmers are reported to lead the establishment of such systems by expanding its area from 88.4 to 243.6 ha (Casasola *et al.* 2007, Pagiola *et al.* 2007). Abundance of cheap labour resulted in reduced costs for establishment and management, making alley pastures and fodder banks more attractive (López *et al.* 2007b, Pagiola *et al.* 2007).

Human capital is a key factor favouring alley pastures and fodder banks practice. Variables related to human capital such as: years of experience with livestock activity, years in school, technical assistance and previous experiences with SPS in the area were identified as features shared by most of the farmers practicing such technologies in Nicaragua (López 2005, López *et al.* 2007b). Experience in livestock farming helped farmers to acknowledge the necessity of alternative options for cattle feeding during the dry season. This combined with the provision of technical information and previous local knowledge about these SPS options facilitated the adoption of such complex technologies (López *et al.* 2007b). Education may have facilitated dialogue with technical staff, which in consequence helped to assimilate new information and encouraged the establishment of alley pastures and fodder banks.

Several factors related to the context in which livestock production is practiced, the natural, cultural, financial, built, and human assets limited the practice of alley pastures and fodder banks. Elements of the context such as weak markets and low prices for livestock products are likely to discourage intensive practices. This has been reported in Nicaragua where middle-men usually pay low prices to enhance their profits (Yamamoto *et al.* 2007). Farmers receiving low income are likely to have less financial resources for further investment in improving productive systems, including alley pastures and fodder banks.

Factors associated with natural capital discouraged alley pastures and fodder banks establishment. Soils in livestock productive areas present disadvantages such as: low soil fertility, steep slopes, stony and acid soil, and poor drainage. These make it difficult to establish shrub species because of limited survival of seedlings (Pérez-Guerrero 1985, Benavides 1995, Sánchez 2007). Weeds, fungi diseases and pest damages also have affected the establishment of alley pastures and fodder banks. Attacks from pest such as: *Atta* spp., *Heteropsylla cubana*, *Phyllophaga* spp., and *Tettigonia* sp. have been reported for leucaena (Lascano *et al.* 1995, Viquez 1995, Turcios 2008). As a consequence, remediation practices are needed, however, they require more investment. Pest control is not always effective, demands more knowledge and inputs, and in some cases imply the use of practices that are not part of the regular management of pastures such as fertilization and intensive rotational grazing (Pérez-Guerrero 1985, Benavides 1995, Argel *et al.* 1998, Cruz and Nieuwenhuyse 2008).

Financial capital was the most cited factor limiting the practice of alley pastures and fodder banks. Cut-and-carry systems have been reported as unprofitable due to the higher labour required for its management, and its practice represents a risk for the farmer and its household (Lascano *et al.* 1995, Sánchez 2007). This has occurred in countries such as Costa Rica, where hired labour is scarce because people migrated to urban areas or work in other rural activities with higher salaries (Holmann *et al.* 1992, Sánchez 2007). In such a context farmers were less likely to establish alley farming and fodder banks. In the case of Costa Rica, farmers receiving monetary incentives for implementing SPS options, only established additional 3.9 ha of forage banks, whereas in Nicaragua where labour is less expensive they established 155.2 ha in a five years long project (Casasola *et al.* 2007).

Farmers express no interest in using practices that are expensive. Cut and carry systems are more expensive than browsing systems and much more expensive than pastures for grazing. Studies reported expenses in cut-and-carry systems up to six times higher than those of browsing systems (Holmann *et al.* 1992). Recent reports showed differences up to two times higher between cut-and-carry systems and browsing systems (Sánchez 2007). On the other hand, browsing systems require higher investment than pastures. Jansen *et al*. (1997) reported that browsing systems costs 90% higher than those of establishing a *Brachiaria brizantha* pasture, making alley pastures and fodder banks systems unattractive to farmers. However, tangible benefits from alley pastures and fodder banks are obtained in the medium term. Jansen *et al*. (1997) specified that at least five years were needed to recover the investment. Moreover, farmers may require further investment in built capital such as: cattle breeding, machinery and feeding facilities to enhance the benefits that could be obtained from alley pastures and fodder banks (Holmann *et al.* 1992, Jansen *et al.* 1997). It is difficult for farmers with limited financial assets or no access to credit, and economic incentives such as PES or subsidies to implement such SPS options (Jansen *et al.* 1997, Pagiola *et al.* 2007).

Human capital factors also constrained the practice of alley pastures and fodder banks. Rural areas in Central America have weak formal education programmes, as well as poor research and technical assistance services. Therefore most poor farmers have low levels of formal education, and limited access to technical assistance and information programmes (Argel *et al.* 1998, Love and Spaner 2005). The few technical assistance services available are weak because of financial and staff restrictions, and are likely to use inadequate methods of communication and work strategies (Love and Spaner 2005). All these have limited the implementation of alley pastures and fodder banks (Lascano *et al.* 1995).

There are cultural factors that also limit the practice of alley pastures and fodder banks such as the incompatibility with the livestock production systems. For instance, cattle extensive production systems have low yields, however, they are able to maintain cattle with feed supplementation and rented pastures during the dry season (Love and Spaner

2005). Preventing cattle mortality is one of the main concerns of small and medium farmers practicing extensive livestock production systems. Increasing productivity is not a priority for them, thus, alley pastures and fodder banks are not implemented, more when the latter usually did not result in significant increases in cattle survival (Love and Spaner 2005). Furthermore, the use of woody perennials for feeding cattle represents a drastic change in the traditional image of feed resources from farmers, such change can be more difficult due to negative myths around the use of fodder banks; and the lack of observable experiences for demystifying some negative perceptions about alley farming and fodder banks (see Chapter Five, Dias-Filho 2008).

2.6.3. Promoting silvopastoral systems in Central America

Regional, national and local programs encouraging the establishment of SPS options have been carried out in Central America since the early 1980s. Based on the evidence of farmer's knowledge about using woody perennials for feeding livestock (Benavides 1994, Alonzo *et al.* 2001), it was proposed the feasibility of designing and implementing improved SPS. Strategies used by SPS programs usually include the provision of incentives and technical assistance, which have temporary effects in the intervention areas. However, such programs usually failed to identify and promote supportive strategies such as policies. Thus, the efficiency of SPS initiatives was limited by external factors, such as markets, price trends, and national policies.

Technical assistance has been pointed out as a strategy for encouraging the implementation of SPS, and this has been used in most efforts for promoting SPS in Central America. However, its efficiency has been criticized because of the following: (a) the use of top-down approaches that did not encouraged farmers participation; (b) insufficient number of technical staff hired; (c) tended to focus its efforts on SPS options designed by researchers; and (d) failed to recognize farmers' capacity of innovation and the value of traditional systems. The technical assistance efficiency was also been affected by the structural adjustment reforms that recommended reduced responsibilities from the state and the privatization of some activities such as the farming extension. Consequently, the organizations working with the generation, adaptation and extension of farming technology in Central America had less financial and human resources, that in most of the cases reduced the quality and quantity of the services provided to the farmers.

Provision of incentives by R&D projects is another common strategy used for SPS promotion in Central America and elsewhere (Hauff 1998). The range of incentives includes tangible ones such as food and inputs, as well as non-tangible ones such as social prestige and power obtained from establishing friendship relationships with staff working for the SPS projects (Hauff 1998, Kiptot *et al.* 2007). Incentives can encourage temporarily SPS and agroforestry practices (Current 1997), as illustrated by reports of technology abandonment once the provision of incentives was discontinued. This was observed in Western Kenya where farmers temporarily practiced the improved fallow technology, motivated by social prestige gained by having contact with project staff and by the additional income obtained from selling seeds bought by the project for establishing more improved fallow plots (Kiptot *et al.* 2007).

Other programmes have suggested the necessity of providing economic incentives through subsidies, or PES. In the past, most of the monetary incentives in forestation projects were granted to block plantations and forests plots. Nevertheless, after the recognition of environmental benefits provided by SPS such as carbon sequestration and storage, biodiversity conservation, watershed protection, and landscape aesthetic beauty, PES has also been conceded to SPS (Gobbi and Casasola 2003, Zbinden and Lee 2005, Pagiola *et al.* 2007). However, some challenges remain for their feasibility: First, it is necessary to find sustainable mechanisms for the payments, because until now there is no committed buyer for such services in the local and global perspective. Second, PES must find mechanisms for the participation of small and medium farmers, as it has been found that in previous experiences their participation was minimal compared with large landowners (Zbinden and Lee 2005).

A potential alternative that has been less explored is to implement a similar approach to that used with some agricultural products by generating organic, ecological, animal welfare or quality labelling for meat, milk and derivates and wood produced in SPS. Thus, consumers' preference for such products could provide the necessary funds for increasing farmers' interest in more environmentally sound practices such as SPS. Currently, Rainforest Alliance and CATIE are developing the first voluntary norms for sustainable livestock production in Central America (SAN 2010). A surplus in the livestock products obtained from certified farms would help to obtain better prices compared to conventional products. Nonetheless, such alternative would increase transaction and management costs, and is likely to require more organizational capacity and knowledge.

On the other hand, policies supporting SPS implementation must be identified and applied according to the local conditions of the farmers (López 2005, Trautman-Richers 2007). This has been a bottle neck in agroforestry research and practice, as most of the programmes have addressed technical aspects of generation and diffusion of SPS; yet almost none have formulated national policies that would encourage SPS practice. In the same way, social and cultural assets related to agroforestry and SPS practice must be investigated to define suitable strategies in agroforestry programmes. Both factors have been considered in fewer studies, in contrast with the large use of economic and biophysical variables (Sood and Mitchell 2009), especially in SPS practice studies. Thus, the influence of such factors that limits SPS practices has been underestimated and unattended.

Chapter 3. Methodological framework

3.1. Study area

The Multi-stakeholder Participatory Development of Sustainable Land Use Alternatives for Degraded Pasturelands in Central America project (DEPAPRO) established three pilot zones: El Chal-Dolores, Petén, Guatemala; Juncal, Yoro, Honduras; and Muy Muy, Matagalpa, Nicaragua. The fieldwork for the first specific objective with the aim of documenting DEPAPRO intervention was carried out in the three pilot zones (see Chapter 1). The areas were identified as livestock negative impact hotspots in Central America (Szott *et al.* 2000).

The information to respond to the second and third general objectives regarding to technology preference and livelihoods impact (mentioned in Chapter 1) was generated only in the El Chal-Dolores pilot zone. This is because the methods used required more time and closer interaction with the different stakeholders. Budget was another limiting factor in a potential attempt to achieve the last two objectives in the three pilot areas. The first objective was oriented to obtain a general view of DEPAPRO's work and impact, while the second and third objectives were used for obtaining more in-depth information and analysis regarding the practices tested, farmers' preferences and impacts of the interventions promoted by DEPAPRO.

3.1.1. Location

Guatemala, Honduras and Nicaragua are part of the Central American Isthmus (Figure 3.1). The department[8] of Petén is located in the north of Guatemala and shares borders with México to the north and the west; with Izabal and Alta Verapaz departments to the south; and with Belize to the east (Colón 2005). El Chal-Dolores pilot zone is located between longitudes from 89º30' to 89º45' West; and latitudes from 16º35' to 16º46' North, and covers part of the Dolores and Santa Ana municipalities (CATIE-NORAD 2003a). The Matagalpa department is located at the North central Nicaragua. Matagalpa limits with Jinotega, Estelí and the Atlantic North Autonomous Region departments to the North; the Leon department to the West, Managua and Boaco departments to the

[8] The main administrative and political units in Central America are either the departments (Guatemala, Honduras, Nicaragua, and El Salvador) or provinces instead of States (Costa Rica).

South, and with the Atlantic North and South Autonomous Regions to the East (INETER 2005).

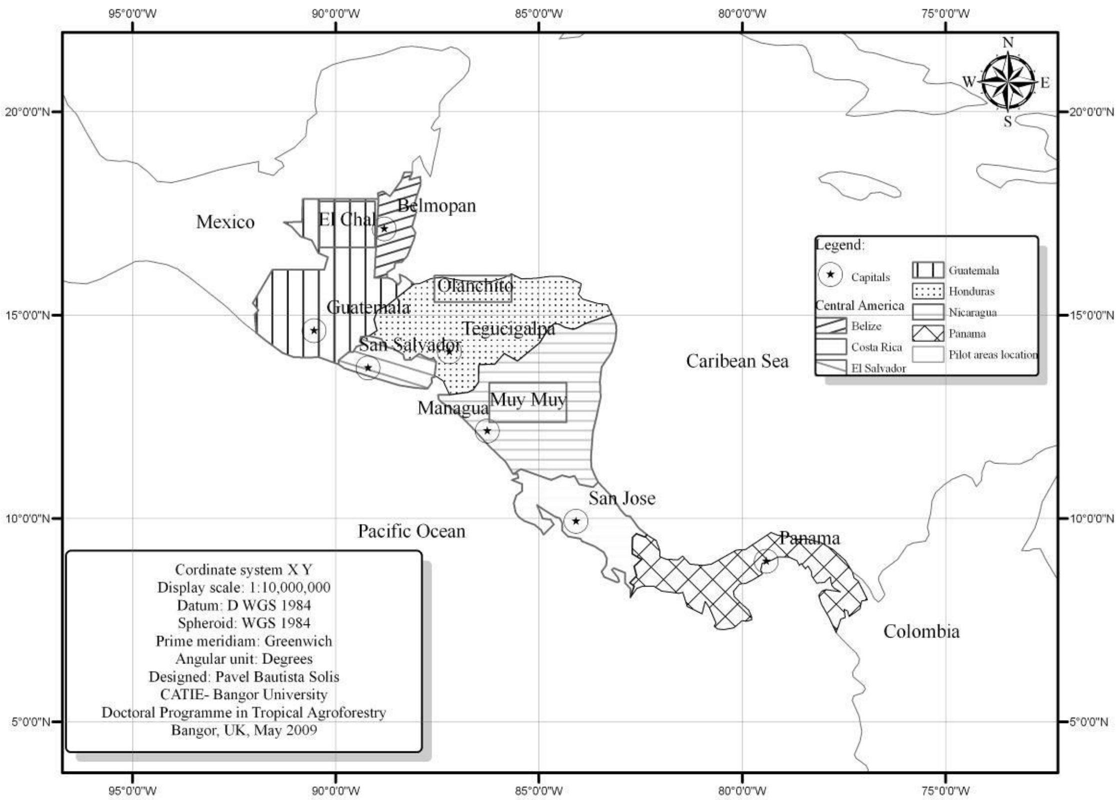

Figure 3.1. Study area location in Central America.

The Muy Muy pilot zone is located between longitudes 85º30’ to 85º45’ West; and latitudes 12º40’ to 12º50’ North, and corresponds to the Muy Muy municipality (CATIE-NORAD 2003a). The Yoro department is located at the North-Eastern Region of Honduras (Alvarado 2005), and limits with Atlántida department to the North; Comayagua, Francisco Morazán and Olancho departments to the South, the Cortés department to the West; and Olancho departments at the East. The Juncal pilot zone is located between longitudes 86º15’ to 86º27’ East; and latitudes 15º27’ to 15º35’ North, and covers part of Olanchito and Sabá municipalities (CATIE-NORAD 2003a).

3.1.2. Area and population

The area covered by DEPAPRO in the El Chal-Dolores pilot zone was of about 200 km^2 with a cattle farmers’ density of 1.4 farmers/km^2, whilst the Muy Muy pilot zone was of 110 km^2 with a cattle farmers’ density of 0.5 farmers/km^2, and the Juncal pilot zone was of 100 km^2 and a estimated cattle farmers' density of 2.1 farmers/km^2 (CATIE-NORAD 2003a). As indicated above, the El Chal-Dolores pilot zone covered parts of Dolores and Santa Ana municipalities. As of 2002, Dolores had a total population of 32,404 inhabitants and 75.26% of them (24,388 inhabitants) was rural. The total population of Santa Ana was 14,602 inhabitants, and 57.43% (8,387 inhabitants) was rural (INE 2002). The Muy Muy municipality had a total population of 14,721, and 72.6% (10,684 inhabitants) lived in rural areas (INEC 2006). The Juncal pilot zone is located in Olanchito and Sabá municipalities. Olanchito had a total population of 78,776 inhabitants, 67.79% (53,399 inhabitants) lived in rural areas; whereas the total population in Sabá was 19,266 inhabitants, and 39.80% (7,668 inhabitants) of them were rural settlers (INE 2001). Table 3.1 shows more detailed information about the municipalities covered by DEPAPRO.

Table 3.1. Land area and population characteristics in the countries, departments and municipalities from the study area.

Location	Land area (km^2)	Total population	Density (inhabitants/km^2)
Guatemala*	109,117	11,237,196	102.98
Petén**	35,854	366,735	10.22
Santa Ana***	1,541	14,602	9.47
Dolores***	2,495	32,404	12.98
Nicaragua*	130,737	5,142,098	42.7
Matagalpa**	6,803	469,172	69
Muy Muy***	375	14,271	39.2
Honduras*	112,492	6,535,344	58.09
Colón**	8242.8	235,272	28.5
Yoro**	7,776.9	470,544	60.5
Olanchito***	2,027.9	78,776	38.8
Sabá***	360.96	19,266	53.3

Notes: *Country. **Department. ***Municipality. Source: (Barona *et al.* 1988, INE 2001, 2003, INEC 2006).

3.1.3. Climatic conditions

Historic weather series for El Chal-Dolores were not found. The closest data available are those for the neighbour municipality (Flores) which is located at 123 meters above sea level (masl). Flores has an average annual mean temperature of 26.7 ºC and an annual average rainfall of 1589 mm (INSIVUMEH w. d.) (Figure 3.2).

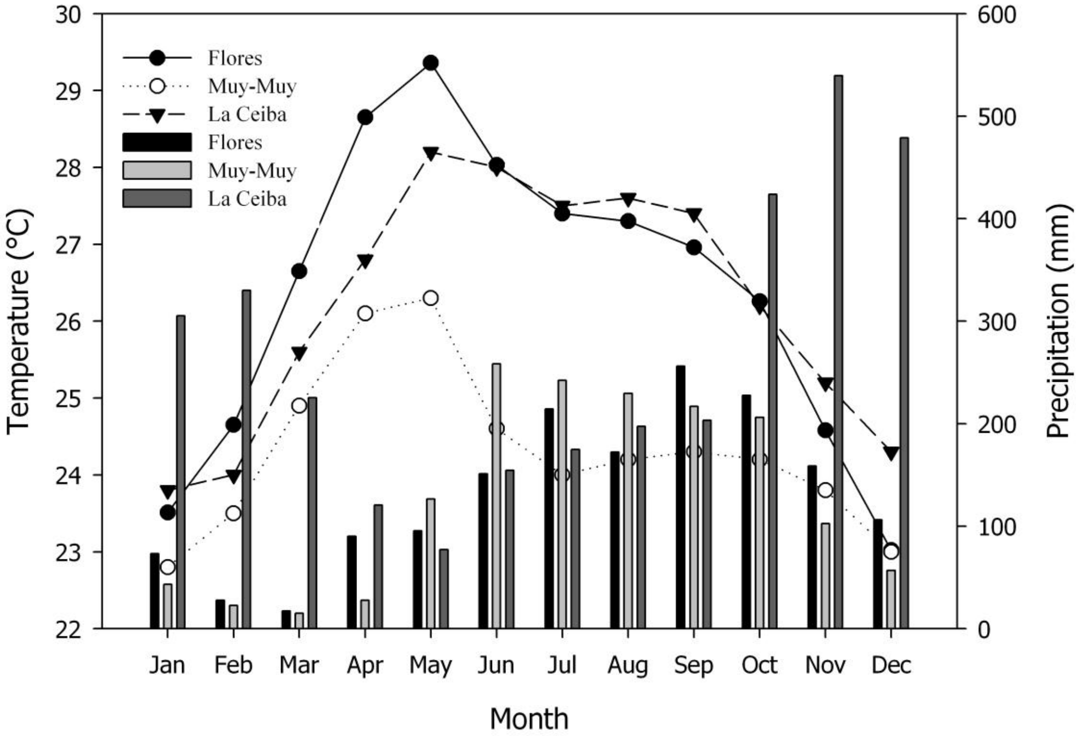

Figure 3.2. Monthly average temperature and precipitation in Flores, Guatemala (1990-1999 series), Muy Muy (1971-2000 series) and La Ceiba (1970-1999) (Freemeteo 1999, INETER 2007, INSIVUMEH w. d.).

The Muy Muy pilot zone corresponds to a sub-humid tropical forest in transition (CATIE-NORAD 2002). The rainy season in Muy Muy is between June to December, with an annual average rainfall of 1547.1 mm; while the annual average temperature is around 24.3ºC with a maximum mean temperature of 26.3ºC in May and a minimum of 22.8ºC in January (INETER 2007). Finally, the Juncal River pilot zone is located in a humid-tropical-forest area, with an annual average rainfall of 1,910 mm and average mean temperature of 24.0ºC (CATIE-NORAD 2003a). The nearest weather station is located in La Ceiba, at about 70km from Juncal. However, it must be stressed that the annual rainfall average could be highly influenced by excessive rains registered in 1998, when hurricane Mitch affected the area.

3.1.4. Topographic and soil conditions

Dolores is located at an average elevation of 436.5 meters above sea level (masl). Nonetheless, the elevation in the pilot zone presents differences in a range from 140 to

490 masl (Betancourt 2006). Despite such differences, the land in Petén is generally flat to undulated, commonly with slopes ranging from 2.0 to 10.0% (Hernández 2001), and very few steep slopes, mostly out of the pilot zone (SEGEPLAN 2000). Muy Muy is located at an average of 337.6 masl (INETER 2005). However, the elevation in the pilot zone ranges from 220 to 780 masl (CATIE-NORAD 2003a). The Muy Muy municipality topography is distributed as follows: 32.1% flat lands, 41.0% undulated, and 26.9% steep slopes lands (INIFOM w.d.). The Juncal pilot zone is located between 110 to 650 masl (CATIE-NORAD 2003a), and the slope varies from zero to 31%.

Most soils in Petén are low fertility soils. Usually Alfisols, or moderately leached forest soils with relatively high native fertility, and high base saturation; and Ultisols or strongly leached acid forests soils, with relatively low native fertility and low base saturation (Bach 2005, McDaniel w.d.). In Muy Muy Vertisols or high clay soils that usually shrink and swell when moisture content changes are found, and also Inceptisols or soils with low developed horizons, and less frequently Molisols or grasslands soils with a high base status, and thick and dark surface horizon (Ospina 2005, McDaniel w.d.). Soils in the municipalities of Olanchito and Sabá are mostly Cambisols, Fluvisols and Nitosols (Barona *et al.* 1988).

3.2. Materials

The main materials used for obtaining background information in the present research project included the use of digital maps available in the national cartographic services of Guatemala, Honduras and Nicaragua; climatic data from the national meteorological institutes; the socioeconomic and GIS data, as well as general information gathered by DEPAPRO for its baseline study, and other documents like theses and national censuses already published.

3.3. General approach

The present study was accomplished using participatory, adaptive, *emic*, *etic* approaches. In qualitative research *emic* is related to the insiders' point of view, whereas *etic* can be considered the vision of the outsiders or researchers (Given 2008). This research is considered participatory because it tried to promote reflection and learning among all participants. Moreover, previous research with participatory approaches have shown to be useful for eliciting reliable qualitative data and helped to achieve intended objectives (Rölling and Fliert 1998, Staver 2005, Adato and Meinzen-Dick 2007, Piniero and Aguilar-Støen 2009). Adopting this approach facilitated working in concordance with the Farmer Field School (FFS) and the participatory endeavour that DEPAPRO encouraged for its intervention activities. The research was adaptive because the process and even the goals of the study were not fixed *ex-ante*, instead those were adapted or modified as the research results showed what was relevant and what was not (McCracken *et al.* 1988). The use of the *emic* approach was emphasized during the fieldwork and in the data analyses because the insiders' points of view were considered and prioritized. On the other hand, the *etic* or researcher's perspective was integrated in the analyses and in explaining the results. Finally, outputs of any specific stage of the research were used as inputs for other sections. Some of the elicitation methods or techniques were used more than once.

3.3.1. Ethical issues

The principles for conducting ethical research such as autonomy, non-malfeasance, beneficence and justice (Flicker *et al.* 2007) were adopted and practiced in this study adopting the following procedure:

i. The authorized consent was asked from every actor who participated in the study. This was accomplished initially with local authorities and leaders; and later, applied while undertaking any of the research elicitation techniques and activities with groups or single actors.

ii. The objectives of the research and how the information elicited would be used were explained to all actors participating in the research. This helped to prevent raising false expectations about the use of the information or the implications of the research (Laws *et al.* 2003).

iii. Anonymous status for all the participants was guaranteed through a codification of the instruments applied. Any single participant was identified by a number and their real identity was not revealed. This was explained to all actors who provided information with the aim of avoiding the fear of being affected for revealing potential conflictive facts.

iv. The time spent by participants was considered important, therefore special attention was put to not overuse farmers' time (Rambaldi *et al.* 2006). This was done by reviewing and obtaining any information already available, instead of asking it to interviewees. Some of the elicitation methods or techniques were not strictly designed to be answered by the household head, so other members participated. In this way, the time invested by each household member in the study was reduced.

v. When possible, workshops and focus group discussion were undertaken to present the research main results. The methods applied were chosen for maximizing the participation of the stakeholders and the internal validity of the data, as well as to allow mutual learning and reflection between the stakeholders and the author of this study. This was done to avoid criticism about extractive research (Thrupp 1989).

3.4. Population frame

The population of the study varied according to each of the objectives. In objective one the population was formed by any stakeholder of DEPAPRO: from farmers to decision makers of partner institutions. In objective two the population frame was the group of livestock farmers participating in DEPAPRO activities in Petén. In such pilot zone there were four groups of livestock farmers working with DEPAPRO: El Ejido, El Chal, Santa Rosita and La Amistad (n_1=39). Additionally, two more groups: El Porvenir and La Cumbre from the anchoring and expansion area from DEPAPRO were also selected because they were already testing some of the technologies promoted by DEPAPRO (n_2=24). The population frame considered for objective three was 42 farmers participating with DEPAPRO in the pilot area of Petén; and 36 livestock farmers who were not participating in the learning groups. The latter participated as control to establish FFS participants versus non-participants livelihoods comparison.

3.4.1. Sampling strategy

The lack of sampling frames, restrictions of time and limited budget for carrying fieldwork made difficult the use of probabilistic sampling. However, results were not intended to be valid to represent larger populations. Therefore, probabilistic samples were not used because these are not compulsory for this particular case (Laws *et al.* 2003). Furthermore, since the total population of interest was 63 FFS farmers, selecting a random sample of this population would have reduced the possibilities of finding statistical differences. Thus, a purposive or non-probability sampling technique that considered the maximum number of available participants per objective was used. The sampling strategy then was more similar to a census rather than to a probabilistic sample. On the other hand, to elicit the information, a two stage sampling process was conducted. The first stage was intended to compile preliminary information like the technologies census, farms, farmers, and technologies' general characteristics. The second stage focused on eliciting more in depth information about farmers and their livelihoods.

3.5. Methods

Three main steps were followed according to the specific objectives (Figure 3.3). Each of these steps was considered a potential input for the other steps. The three steps had a common phase of establishing rapport with partner farmers and DEPAPRO staff, carried out from September 2007 to December 2007. This was done by interacting with farmers in the participatory learning and other activities performed by DEPAPRO. The role of this author in those activities was to assist both DEPAPRO's staff and farmers, but not being engaged in instructing, lecturing or giving advice about the technologies being discussed. This was done to prevent being identified as DEPAPRO`s staff. Additionally, this author observed the groups' dynamics to become familiarized with local terminology and farmers' vocabulary. This helped to improve the communication and confidence for future activities.

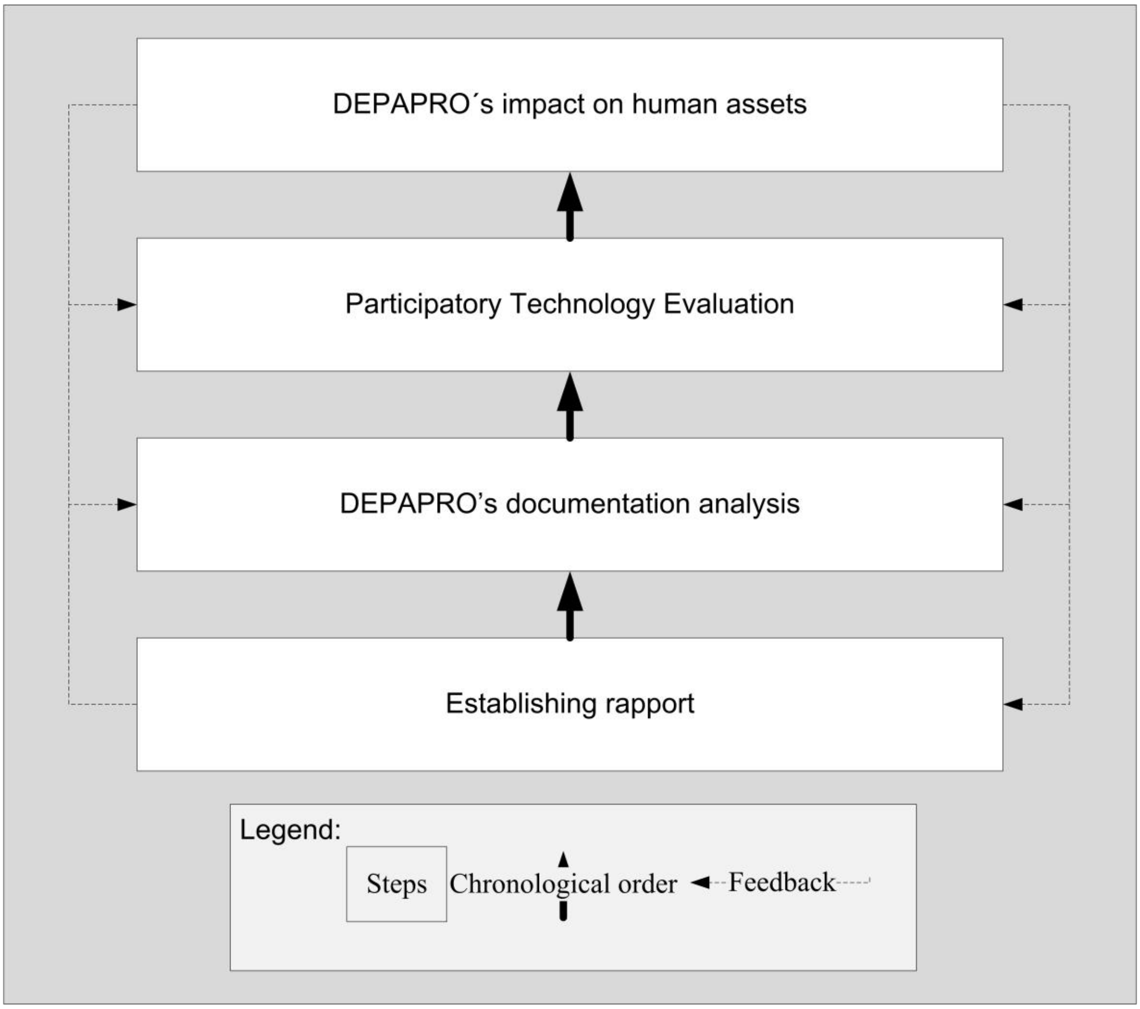

Figure 3.3. General scheme of the study.

3.5.1. Documentation process

The "documentation process" also referred to as "systematization" (Chavez-Tafur *et al.* 2007:10), was carried using the information generated from Guatemala, Honduras and Nicaragua. Experience documentation as defined by Jara (1994) means "understanding why the process is developing in a given way, understand and interpret what is happening with an ordering and reconstruction of what happened in such processes". The documentation was considered an analysis of the historical process of DEPAPRO, interpreting critically its experience by ordering and reconstructing the activities that were implemented.

The documentation process was then undertaken: (1) to understand how the socio-economic and institutional contexts of the pilot zones before and during the project influenced the DEPAPRO's activities; (2) to narrate the project intervention related to the participatory learning and experimentation with technologies; (3) to critically reflect of DEPAPRO's experience about the participatory approach and the technology trial and promotion; and (4) how to use the lessons learned for current and future activities and to guide future interventions (Varela *et al.* 2005, Chavez-Tafur *et al.* 2007).

The information was documented and analysed considering the implications of the project as a whole (Varela *et al.* 2005). However, the axis suggested by the stakeholders for documenting was the process used for promoting participatory learning and the experimentation with alternative land uses: the FFS. The documentation exercise was intended to be participative in a kind of "consultation" way, because the different stakeholders participating in the exercise were not included in the planning process and in defining the documentation objectives (AGRECOL ANDES 2003). The following stakeholders were considered for accomplishing the documenting process:

i. Farmers participating in any of the DEPAPRO's FFS groups.
ii. Current DEPAPRO's field technicians.
iii. DEPAPRO's National Coordinators in participating countries.
iv. Staff from partner organizations with formal collaboration agreements with DEPAPRO.

Several references were consulted to develop the documentation procedure (Berdegué *et al.* 2002, AGRECOL ANDES 2003, Coppens and Velde 2005, Varela *et al.* 2005, Chavez-Tafur *et al.* 2007). The procedure is summarized in the following steps (Table 3.2). First, the "starting point" or context influencing the initiative was obtained (AGRECOL ANDES 2003), emphasis was made in documenting and understanding the influence of the procedures employed by previous organizations working with trainings in each pilot area. Second, the "boundaries definition" or the objectives, utility, time, place, stakeholders, and topic of the documentation were defined. Third, the intervention reconstruction in a chronological order was made. Fourth, inputs of the previous steps were used for analyzing and constructing a critical reflection. Fifth, the main conclusions and recommendations were formulated and communicated to the stakeholders.

The elicitation techniques employed for the documentation were: stakeholders' prioritization, field visits, semi-structured interviews, systematic observation, focus group discussions and workshops for promoting feedback and presenting results. More detailed information about the latter techniques is provided in section 3.7. Techniques like probing in semi-structured interviews helped to enhance the amount and quality of the information.

Table 3.2. Documentation general procedures.

Phase	Objective	Methods
Starting point	To obtain key-secondary information and to define what is relevant for establishing the context	Literature review, informal dialogues
Boundaries definition	To define the objectives, stakeholders, place and time of the systematization	Literature review, field visits, observation, stakeholders prioritization
Intervention reconstruction	To develop a narrative of the intervention of DEPAPRO in the three countries, the learned lessons and reversal learning	Literature review, semi-structured interviews
Analysis	To obtain a critical reflection of DEPAPRO's experience	Interviews and secondary information analysis and reflection
Final phase	To obtain and socialize the main conclusions and practical recommendations	Workshop, thesis report, paper, congress presentation

Based on: (Jara 2001, Berdegué *et al.* 2002, AGRECOL ANDES 2003, Coppens and Velde 2005, Varela *et al.* 2005, Chavez-Tafur *et al.* 2007).

3.5.2. Participatory technology evaluation (PTE)

How farmers perceived technology interventions and how it influenced their testing was analysed in this part of the study. Farmers' perceptions is useful in understanding the decision making process for land use establishment, beyond economic benefits (Cook and Grut 1989, Adrian *et al.* 2005). Understanding farmer's perception can help clarify the adoption intensity of any technology intervention. This was identified as a research-need in adoption studies (Mercer 2004). However, despite such importance and even when perceptions have shown reliability in the comprehension of agricultural technology adoption processes (Abul Kashem and Jones 1988, Adesina and Zinnah 1993, Wossink *et al.* 1997, Makokha *et al.* 1999, Sall *et al.* 2000, Pavlikakis and Tsihrintzis 2003, Rahman 2003, Masangano and Miles 2004, Waithaka *et al.* 2006, Wubeneh and Sanders 2006); few studies of agroforestry technology have included the analysis of farmers' perceptions (Matthews *et al.* 1993, Douthwaite *et al.* 2002, Neupane *et al.* 2002, Zubair and Garforth 2006), and even fewer considered farmers' perceptions of silvopastoral technologies in Central America (Anfinnsen 2005). For the evaluation of farmers' perception of technologies, the following actors were considered:

i. Farmers participating in DEPAPRO's FFS groups and testing the *Leucaena leucocephala* plots.
ii. Farmers participating in DEPAPRO's FFS groups, but not testing leucaena plots.

DEPAPRO promoted and tested several SPS technologies in the three pilot zones, however, the most accepted was the establishment of *Leucaena leucocephala* plots, with or without pastures. Other technologies related to solving problems associated with the overall livestock production systems were promoted as well. Among those were the multi-nutritional blocks, silage conservation, grass-legume mixtures and improved rain water reservoirs. A list of the technology trials in the three pilot zones of DEPAPRO for 2005-2006 is presented in Table 3.3.

Table 3.3. DEPAPRO's experiments and technology trials 2005 - 2006.

Technology	El Chal	Olanchito	Muy Muy
Improved pastures with and without *Arachis pintoi*	1	27	6
Arachis pintoi multiplication plots	22	--	--
Fodder banks for cut and carry or browsing	25	3	10
Weed control and rehabilitation of degraded pasture lands	9	2	1
Improved rotational grazing systems	5	--	1
Enrichment of fallow vegetation	2	--	--
Live fences and timber trees in perimeter fences	12	--	--
Gliricidia sepium compact blocks for poles production	1		
Arachis pintoi as cover crop in timber tree plantations	3	--	--
Silage making	--	--	7
Milking parlor	2	--	3
Total number of trials	***82***	***32***	***28***

After: (CATIE 2006b). The number of trials not necessarily corresponds to the total number of farmers carrying out the trials.

The general procedure started with a census and a technology prioritization of land use technologies promoted by DEPAPRO, and the procedure for doing it in Petén, Guatemala (Appendix 1). These were prepared by reviewing previous reports and interviewing key actors like DEPAPRO's technicians, professional staff from partner organizations (experts), and farmers. Based on the technology census and prioritization, eight focus group discussions were carried out. The aim of these sessions was to document and discuss farmers' perceptions and preference of technologies and corroborate information obtained through semi-structured interviews. The following elicitation techniques were adapted and used for documenting farmers' perceptions: free listing, pile sorts, ranking order, semi-structured interviews, systematic observation, and informal dialogues (Quirós *et al.* 1992, Guerrero *et al.* 1996, Rusell 2006). The analysis of the information included descriptive statistics, coding, cross-tabulation, and narrative analysis. A condensed description of the procedure is presented below in Table 3.4.

Table 3.4. Technology evaluation, perceptions and characteristics influencing its trial procedures.

Phase	Objective	Methods
Inventory of technologies	To identify which technologies were tested and select those considered for the perceptions and evaluation exercise	Semi-structured interviews, systematic observation, informal dialogues, free listing, pile sorts, technology ranking
Preliminary information	To obtain household, farm, farmers and technology characteristics	Semi-structured interviews, GIS, field visits, literature reviews
Documentation of farmers' perception	To assess farmers' perception	Informal dialogues, focus group discussions
Data analysis	To analyze quantitatively and qualitatively the information obtained	Contingence tables, coding, narrative analysis, logistic regression
Outputs	To communicate the main conclusions and recommendations	Workshop, thesis report, paper, poster

Farmers' typologies were used to identify which technologies were being tested or adapted by specific groups of farmers based on their general characteristics. Semi-structured interviews and literature review helped to identify and describe the characteristics of the technologies promoted by DEPAPRO and the adaptations or modifications carried out by the farmers.

3.5.3. FFS impact on farmers' human assets

The sustainable livelihoods approach (SLA) was used to assess the effects of the FFS and land use technologies encouraged by DEPAPRO on farmers' human assets. SLA served to assess the impacts of FFS in an integrated and more holistic way, as it allows to include more components of the silvopastoral technologies promotion, capacity development and social capital interventions (Adato and Meinzen-Dick 2002, Meinzen-Dick *et al.* 2004, Alene *et al.* 2007). SLA considers the main factors affecting people's livelihoods including the vulnerability contexts, influence of and access to livelihood assets, structures and processes of transformation. Relationships between these variables determine people's livelihood strategies and their outcomes.

SLA can be used for both planning and design of new development interventions and assessing the contribution of existing activities to the livelihood sustainability (DFID 1999). However, the approach has been criticized for excluding key factors such as culture, power and farmers' experiences. As such factors are important for understanding the farmer's decision making, SLA is considered to have limitations for analyzing innovations (Meinzen-Dick *et al.* 2004). Based on this the present study complemented the human assets included in the SLA with the cultural capital, and the political capital as suggested in the Community Capitals Framework (Flora *et al.* 2004, Gutiérrez-Montes 2005). Seven assets were considered in the present study, however, the discussion is focussed in the impacts of the FFS on the human assets: human, social, cultural and political (Table 3.5, Figure 3.4).

To address this objective, a literature review about livelihood assets and capitals in the pilot zone was carried out. The sources of secondary information reviewed include diagnostic studies of villages performed by undergraduate students working with DEPAPRO and the household socioeconomic survey. The missing information about assets or capitals was elicited in the villages using household semi-structured interviews, key informant interviews, systematic observation and focus group discussions using PLA (Geilfus 1997). The target population was formed by farmers working with DEPAPRO in the El Chal-Dolores pilot area (n=39). The study was focused on analyzing FFS impact on the livelihoods of these farmers and not in communities of Central Petén. Consequently, the questions in the semi-structured interview were directed to investigate the perceived changes in the household.

Table 3.5. Capitals or assets considered for studying the famers' livelihoods.

Capital/vulnerability context	Description
Capital	
Social[9]	Interactions, connections, relations with formal and informal groups and individuals, organizations number and status, trust relationships, cooperation, reciprocity norms
Human	Aptitudes, knowledge, labour capacity, health, self-esteem, and leadership
Cultural	Values, traditions, dressing, language, art, customs, ways of knowing and being
Natural	Natural resources, biodiversity, water, air, trees, land, soils
Financial	Money availability or equivalents, savings, bank deposits, actives like livestock, jewels, credits, remittances, investments, among others
Built	Basic infrastructure for home and production, production assets, tools, equipment, transportation, accommodation, water supply, served water disposal, energy, information
Political	Governance, access to resources, influence in the rules of the game, institutions
Context	
Shock(s)*	Human health, natural, economic, conflict, crop or livestock health shocks
Trend(s)*	Population, resource, economic, governance, technological
Seasonality*	Prices, production, health, employment, labour, rainfall

Notes: * Not a capital, but a factor of the vulnerability context. Based on: (DFID 1999, Flora *et al.* 2004, Gutiérrez-Montes 2005).

[9] In this research two types of social capital were distinguished: (i) bonding social capital or relationships among individuals with similar background i.e., farmers; (ii) bridging social capital corresponding to relationships among individuals or organizations from a different background such as linkages between staff from organizations and farmers.

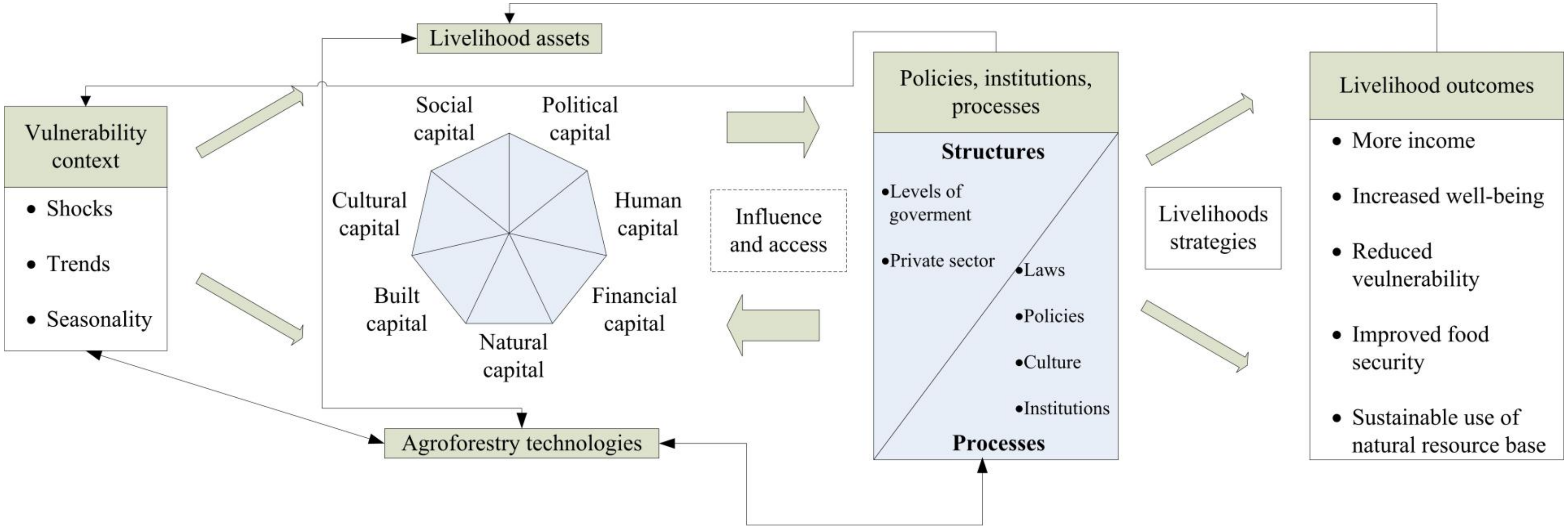

Figure 3.4. Sustainable Livelihoods Approach general scheme complemented with the cultural and political capitals (Based on: DFID 1999, Flora *et al.* 2004, Adato *et al.* 2007).

The first step undertaken was key informants' interviews. This tool was oriented to identify key indicators for analysing the impacts of DEPAPRO activities on farmers' livelihoods. Semi-structured interviews and systematic observation were used to elicit information about the current and past status of the farmers' assets, considering the lifespan of DEPAPRO 2003-2008 for comparing the changes that occurred. This helped to reveal changes in the human and material assets induced by DEPAPRO's activities. Farmers were interviewed about such changes and the reasons for their occurrence.

According to SLA, people's livelihoods are influenced by a vulnerability context (VC). The VC's main characteristic is that it is not susceptible to being controlled by the local people in the short or medium term (DFID 1999). The VC in the SLA is usually defined by factors such as: "seasonality", "shock(s)" and "trend(s)". However, aspects related to the political capital might interfere as well. To assess the VC that the livestock farmers face in the pilot zone, PLA techniques like timelines and seasonal calendar diagrams were used and these were supported by secondary information.

3.6. Elicitation techniques

Twelve elicitation techniques were employed in the present research. The following paragraphs summarize a brief description of how each technique was employed.

3.6.1. Interviews

The main characteristic for identifying interview types is the amount of control that the researcher sets *ex-ante* (Laws *et al.* 2003, Hillyer and Ambrose-Oji 2005, Rusell 2006). Considering this criterion Russell (2006) distinguishes four main types of interviews: (1) informal interviewing (INI), (2) unstructured interviews (UNI), (3) semi-structured interviews (SSI) and (4) structured interviews (STI). INI and SSI were used in the present research. INI formed part from the documentation procedure employed in the first specific objective; while SSI was used in the three specific objectives.

3.6.1.1. Informal interviewing (INI)

INI is characterized for its lack of control and structure in terms of the questions to be asked (Rusell 2006), being more similar to a normal conversation. INI was used during the initial stages to enable to know informants, generate rapport and to elicit basic data from the study area and of DEPAPRO. The process was carried out by establishing informal dialogues, on an individual basis, with informants contacted from DEPAPRO's office or directly in the study area. The requisite for selecting participants was that informants should have been involved in DEPAPRO related activities. The interview was focused in directing the conversation to the informant expertise, with non planned questions. Conversations were recorded with the informants' previous authorization. If not, brief notes were taken and the remembered information was transcribed at the end of the conversation.

3.6.1.2. Semi-structured interviews (SSI)

SSI was also employed for reconstructing the history of DEPAPRO intervention (Appendix 1), carrying out the technology census (Appendix 2), and in the assets mapping (Appendix 3). Pre-testing of the SSI protocols helped to correct some issues related to the necessity of adapting it to register quantitative or qualitative data. This was accomplished to speed up the process of transcription. The pre-testing of the SSI protocols also helped to change the strategy on how the questions should be asked, but no major changes were made in terms of the content of the questions. Moreover, voice recordings were found useful for corroborating data and increased the validity of the information elicited. Other elicitation techniques such as free listing and ranking and scoring were embedded in the SSI protocols when it was needed to rank the preference of land use alternatives or for estimating the level of knowledge about some technologies in specific tasks.

3.6.2. Free listing

Free listing was carried out with the aim of studying which technologies were salient for certain kind of farmers. In that sense, it was implemented in the livelihoods SSI to get information on the feed resources used for cattle. However, as the information obtained could be affected by seasonal bias, with farmers tending to list technologies related to the dry season when there is scarcity of pastures, farmers were asked to consider a time frame longer than one year. The procedure started with simple questions including: (1) what activities did you perform with DEPAPRO? (2) What do you use for feeding cattle? Additionally, the probing technique was used for helping farmers to remember the activities, for understanding some local terms related to cattle production activity in Petén and for corroborating the validity of information provided by the participants.

3.6.3. Field visits

This technique was basic for obtaining a better understanding of the factors affecting the production systems of the farmers. In this research two types of field visits were considered: (1) visits to the farmers' house or communities; (2) visits to the farmers' farms. Field visits were used jointly with other techniques like systematic observation for checking or obtaining information about house materials, livelihoods strategies and tested technologies by farmers.

3.6.4. Systematic observation

The present study observed people behaviour, the state of the technologies or pastures promoted in the field and the infrastructure of the farmers' household or the communities. Information obtained through other techniques was corroborated with the observed facts in the field. This helped to increase the internal validity of the results. Guides for the observation of farms, households, relationships and infrastructure characteristics were prepared prior to undertaking the activity.

To reduce observer bias the author tried to be as objective as possible while making observation notes. The motivations, meaning or implications of the observed facts were further investigated with the support of other elicitation techniques when this was necessary. Results of observations were supported by pictures from households, farms and communities.

3.6.5. Focus groups discussions (FGD)

Two focus group discussion session types were carried out during fieldwork: (1) technology preference FGD; (2) context of vulnerability FGD. The technology preference FGD session was carried out with the aim of estimating the preference that the farmers had for the land use alternatives encouraged by DEPAPRO. Ten FGD sessions were carried out: six sessions were developed with the participation of farmers from the pilot area FFS groups; two sessions with farmers from the anchoring and expansion FFS groups; and two more sessions corresponded to participants from *ad hoc* groups formed by farmers who did not participated in the FFS groups. The technology preference FGD included the brainstorming, technology ranking, technology scoring and pile sorting techniques which are explained in the following sections.

3.6.6. Brainstorming

Brainstorming was used in the technology preference FGD with the aim of establishing confidence, identifying the technologies that were analyzed and obtaining characteristics of technologies analyzed as perceived by participants. Participants were asked to choose a name for a collage of pictures representing the eight technologies analyzed. For avoiding influences from other participants the information in this activity was asked to be answered individually by writing the suggested name on a piece of paper. Furthermore, farmers and their wives were asked to identify advantages and disadvantages of the technologies analyzed and to explain their reasons about such selection. Even though it is recognized that some participants could have been influenced by comments of others, the facilitator asked to provide such comments according to the particular situation of each household.

3.6.7. Ranking and scoring

Technology ranking was used during the technology preference FGD session for identifying which technologies were more acceptable for participating farmers. Participants were asked to perform a pair-wise matrix exercise were nine technologies were compared, each participant was asked to write which technology is preferred from 36 possible pairs. Results were calculated through the session and presented in each FGD session for further discussion.

On the other hand, scoring was employed for determining the perception of the farmers about the negative or positive attributes of each technology. Participants were asked to score the previously selected comments or indicators. The scoring exercise was performed by providing participants with adhesive, small pieces of paper. Using these papers, participants were asked to score -with a maximum of 20 points per indicator- those technologies that for them were more likely to correspond to the comment or indicator (positive or negative) mentioned. This exercise was only performed with those farmers who participated in DEPAPRO’s activities, and not with the two *ad hoc* groups.

3.6.8. Pile sorts

Pile sorts were used for producing in-depth understanding of farmers' cognition about the technologies promoted by DEPAPRO. Results from the pile sorting exercise were video recorded. Pictures representing stages of improved pastures and Leucaena were selected for representing each technology. Pictures were printed and protected with a transparent plastic. Farmers were asked to order the pictures as they like to identify key stages of the on-farm technology testing procedure promoted by the FFS where they face more problems. Discussion was encouraged to obtain further information about such issues and the action taken by farmers and DEPAPRO to overcome those.

3.6.9. Time line

Time line was used during focus group discussions for trying to improve the understanding of the vulnerability context affecting farmers' livelihoods through time. Farmers were asked to record on paper sheets important events affecting their lives and then order those chronologically. After the time line was formed discussions about why those facts were selected, and how such facts affected their livelihoods was encouraged. Discussions were audio recorded and pictures about each timeline were taken and then transcribed in Visio 2007 diagrams (Microsoft Corporation 2006). Dates were triangulated with other publications for ensuring its veracity.

3.6.10. Seasonal calendars

The aim of the former activity was to obtain the most salient events influencing the vulnerability context of the farmers along the year. In this exercise the participants were asked to think and list “things” that vary along the year and which variation resulted in affections to their household or the farm. The activity was oriented by the following questions (Table 3.6).

Questions one and two helped to explain that the exercise to be performed was similar to a calendar and have a similar function. Question three aimed to increase the participants' familiarity with the months, by naming specific events that usually happens in each month or using an object for identifying it. Question four served to identify the factors that participants considered as important analysis of the seasonal variations affecting farmers' households. Question five provided the information necessary for constructing the calendar. Usually this question encouraged discussions that nourished the exercise. Finally, question six intended to promote the reflection learning skills of the participants. The activity ended when participants could not identify further activities to analyze trough the calendar.

Table 3.6. Main questions for the seasonal calendar exercise

Number	Question
1	What is a calendar?
2	What is the calendar function?
3	How many months the year has?
4	What "things" that vary along the year affect your household or farm?
5	Can you explain of which way this factor varies and how it affects your life?
6	Can we use the seasonal calendar that we just constructed for something?

3.6.11. Informal social networks (Venn diagrams)

The objective of this activity was to compare the perception of farmers about the individuals, organizations or institutions that were important for the participants in two different years: 2003 or the first year of DEPAPRO in Guatemala and 2008, the last year of activities with the former project in Guatemala. The informal networking exercise started by asking the participants to remember "things" that occurred in the year 2003 and 2008. The timeline results were used for providing clues to the participants to recall the former year. Later, participants were asked to list the name of the individuals, organizations or institutions working with them during that year.

Results were recorded on pieces of paper and placed on the floor. Then the informants were asked to explain the type of relationship that they had with the individuals or organizations. Later, participants were asked to rank the importance of the individuals, organizations, and institutions by selecting circles of three different sizes: large circles for items considered as very important, medium circles for items considered as more or less important, small circles for items considered with low importance. The assignation of the circles was made by voting. However, sometimes when some of the members were not familiar with the actor to be evaluated, just those actors who had a relationship with the actor in question was asked to determine its importance. Afterwards, participants were asked to determine if the identified actors were from the community (insiders) or from outside the community (outsiders). Finally, participants identified the work relationships among the actors by explaining in which way the institutions and/or individuals were related.

3.7. Data management protocol and software

The use of a database package (Access 2003) was used for registering, manipulating, exploring and checking data. This helped to import data into the statistical software minimizing possible mistakes while transferring such data to other software for analysis. In addition, a codebook was prepared for describing the name, source, and coding instructions of each variable. This helped the researcher to become familiarized with the data and to save time in understanding them. Finally, a strict policy of backup and virus infection prevention was followed by backing up the information weekly, updating the antivirus software daily and scanning the whole system for viruses on a monthly basis.

Several software packages were used for writing the thesis, storing the data, and performing data analysis. A database with the socioeconomic, personal, farm and ecological data of the partner farmers was constructed using Access 2003 (Microsoft Corporation 2000). Statistical data analysis was performed using PASW 18 and R Statistics, although other statistical software (e.g., InfoStat or LogXact) was used as well (InfoStat 2004, RDCT 2008, SPSS Inc. 2009, Cytel Inc. 2010b). The coding of semi-structured interviews and FGD data supervised by the qualitative research software Nvivo 9 (QSR International 2011). Diagrams for summarizing and presenting qualitative and quantitative methods and findings were constructed with Visio 2007 and SigmaPlot 2011 (Microsoft Corporation 2006, Systat Software Incorporated 2008). Finally for preparing reference maps for the study areas and the ArcView 3.3 program was employed (ESRI 1992).

Chapter 4. A learning experience: Farmer Field Schools with livestock farmers in Central America

4.1. Abstract

The Multi-stakeholder Participatory Development of Sustainable Land Use Alternatives for Degraded Pasture Lands in Central America project (DEPAPRO) was conducted in Central America. Its aim was to help livestock farmers to address problems related to pasture degradation (PD) through strengthening their capacities. In partnership with livestock farmers and local organizations DEPAPRO encouraged the application of a participatory learning and experimentation approach, based on Farmer Field Schools (FFS). The objective of this study was to describe and discuss critically the implications of such DEPAPRO intervention. Fieldwork was carried out in El Chal, Guatemala; Juncal, Honduras; and Muy Muy Nicaragua. Elicitation techniques used for this purpose were: informal dialogues, semi-structured interviews, systematic observations and field visits. Information gathered permitted the investigation of perceptions of stakeholders about the project, their roles, preferred project components, and lessons learned. This information contributes to the development of better practice for consideration in new programmes. Participation, dialogue among stakeholders and adaptive management were essential for strengthening the participant's human capital.

4.2. Introduction

Livestock production is one of the most important agricultural activities in Central America. In 2008 the regional production of beef cattle was estimated at 396,183 t, and 3,425,643 t for cow's milk; while cattle population was 13,774,993 heads (FAO 2010). Cattle production is mostly based on the use of pastures (cultivated and natural) which is the most extended land use in Central America, covering 111,380 km^2 (FAO 2010). However, the sustainability of cattle production systems is threatened by pasture degradation processes. Pasture degradation (PD) is defined as a decline in pasture quality and quantity that could eventually result in soil and environmental degradation (Szott et al. 2000, Dias-Filho 2005). It is estimated that at least 50% of the total area in pastures are degraded, causing reductions in the yield of cattle products, degradation of the pasture agro-ecosystem, and environmental deterioration that affect the livelihood of livestock farmers (CATIE 2002).

The Multi-stakeholder Participatory Development of Sustainable Land Use Alternatives for Degraded Pasture Lands in Central America project (DEPAPRO) was carried out from 2003 to 2008 with the financial support of the Government of Norway. DEPAPRO was led by the Tropical Agricultural Research and Higher Education Centre (CATIE); and its main objective was to encourage the use of sustainable, sound management land use systems by livestock farmers and their families (CATIE 2002). Activities were accomplished by adopting a pilot zone strategy. Three pilot zones were established in: El Chal, Guatemala; Juncal, Honduras; and Muy-Muy, Nicaragua. DEPAPRO used a multi-institutional approach, thus the expertise of partner farmers and national organizations was used as a basis for intervention. Each stakeholder was responsible for providing assistance in its own field of expertise. Moreover, DEPAPRO combined the Farmer Field Schools (FFS) approach developed by FAO (Pontius et al. 2002) and adapted to livestock production by ILRI, with the Participatory Ecological Reasoning Approach promoted by the Integrated Pest Management Project of CATIE (MIP-AF, CATIE 2002, Staver 2005).

This study is an effort to document with critical and participatory lenses the approach applied by DEPAPRO. It is in line with a method that emerged in Latin America in the social work area in the 1950s, consisting of the compilations and classification of knowledge and enhanced in the 1970s with critical reflections about the performance of development initiatives (Jara 2006). The purpose of documentation was to generate knowledge and improve the course of the actions in rural development initiatives (Jara 2006). One definition is: “a process which seeks to organise information resulting from a given field project, in order to analyse it in detail and draw lessons from it” (Chavez-Tafur et al. 2007). Another definition runs thus: “a methodology that facilitates the continuous reflection from processes and results resulting from our work in projects, with the goal of learning from the experience and thus to modify and improve the work” (Tipán 2006). Finally, Jara (1994) proposed that it is: “that critical interpretation from one or many experiences, that, from its ordering and reconstruction, discovers or makes explicit the logic from a lived process, the factors that have intervened in such process, how they have related among each other, and why they have made it that way”.

The FFS approach emerged in Indonesia as a model capable of generating and strengthening local capacities for implementing Integrated Pest Management (IPM) in rice (Rölling and Fliert 1994, Pontius et al. 2002). From this experience, the use of FFS extended to other geographical areas of Asia, Africa, and eventually to America in 1999 (Pontius et al. 2002, Braun et al. 2006). In Central America the first experience with FFS was headed by The Pan-American Agricultural School of Zamorano in 2000 (Braun et al. 2006). However, most of the FFS experiences developed in Central America were with crops. The use of FFS in livestock production systems has been promoted by ILRI mostly in Africa (Minjauw *et al.* 2002), South East Asia and China (Devendra and Pezo 2002). Because DEPAPRO was a pioneer experience of FFS working with cattle production in Central America (Pezo *et al.* 2007), it is of value to investigate how it was carried out, what were the perceptions of the stakeholders about it, and what contexts influenced the performance of its interventions. This would help in understanding the implications of using the FFS approach with livestock farmers in the Central American context; and provide lessons for consideration in future interventions.

4.3. Materials and Methods

4.3.1. Study area

The documentation process was carried out in Central America. The influence area of DEPAPRO was initially located in three pilot areas: El Chal, Petén, Guatemala (89º30’- 89º45’ W to 16º35’ - 16º46’ N) ; Muy Muy, Matagalpa (85º30’ - 85º45’ W to 12º40’ - 12º50’ N), Nicaragua; and Juncal, Yoro, Honduras (86º27’ - 86º15’ W to 15º27’ - 15º35’ N) (CATIE 2003a). In 2006 DEPAPRO and its partners established FFS in other areas of the same countries as part of an anchoring and expansion phase, some of them were considered in the present study (Table 4.1).

Juncal and El Chal are classified as humid tropical forest areas, whereas Muy Muy is considered a sub-humid tropical forest transition (CATIE 2003a). El Chal and Muy-Muy pilot areas are characterized by a defined dry season from December to June; whereas Juncal has a shorter dry period from April to June. Juncal is also the area with highest average rainfall with 1910 mm/year, followed by El Chal with 1796 mm, and Muy Muy with 1576 mm (CATIE 2003a). Annual average mean temperatures are 26.0ºC in El Chal, 24.5 ºC in Muy Muy and 24.0ºC in Juncal (CATIE 2003a).

Table 4.1. Municipalities with DEPAPRO Farmer Field Schools groups in Central America.

DEPAPRO area	Municipalities		
	Guatemala	*Honduras*	*Nicaragua*
Pilot	Dolores, Santa Ana	Olanchito, Sabá	Muy-Muy
Anchoring and expansion	Poptún, San Luis, San Jerónimo, Paso Duro, La Gomera, Quiché, Patulul	Comayagua, Sonaguera, Olanchito (Valle Arriba), La Ceiba, Siguatepeque, Juticalpa, Talanga, Dalí	Matiguás, Paiwas, Río Blanco, Esquipulas, Matagalpa, San Rafael del Norte, La Concordia

At least 50% of pastures in Central America are facing degradation processes, corresponding to 10.7% of the total land area, or 111,380km^2 (Table 4.2) (CATIE 2002, FAO 2010). However, other local estimations suggested that the amount of degraded pastures corresponds to 70% of the established pastures (Holmann *et al.* 2004b, Betancourt *et al.* 2007). Pasture degradation in the pilot areas is characterized by a lack of palatable species and reduced soil cover (CATIE 2003a). Regarding soil physical and chemical properties, degraded pastures showed a decrease in the levels of available phosphorus in pastures with more than four years after establishment (CATIE 2003a).

Table 4.2. Estimated area with degraded pastures on DEPAPRO's pilot areas.

Country	Total land area (km^2)	Pastures area (km^2)	Pastures area (%)	Degraded pastures (km^2)[1]
Guatemala	108,890	19,500	17.91	13,650
Petén	35,893	10,008	27.88	7,006
Honduras	112,090	17,000	15.17	11,900
North Region[2]	NA	1,440	NA	1,008
Nicaragua	130,370	30,160	23.13	21,112
Matagalpa	6,803	5,289	77.75	3,702
Central America	521,880	111,380	21.34	77,966

Notes: Regional and national data from 2007 (FAO 2010). Department data from 2001 for Matagalpa (INEC 2003), 2009 for the North Region (SAG 2010), 2003 for Petén (MAGA 2006). [1] Degraded pastures estimated in 70% of pastures (Holmann *et al.* 2004a, Betancourt *et al.* 2007). [2] North Region includes areas in other departments. NA= Not available.

Most livestock production systems in the pilot areas are extensive, with stocking rates from 0.7 to 2.04 animal units (AU)/ha, and an average milk production ranging from 1.2 to 4.8 kg/cow/day (Table 4.3). However, smallholder farmers usually have lower stocking rates than 1.0 AU/ha. The average farm size is 114 ha, although smallholders usually own less than 35 ha. The level of technology applied in all pilot areas varies, although it could be considered low according to the standards used for dairy systems because most farms apply hand-milking, usually do not have either milking parlour nor cold storage facilities, use natural mating and do not use fodder conservation techniques. In general, most intensive practices are implemented in Juncal; while the less intensive ones corresponded to Muy Muy.

Table 4.3. Some characteristics of the cattle production in the DEPAPRO pilot areas.

Indicator	Pilot area		
	El Chal, Guatemala	**Juncal, Honduras**	**Muy Muy, Nicaragua**
Sample size (n)	70	83	68
Family head age ($\bar{x}$)	51.8	51.1	48.3
Years of experience	23.1	23.1	24.1
Farm size (ha)	146.3 (37.7-321)	81 (67-90)	114.5 (21.9-229.3)
Pastures area (ha)	104.7 (27.1-215.8)	54.2 (33.4-78.2)	98.6 (15.4 - 202.8)
Herd size (AU)	96 (39–176)	90 (33-175)	87 (41-155)
Stocking rate (AU/ha)	1.2 (1.0-1.48)	1.4 (0.81-2.04)	1.1 (0.7-1.4)
Milk yield (kg/cow/day)	2.5 (1.2 – 3.7)	4.7 (4.3-4.8)	4.3 (4.1-4.5)

Notes: Values are averages obtained from the baseline study (CATIE 2003a). Values in brackets are ranges, taken from: (CATIE 2006b, Zamora 2007).

4.3.2. Documentation process

The documentation process was carried out in five phases (Figure 4.1), these were not conducted in a linear progression, and instead a process approach was used. This implied a continuous focus for enhancing rapport with DEPAPRO staff, farmers, and staff from partner organizations. The fieldwork was undertaken during the last 15 months of DEPAPRO activity, from September 2007 to December 2008. Information from the three countries where DEPAPRO worked was analysed, however, due to financial constraints fieldwork in Honduras and Nicaragua was done in one month.

The first phase or starting point helped the author to become familiarized with DEPAPRO activities in Guatemala. It also allowed identification of key factors such as availability of livestock extension services, which affected both farmers and DEPAPRO. This was carried out through literature reviews, informal dialogues with key stakeholders and observation. Rapport building and enhancing was done for the first three months of fieldwork in Guatemala, by participating in field activities with DEPAPRO staff and partner farmers. The first three days of field work in Honduras and Nicaragua were used for familiarization with local stakeholders and study areas.

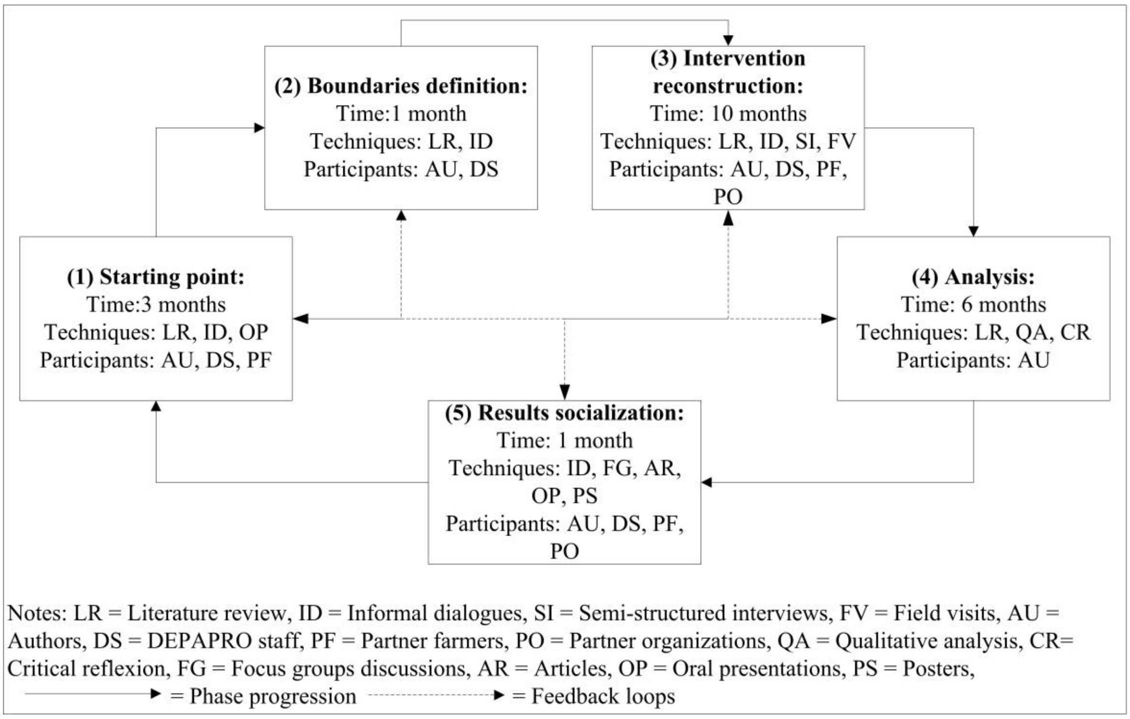

Figure 4.1. Documentation process phases, elicitation techniques and participants.

The second phase or boundaries definition identified the documentation process objectives, stakeholders, and location-time boundaries of the research. Key informants approached during the early stages of this research pointed out that the most interesting DEPAPRO’s feature was its learning approach based upon FFS principles. Hence, the documentation aimed to describe and critically analyse the learning process facilitated activities related to the learning process were identified. These included the representatives of national universities, government organizations, NGO’s, and of course participating livestock farmers and their families.

The third phase or intervention reconstruction is presented as a narrative of DEPAPRO and its FFS approach. The narrative was structured according to each of the five planned phases of DEPAPRO. For this, DEPAPRO progress reports were imported into the software for qualitative analysis NVivo9 (QSR International 2011) following a chronological order, then text queries of key words were used to compile references for constructing a reflective narrative of DEPAPRO interventions. Participation from all the stakeholders' categories involved in DEPAPRO interventions helped to document and imparted to the narrative strengths, limitations and lessons learned as perceived from the perspective of each actor.

The fourth phase included the qualitative analysis and triangulation with other FFS experiences. Pretested semi-structured interviews were transcribed and then imported into NVivo9 for the coding of participants' open-ended answers. Themes emerged from the answers of participants or *in vivo* coding according to each of the sections from the interview (Rusell 2006). Later, putative themes were further aggregated following the Sustainable Livelihoods Approach (SLA), complemented by the Community Capitals Framework (CCF) (DFID 1999, Flora *et al.* 2004, Gutiérrez-Montes *et al.* 2009a). The narrative was contrasted with FFS guidelines and reports from other FFS experiences. The aim was to identify key concordances and differences among the implementation of FFS approaches.

Stakeholders' opinions, reports and facts observed during fieldwork were triangulated, this helped to increase the internal validity of the information. A database in Access 2003 (Microsoft Corporation 2000) was prepared for monitoring the qualitative analysis in NVivo9. Codified answers were transferred to SigmaPlot10 (Systat Software Incorporated 2008) or Visio 2007 (Microsoft Corporation 2006) for creating charts and diagrams that helped to visualize participants' relationships and perceptions. The fifth and final phase provided feedback to the participants and presented the documentation findings. Several strategies were used for this purpose: informal dialogues; workshops; written reports such as thesis, papers, posters; congress presentations; and the divulgation of the outputs such as the thesis report.

The study utilized four main elicitation techniques: (a) informal dialogues, (b) semi-structured interviews, (c) systematic observations and (d) field visits. Informal dialogues were conversations about topics related to DEPAPRO that were undertaken with people involved in this initiative. The aim was to obtain basic information about the study areas, to identify the axis of the documentation process, to generate rapport with stakeholders, and disseminate the results obtained. Informal dialogues were not audio recorded, instead notes were taken about the facts provided by participants. Note taking was carried out either during the conversation or soon after the conversation finished.

The semi-structured interview was based on a guide that included four stages (Table 4.4). The aim was to obtain detailed information about the participant’s role, DEPAPRO’s strengths and limitations, changes caused by DEPAPRO, and elements of the local context influencing the project performance. When participants were observed to be capable of providing detailed information about a specific topic he/she was encouraged to share it. Interviews were audio recorded with participants’ consent. Most participant farmers were interviewed in their farms. This helped to observe the status of some of their activities in the field, and to become familiarized with the salient features of the localities that were visited. Some additional questions were asked to investigate potential themes of interest that emerged from literature review or during the conversation with interviewees.

Systematic observation and field visits served to compare the information provided by informants during the interviews with what was implemented on the farms, and helped to obtain a general perspective of the study areas as well. Aspects such as: condition of the experimentation plots; informants’ attitudes during interviews; livestock production systems; and FFS meetings were audio, video or note recorded. Additionally, literature reviews were conducted for obtaining specific information about the study areas, documenting the previous activities carried out by DEPAPRO and triangulating the information. The main sources employed for this were: national censuses, national geographical databases, DEPAPRO’s reports and academic publications.

The author started the interview by providing an explanation about the purpose of the study and how the information would be used. This was intended to control potential false expectations about the study. Participants voluntarily accepted to contribute in the study, their authorized consent was obtained. In Guatemala, some refreshments were offered to participants after field trips or during focus group discussions. Participants were granted an anonymity status to promote confidence for expressing sincere perceptions about DEPAPRO.

Table 4.4. Guideline for the semi-structured interviews.

Number	Documentation stage	Question
1	Ethical issues	Presentation, interview objectives, and authorized consent
2	Rapport	Introductory conversation
3	Starting point	How and when did you start to work with DEPAPRO?
4	Intervention reconstruction	What activities did you accomplish with the project?
5	Intervention perception	What do you like most of the project?
6		Did you find any kind of limitation interfering DEPAPRO's efforts?
7		If the project would start again and you were able to change something what would it be?
8		Have you changed something after working with DEPAPRO?
9	Context	Did you participate in other trainings before DEPAPRO? From which entity? What was such training like?
10		Have you noticed similarities or divergences between other training approaches and the ones of DEPAPRO?
11		How will affect farmers working or receiving assistance from more than one project at the same time?*

Notes: *Question asked in Nicaragua where there was a greater organizational presence.

4.3.3. Sample selection

The sampling strategy was a non-parametric purposive sample. Available informants were approached and the participation of at least one participant, representing each of the stakeholders' categories and organizations participating in organizing FFS was achieved. The total number of participants was 106 (Table 4.5).

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Table 4.5. Type and number of participants by partner organization and country.

Country	Participant type	Number of participants	Organizations
Guatemala	Partner farmers	29	CATIE, CUDEP-USAC, FA-USAC, FMVZ-USAC, FUNDEBASE, MANMUNISURP, PROPETEN
	FFS Promoters*	6	
	FFS Facilitators	4	
	Students**	3	
	Specialists	3	
	Decision makers	3	
	Supervisors	2	
	Subtotal	***50***	
Honduras	Partner farmers	13	CAPRO, CATIE, COLCAPRO, ESNACIFOR, FUBNAPIB, INFOP, DPA-UNAG.
	FFS Facilitators	5	
	Specialists	2	
	Decision makers	2	
	Subtotal	***22***	
Nicaragua	Partner farmers	18	CETA, CATIE, FONDEAGRO-TECHNOSERVE, INTA, NITLAPAN-UCA, FACA-UNA, FCE-UNAN-MANAGUA.
	FFS Facilitators	5	
	Supervisors	5	
	Specialists	4	
	Decision makers	2	
	Subtotal	***34***	
Total number of participants		**106**	

Notes: *Promoters were not interviewed in Honduras and Nicaragua because this category was used exclusively in the anchoring and expansion area from Guatemala, following the Farmer to Farmer approach implemented by FUNDEBASE. **Undergraduate or graduate students were not interviewed in Honduras and Nicaragua, because they were not involved in FFS activities.

4.4. Results

4.4.1. Institutional support and extension services for livestock in the study areas

Most of the national entities that carried out extension and agricultural research and development (R&D) activities in Central America have a restricted budget, and consequently limited activities. This was the result of the policies implemented by governments in response to criticisms due to the poor results of extension and agricultural research efforts (Trigo and Kaimowitz 1994). International organizations such as the IMF, OECD and World Bank suggested and even promoted this policy to "make more efficient states" through structural adjustment reforms that implied a reduction of funds for agricultural research institutes, or the privatisation of the national extension services (Samayoa 1995, Sánchez de Puerta 2004).

Many households in Central America rely on agricultural production (Figure 4.2), even with limited assets such as: labour, infrastructure, access to credit and membership to organizations; therefore, it is difficult for poor farmers to have access to private extension services and even worse when private extension usually targets wealthy farmers to obtain profits or provide and expand their coverage area. This has produced deficiencies in research and extension services in most Central American countries, where most smallholders have limited or no access to either private or public extension services.

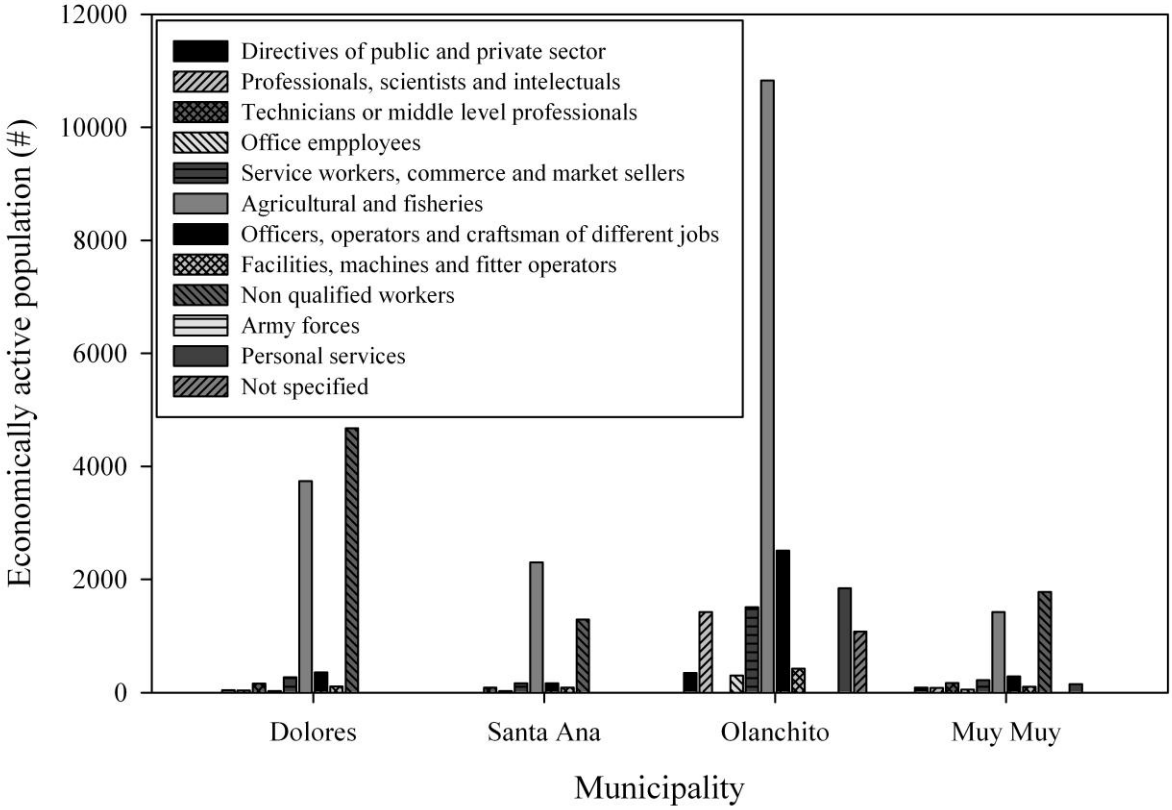

Figure 4.2. Economically active population in the municipalities where DEPAPRO established pilot areas (INE 2001, 2003, INEC 2006).

The absence of agricultural extension services in Central America has been partially covered by non-governmental organizations (NGO's), international and regional organizations, educational organizations and sometimes by local governments (Figure 4.3). However, these organizations have a limited budget, rely on international cooperation which is not permanent and only supports projects with short or medium life horizons (five years or less). Moreover, funds from international cooperation are generally granted for addressing worldwide agendas which are not always conciliated with local needs. This affects the implementation of initiatives working with complex production systems i.e. agroforestry, silvopastoral systems, which usually require longer time horizons to implement, evaluate and understand their benefits or constraints.

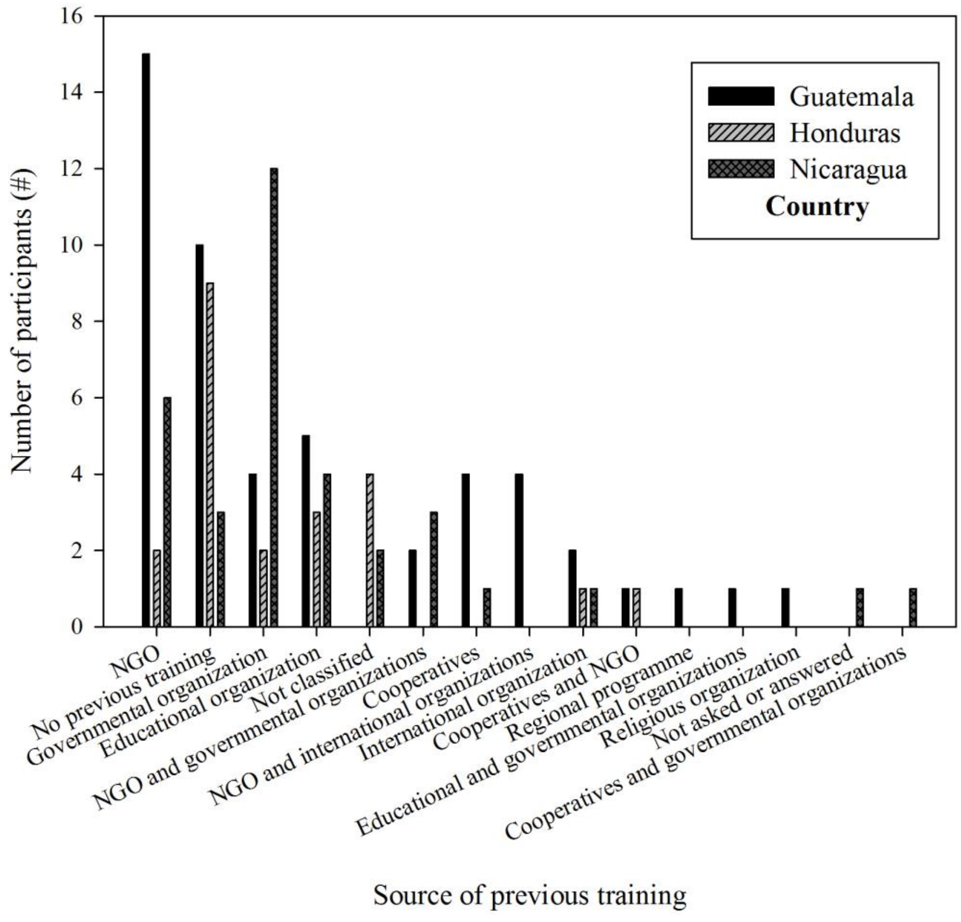

Figure 4.3. Source of previous training from participants (n=106).

Before DEPAPRO started its intervention, the coverage of public extension services in the pilot areas was weak, and it rarely involved livestock activities or PD issues (Table 4.6). This can be related to the limited international funding granted for livestock production because the sector was frequently associated with detrimental impacts on the environment (Steinfield *et al.* 2006). On the other hand, some participants such as decision makers and specialists pointed out that working with livestock farmers is more difficult than working with farmers dedicated to crops. This is because livestock farmers are widely dispersed, have more economic and/or land resources than subsistence farmers. Hence, the potential "incentives" being offered by many projects do not attract livestock farmers, and long distances between livestock households make meetings difficult.

Table 4.6. Organizations working in the DEPAPRO pilot areas in 2003.

Area	Organization	Type	Main interest	Trainings	Cattle
El Chal	MAGA	Government	Farming	+	+
	SAR	Government	Crops	+	-
	ProPetén	NGO	Conservation	+	-
	Centro Maya	NGO	Conservation	+	-
	FUNDEBASE	NGO	RD	+	+
	FEDECOAG	Cooperative	Crops	+	-
	PDS	Programme	RD	+	+
Muy Muy	CETA	Education	Farming	-	+
	ODESAR	NGO	Farming	+	-
	INTA	Government	Crops	+	-
Juncal	EAP-Zamorano	Education	Livestock	+	+
	Land-Of-Lakes	NGO	Livestock	+	+
	CAPRO	NGO	Education	+	-
	INFOP	Government	Crops	+	-

Notes: Trainings= Training activities in 2003. Cattle= Working with cattle farmers in 2003.
RD= Rural development. +=Yes. -=No.

Minimum integration or cooperation alliances among the institutions and organizations working in agricultural extension and technology generation were observed in the three areas where DEPAPRO worked (Aguilar et al. 2010). This affected the possibility of maximizing the resources available for trainings and also brought about issues such as confusion amongst farmers arising from receiving contradictory recommendations and competition for farmers' attendance. Moreover, most of the trainings known by participants were categorized as "traditional", because those consisted of meetings where the technician lectured the topic in a top-down style, usually in a onetime visit, and without executing practical exercises. A testimony of one of the male promoters from Guatemala illustrates the point as follow:

> "*...the extension staff used to say: this is how such thing should be done boys. Apply vitamins to the animals, feed them, and every two to three months you can treat them for parasites. He only talked, but never did the practical demonstrations. That is the main difference with what we have done now with DEPAPRO*".

When DEPAPRO started activities in Petén, The General Directorate for Livestock Services (DIGESEPE), the government organization in charge of livestock extension services had already ceased to function (CATIE 2006b). The Ministry of Agriculture, Livestock and Food (MAGA) carried out some training sessions, but mostly related to crops. The municipalities in Petén usually had at least one technician assigned to coordinate agricultural activities, including training as part of their municipal Agricultural Section (SAR). Different local NGO's and organizations developed production and conservation programmes that included training events, among them were ProPetén Foundation, Centro Maya, The Foundation for the Development and Strengthening of Grassroots Organizations (FUNDEBASE) and The Federation of Agricultural Cooperatives from Guatemala (FEDECOAG), among others. International NGO's were also present, however, most of their projects were related to the conservation of natural resources in the Mayan Biosphere Reserve.

The livestock related activities implemented by different organizations in Petén included: (1) blood test and vaccination services for cattle provided by MAGA; (2) and monetary support for buying cattle that included training in livestock management funded by the Petén Sustainable Development Programme (PDS) but implemented by local NGO's. The public extension services in Guatemala were by law a responsibility of the municipalities, the University of San Carlos and the Institute of Agricultural Science and Technology (ICTA) (Aguilar et al. 2010), but they have financial and even human capital limitations. ICTA was created in 1973 and pioneered a model of R&D that included the participation of farmers, integration of holistic teams and more interaction between the stakeholders in the process (Gostyla 1979); unfortunately, its effectiveness has declined significantly because the institution relies mainly on government provided funds, and Guatemala has been reducing its budget for public agricultural research and extension services in the last decade (Stads and Beintema 2009).

In the case of the Nicaraguan pilot area, in 2003 Muy Muy was not receiving any public extension service for livestock production. By that time two local organizations were working in the area: the Technical Agricultural School (CETA); and the Municipal Development Organization (ODESAR). CETA is an educational institution which has been for almost 10 years running with its students a programme called The Rural Development Programme for the Midlands. The programme includes a weekly on-farm practical training in which students are supposed to learn by performing agricultural practices related to livestock production in collaborating farms. ODESAR is an NGO established in 1990 (Pfister and Barrios 2007) which implements technical assistance and development projects with smallholders in Muy Muy, mostly on poultry and small livestock species production. The Nicaraguan public extension services are the responsibility of the Nicaraguan Institute for Agricultural Technology (INTA) (Fernandez 2004). Previous to the arrival of DEPAPRO to Muy Muy, INTA carried out extension activities related to basic crops. The Institute of Rural Development (IDR) coordinated public extension services with livestock farmers in other areas of Nicaragua, but not in Muy Muy (Aguilar et al. 2010).

In Olanchito, Honduras (Juncal pilot area), two organizations were working with projects related to livestock production in 2003: The Pan-American Agricultural School EAP-Zamorano and the US-based Land of Lakes Cooperative, the former providing training to strengthen farmers' organizations, and the improvement of milk quality and pasture management and the latter facilitating equipment for the establishment of Milk Collection and Cooling Centres (CRELs) (CATIE 2005a, Rojas 2008). Christians Associated for Education (CAPRO), a local NGO, was implementing "after Mitch hurricane" projects mainly related to housing and adult literacy. The National Institute of Professional Formation (INFOP), a decentralized governmental entity, is in charge of developing and strengthening the capacity of technical workers. It was created in 1972 and due to the importance of agriculture in the national economy it addresses agricultural training activities. INFOP was carrying out agricultural training in the Juncal pilot area. The official governmental institution in charge of agricultural extension is the Directorate for Agricultural Science and Technology (DICTA) which is part of the Ministry of Agriculture (SAG) (Stads and Beintema 2009). However, participants of the current study could not identify any training or extension initiative carried out by such organization.

4.4.2. DEPAPRO intervention

The documentation analysis illustrated three main facts that influenced the genesis of DEPAPRO. First was the need to address the PD problem in Central America identified in a report published by CATIE (Szott et al. 2000). The problem was prioritized since 1999, during the first contact between CATIE staff and farmers. The sites where identified as PD hotspots because livestock production was the main expanding economic activity, therefore large areas of forests or natural succession vegetation were being converted to pastures, which eventually would also degrade (Szott et al. 2000).

The second fact was the success obtained by applying the FFS approach for improving smallholder dairy systems in Kenya (Minjauw *et al.* 2002, Abate and Duveskog 2003, Groeneweg *et al.* 2007). Such experiences suggested that the same approach could address the complexity of rehabilitating PD. The Livestock and Environmental Management Thematic Group from CATIE (GAMMA) has been leading research on PD issues in Central America. GAMMA prepared the proposal for DEPAPRO based on the baseline work developed for the study areas (CATIE 2003a), and submitted it to the Government of Norway to obtain financial support for its implementation. In December 2002, the Norwegian Government and CATIE signed an agreement for funding DEPAPRO, with a budget of 45 million Norwegian krones[10] (CATIE 2004).

Third, previous CATIE experiences showed that the involvement of different stakeholders and a constant dialogue and negotiation among them was necessary for obtaining better results in R&D projects (Borel 2005). In this case the zig-zag training model promoted by CATIE's Integrated Pest Management Project (IPM) in Nicaragua, was used as a platform for structuring the dialogue between farmers, DEPAPRO staff and organization partners (Staver 2005). The use of lessons learned from previous CATIE projects is always difficult because most of the staff members are newly recruited for each successive project. However, the presence in Central America of

[10] Approximately US$6,284,916 dollars, using an exchange rate of 7.16 krones/dollar in December 2002.

personnel that worked with the IPM project helped to communicate to the staff of DEPAPRO the value of the zig-zag training model. Conversely, DEPAPRO interventions were classified in four phases, and these do not necessarily follow a chronological order (Figure 4.4). The narrative is focused on aspects related to the learning process encouraged by the FFS approach from the year 2002 to 2008.

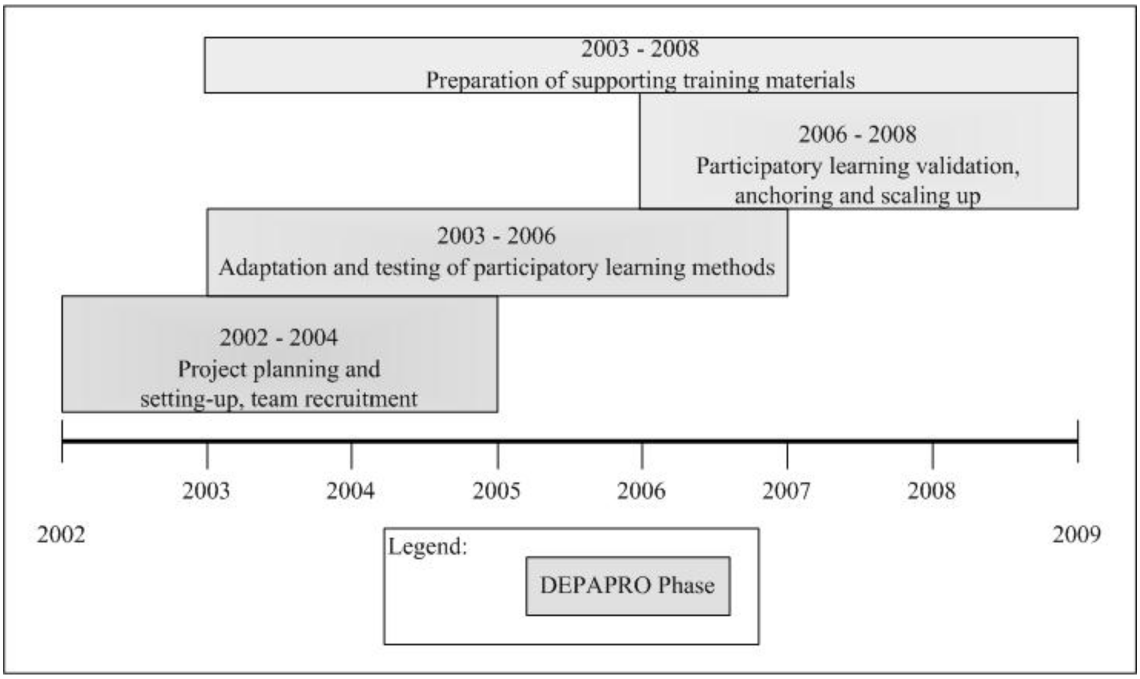

Figure 4.4. DEPAPRO timeline phases of implementation.

4.4.2.1. Project planning, setting-up and team recruitment

The first phase started prior to the signing of the funding agreement in late 2002. The planning was done at CATIE's headquarters and included identifying the project staff vis-à-vis their respective responsibilities. In the beginning, the team was comprised of 12 persons, from which three were classified as international staff: one Social Scientist, one Soil Scientist, and one Plant Ecologist who later functioned as the Regional Coordinator. The international staff positions were widely advertised, and an internal committee in CATIE evaluated the candidates. The final selection ended up with a female Anthropologist with expertise in gender and development, and a male Soil Scientist; both were hired in June 2003 (CATIE 2003b). The recruitment of a male Plant Ecologist with expertise in Pastures and Animal Nutrition was completed in January 2004.

In 2003 a male Plant Ecologist worked as temporary Regional Coordinator. Additionally, the project hired three national coordinators, one per each pilot area. Their recruitment was accomplished following a similar mechanism in hiring to the international positions. Those positions were filled by three male, one with expertise in Forestry and Watershed Management (Guatemala); one in Agroforestry Economics; and one in IPM and Participatory Research. Two of them were hired in October 2003, whilst the one for Honduras was hired in January 2004 (CATIE 2003b). Furthermore, one male technician per pilot area was hired in 2004. Arrangements for administrative procedures, coordination with the CATIE's local offices, DEPAPRO's offices installation and the selection of administrative support staff were negotiated in 2003.

The baseline study showed that the technical capacity of local organizations for implementing a silvopastoral project using participatory approaches was weak (CATIE 2004). Thus, DEPAPRO faced the challenge of: (a) strengthening the technical knowledge about land use alternatives and sustainable livestock management; and (b) creating the necessary capabilities for addressing PD issues with a participatory approach. To accomplish both, in 2003 DEPAPRO encouraged the participation of technical and professional staff working with livestock production in Central America, in local and regional strategic courses[11]. These courses also served as an incentive for increasing the interest of potential partners to join DEPAPRO efforts (CATIE 2005b). Courses offered in the period 2003-2004 were more related to technical aspects of sustainable livestock management and less focused on participatory approaches. In 2005 he first regional workshop on Participatory Methods for FFS facilitators was offered. That workshop helped to create and strengthen capacities in participatory approaches that were needed for implementing the FFS approach. Another workshop on curricula development for the researchers and university lecturers who collaborated on the planning of participatory learning sessions was also offered.

The use of crash courses as a training strategy for FFS has been criticized because they failed to create the skills necessary for understanding and practicing knowledge intensive approaches such as Integrated Pest Management (Rölling and Fliert 1994). However, DEPAPRO used courses as the first step of a learning cycle on the FFS

[11] Corresponded to courses with participants from the three countries where DEPAPRO established pilot areas: Guatemala, Honduras and Nicaragua.

approach that was later reinforced with additional courses and follow practical experiences, such as the preparation of FFS guidelines, facilitation of FFS groups, and the establishment and monitoring of experiments. Moreover, DEPAPRO participatory workshops were facilitated by experienced staff on FFS that conducted courses in a participatory style and applying the principle of learning by doing. Hence, courses encouraged attendees to join DEPAPRO efforts and investigate more about FFS.

DEPAPRO's fieldwork during the setting up phase was preliminary and had the following objectives: (a) the identification of farmer's groups with interest in participating in the project; (b) familiarization with the main biophysical, socio-economic and institutional context of each pilot area; (c) the training of the staff; and (d) the testing of DEPAPRO's participatory strategy (CATIE 2003b). In 2003 DEPAPRO started to work in Muy Muy, Nicaragua and El Chal, Guatemala. A key activity undertaken was the analysis of innovation systems for the livestock sector applying the RAAKS [12] methodology. It was started in the Nicaraguan pilot area, and replicated later in Guatemala and Honduras (Staver *et al.* 2004). Such analysis identified strengths and limitations in the institutional network related to livestock production in the three pilot areas, and helped to approach potential partner organizations (CATIE 2003b). Moreover, it identified two further improvements by DEPAPRO: (1) the need for participatory learning cycles with medium and small scale livestock farmers; and (2) the need to identify a cadre of specialists to be trained in silvopastoral systems management and participatory methodologies.

Dr. Paul Engel a pioneer on RAAKS was hired as a consultant to facilitate the analysis of innovation systems in Nicaragua and train DEPAPRO staff in such methodologies. Subsequent events in Guatemala and Honduras were facilitated by DEPAPRO staff who participated in the first event (CATIE 2005b). Hiring of consultants became a regular DEPAPRO strategy used when required to strengthen specific capacities not represented in its staff, or when those were committed to other activities (CATIE 2008). Facilitators and specialists also replicated trainings, after attending didactic sessions offered by either DEPAPRO staff or consultants.

[12] Rapid Appraisal of Agricultural Knowledge Systems.

The set up phase required 20% of DEPAPRO's lifespan to be completed. Two pilot areas started activities as planned, whereas, the late recruitment of the National Coordinator for Honduras delayed the start of activities in the Juncal pilot area. Based on such experiences, it is recommended that future projects should consider speeding up the processes for hiring staff, contracting services and offices installations. This could help invest more time in the participatory planning, strengthening capacities for local organization and carrying out FFS field activities. Also the project should look for more balanced distribution of fields of expertise in its research staff, as only one of the internationally recruited professionals was a Social Scientist. Thus, a more balanced distribution among Natural, Social and Economic professional staff should be considered for future FFS interventions.

Furthermore, despite of CATIE's policies on gender equality the hired personnel were predominantly male. This may be related to a field trend because agricultural careers have a tendency to be preferred by males, moreover, cattle production in Central America is a male dominated livelihood. Considering that, future interventions should devote more efforts in incorporating female participants in the different categories of stakeholders. This could help integrate and empower women for having more decisive roles in addressing PD issues and farming; but as well as to reduce the gap in gender equality in academic positions, both of the latter have been pointed out as part of the Millennium Development Goals (Machinea and León 2005).

4.4.2.2. DEPAPRO stakeholders roles and activities

Seven key stakeholders were identified and grouped according to the location where DEPAPRO operated. FFS were organized in pilot areas from 2003 to 2006; while from late 2006 to 2009 FFS were implemented in other territories known as anchoring and expansion areas.

Stakeholders working in both areas included:

(i) Partner farmers who were livestock farmers and their families attending the livestock FFS activities promoted by DEPAPRO. Most partner farmers started activities in 2003/2004 in the pilot areas; whereas others initiated participation in DEPAPRO's anchoring and expansion areas in late 2006. DEPAPRO partner farmers' activities consisted of attending the FFS learning sessions, experimenting with PD alternative solutions, participating in field visits, and less frequently attending sessions for monitoring experiments (Figure 4.5).

(ii) The facilitators were technicians working for DEPAPRO or partner organizations, in the coordination and/or facilitation of FFS learning sessions, management of FFS groups, installation and monitoring of experiments, and providing fieldwork assistance in studies related to PD issues. During the development phase of methods for participatory learning, most FFS sessions were directly facilitated by the national coordinators and the international recruited staff.

(iii) The specialists were staff from either CATIE or any partner organization, and even few freelance consultants, with recognized expertise on a given topic of interest for DEPAPRO, who helped in the design of a general FFS curricula, prepared FFS session guidelines, conducted research studies funded by DEPAPRO, some facilitated a few FFS sessions, and all were trained on the FFS approach, livestock production systems and other relevant topics for addressing PD issues.

(iv) Technical, undergraduate and postgraduate students were persons working for a degree or diploma who carried out his/her research funded by DEPAPRO. The research was generally a thesis or a supervised professional practice required by academic institutions for graduation. Moreover, students provided technical support to partner farmers, monitored on-farm experimental plots and in Guatemala facilitated some FFS sessions.

The stakeholders that participated exclusively in the anchoring and expansion areas, being either partner farmers or staff of partner organizations included:

(v) Promoters, who were partner farmers selected by FFS members to function as facilitators in remote communities in the anchoring and expansion area in Petén, Guatemala. They were trained in livestock production and the FFS approach, but did not receive a salary for their services.

(vi) Supervisors, were technical staff from partner organizations who coordinated and monitored some of the FFS groups in the anchoring and expansion areas in Nicaragua and Guatemala. Their role was defined in agreement with the partner organizations they belong to, including the participation in learning sessions, field visits, assistance in administrative tasks, and attendance to trainings in the FFS approach.

(vii) Decision makers were administrative staff from CATIE and partner organizations, working in directive positions. They usually helped to facilitate logistic and human resources. Some of them also participated in learning sessions, experiments, field visits, preparation of FFS session guidelines and in the monitoring of experiments.

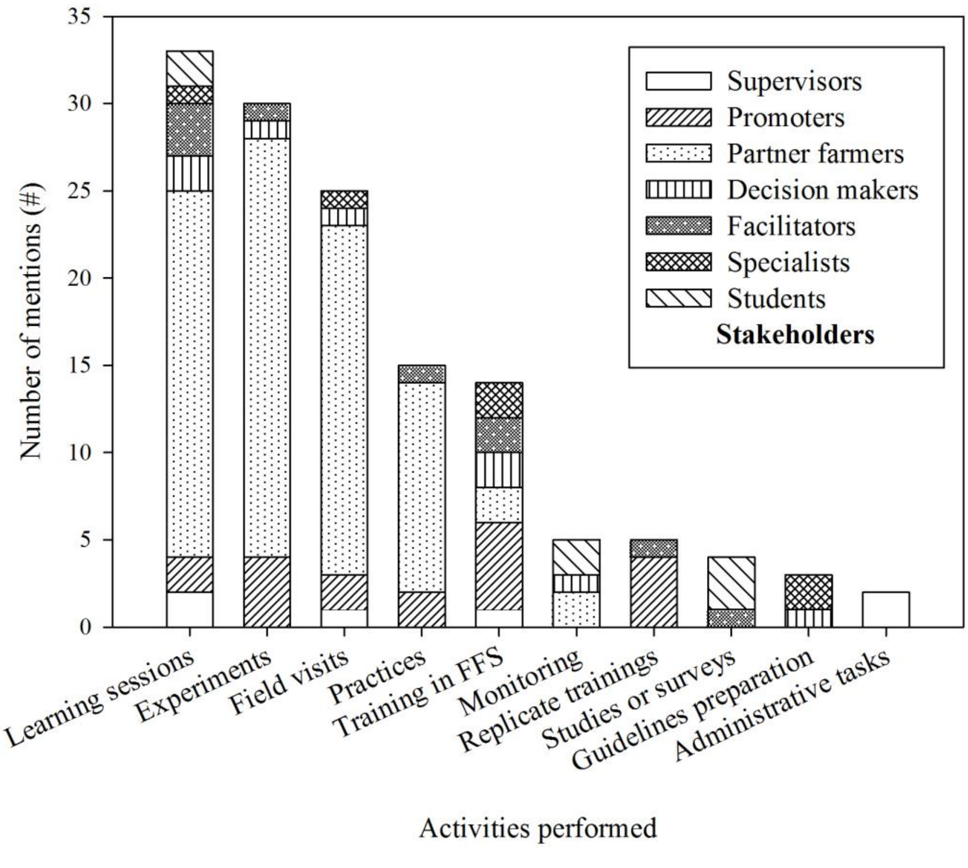

Figure 4.5. Main activities performed by DEPAPRO stakeholders (n=106).

The roles described above allowed the participation of several stakeholders and organizations in DEPAPRO. Hence, new initiatives working with a multi-stakeholder approach in Central America would consider a flexible approach based on the identification of a shared vision, negotiation, and conciliation of the strengths of potential partners (Sanginga *et al.* 2007). This would support FFS activities by adding to existing human resources and without investing in salaries of new staff. Moreover, it would help to reduce the emergence of conflicts with established organizations, other projects and farmers for imposing outsiders' structures and methodologies that can cause aversion. The investment required for adding partners included training on the FFS approach and technical capacities for monitoring their implementation. This would be expected to be easier in countries where there is a more developed governmental apparatus supporting agricultural research, extension and rural development such as Nicaragua (Wiig et al. 2008). However, in countries such as Guatemala and Honduras there were NGO's, educational institutions, government organizations and municipalities whose structure should not be undervalued, because all those could help in the implementation of FFS.

4.4.2.3. Adaptation and testing of methods for participatory learning

DEPAPRO staff from each pilot area were given the flexibility to choose the tools, techniques, and rigour to be used in each FFS. In early stages, the approach in Guatemala was more relaxed and participatory, influenced by the work of the Social Scientist and the experience of participatory approaches of the Regional Coordinator. Conversely, in Nicaragua a more traditional approach was used influenced by the positivist background of the DEPAPRO professional staff: a Soil Scientist, and a Plant Ecologist (Interim Regional Coordinator); and by the legacy of top-down oriented approaches that dominated the agricultural extension arena in Nicaragua (Vieto 1995). The approach followed in Honduras can be considered as a midpoint between those used in Guatemala and Nicaragua. Early training activities in Honduras led by a partner organization were of the top-down type; but with time those evolved to a more participatory scheme.

DEPAPRO's research proposal anticipated that this phase would last for at least three years from 2003 to 2006 (CATIE 2002). After the familiarization with the context of the study areas in 2003, DEPAPRO staff started to identify partner farmers who were interested and had the need to participate in the FFS. The first DEPAPRO farmers' groups identified were from Muy Muy Nicaragua, which corresponded to three groups of farmers that had participated previously in either training initiatives, productive or funding projects led by local organizations. The criteria for selection included geographical, organizational and productive characteristics. Priority was given to cattle farmers participating in groups already formed, whose farms had good accessibility, and practiced production systems typical of the region, and who lived in the pilot area (CATIE 2004).

In Guatemala the group identification process included: several participatory workshops that helped to characterize the pilot area, one-to-one participatory mapping, consultations with key informants and farmer leaders, and field observation (Aguilar et al. 2010). Four potential groups were identified, although only two started activities in 2004. Criteria for selecting those groups included accessibility, convergence of farmers' expectations with DEPAPRO goals, and contrasting characteristics between both groups: (1) The El Chal group, which corresponded to medium scale farmers with privately owned land, organized in the PETENLAC cooperative; (2) The Ejido group was formed by farmers using land owned by the municipality ("*ejido*"), who were encouraged by DEPAPRO staff to form a group to participate FFS activities (Alpízar Ugalde 2007).

In contrast, in 2004 focus group discussions helped to identify the first two FFS learning groups in Juncal, Honduras (CATIE 2005a). Farmers of those groups were associated to commercialize their milk trough Milk Collection and Cooling Centres (CRELs). Selection criteria applied in Honduras included: good access to markets, motivation, presence of several types of farmers from large to small scale, more intensive use of labour and the possibility of replicating the experience with other CRELs (CATIE 2005a). The groups chosen were relatively new and were already organized to receive training and funding for improving milk quality by establishing modern milk collection facilities (CATIE 2005a). The initial total number of farmers participating in FFS among the three pilot areas was 139 (Table 4.7).

Thus, FFS groups in the three pilot areas corresponded to: (a) farmer groups that had or were working with other organizations; or (b) farmer groups purposely formed to participate in DEPAPRO FFS (Aguilar et al. 2010). The same authors pointed out that working with each of these options yielded advantages and disadvantages for DEPAPRO. Among the advantages of working with organized groups were the savings in time and efforts devoted to group organization activities, the establishment of relationships with other organizations by sharing information about their previous work with the farmers; while the disadvantages were the conflicts in goals and activities with those institutions who organized the groups, or the inheritance of conflicts resulting from those groups (Aguilar et al. 2010). On the other hand, the advantages of working with new groups were the absence of pre-established conflicts and acquired habits such as the demand for incentives in exchange for their participation, or animosities among group members. Disadvantages corresponded to the need for investing more time and resources to encourage group organization, and prepare them for team work. All these increased the costs of FFS implementation (Aguilar et al. 2010).

Table 4.7. Number of partner farmers per pioneering Farmer Field School group.

Country	Group name	Number of members	Type of farmers
Guatemala	Ejido	20	Small
	PETENLAC	15	Medium
Honduras	Monte de Oro	13	Medium
	Juncal	36	Medium
Nicaragua	INTA	15	Small
	CETA	25	Medium
	NITLAPAN	15	Medium
Total number of farmers		***139***	

Notes: Number of medium scale farmers dominated groups=5. Number of small scale farmers dominated groups=2. Based on: (CATIE 2004, 2005a, Alpízar Ugalde 2007).

Farmers' group identification and formation process was the first challenge that DEPAPRO faced, because farmers were unfamiliar with DEPAPRO and its staff, accompanied by the fact that government organizations and outsiders in general are not trusted, reflecting what the participants have named as a "non-participatory culture". The causes of such behaviour in Guatemala can be traced to the Civil War (1960-1996), when rural organizations such as agricultural cooperatives were targeted as enemies by the military forces because those were perceived as "threats" to government control (Taylor 2007). Also, farmers had participated in dole-out type rural development projects that generated patronage or paternalistic relationships. Those experiences created farmers' expectations that they will receive incentives in exchange for their participation in development projects. Such expectations were not fulfilled by DEPAPRO FFS, because the project ideology was not an incentive-oriented approach. Moreover, the non-participatory culture could be linked to abuses of development agents (McAreavey 2006); or promises made by rural development projects and professionals that had not materialized, as reported in the evaluation of agricultural programmes carried out in Mexico and Zimbabwe (Meinzen-Dick and Adato 2007). The testimony given by a Honduran male farmer illustrates the point:

> "*I am not going to deny the truth, here just lies have arrived. Everything is a lie because we were always told what they were going to do but it was never done, so we do not believe in them anymore. The government is just words, lies. Look they told us that they were bringing some calves for 10,000 "lempiras*[13]*" and we immediately got enrolled, but later the price of the calves was 30,000. For things like this it is the reason why we say that they are liars!*"

Other specific elements from the context of each pilot area also contributed to the initial struggle with group formation activities. For example, national elections were carried out in Guatemala in November 2003, and farmers suspected DEPAPRO was a strategy from a political party to gain votes; thus, some farmers did not attend DEPAPRO early meetings. On the other hand, in the three pilot areas some farmers attended the first or second meetings, but they left after noticing that the project was not the traditional dole-out type and their participation was constantly required (Piniero et al. 2006). Moreover, in some areas DEPAPRO had to negotiate the consent of local authorities to start working in their territory. All these required the investment of time to negotiate permissions (CATIE 2005b).

DEPAPRO experience suggests that baseline and monitoring studies should be based on approaches that include the political and cultural assets such as the Community Capitals Framework (CCF) (Flora *et al.* 2004, Gutiérrez-Montes *et al.* 2009a). The latter would help the early identification of conflicts such as the false expectations created by previous interventions, anticipate the time required for negotiating permissions or

[13] Official currency in Honduras, with an average exchange rate of 19.03 *lempiras*/USD for 2007.

political support for the FFS establishment, and would help to carry out targeting strategies for achieving a balanced participation of stakeholders.

DEPAPRO made an open call for farmers that resulted in the most effective way for capturing the eye of potential collaborators. However, neighbours and community leaders also contributed because they used their political and social capital for inviting their peers (Figure 4.6). Once the dialogue was established, DEPAPRO explained that the project was interested in the improvement of farmers' knowledge and their livelihoods, neither pursuing any electoral interests nor representing the government. Furthermore, many farmers were invited to DEPAPRO by partner organizations, as they have worked with groups formed by other organizations.

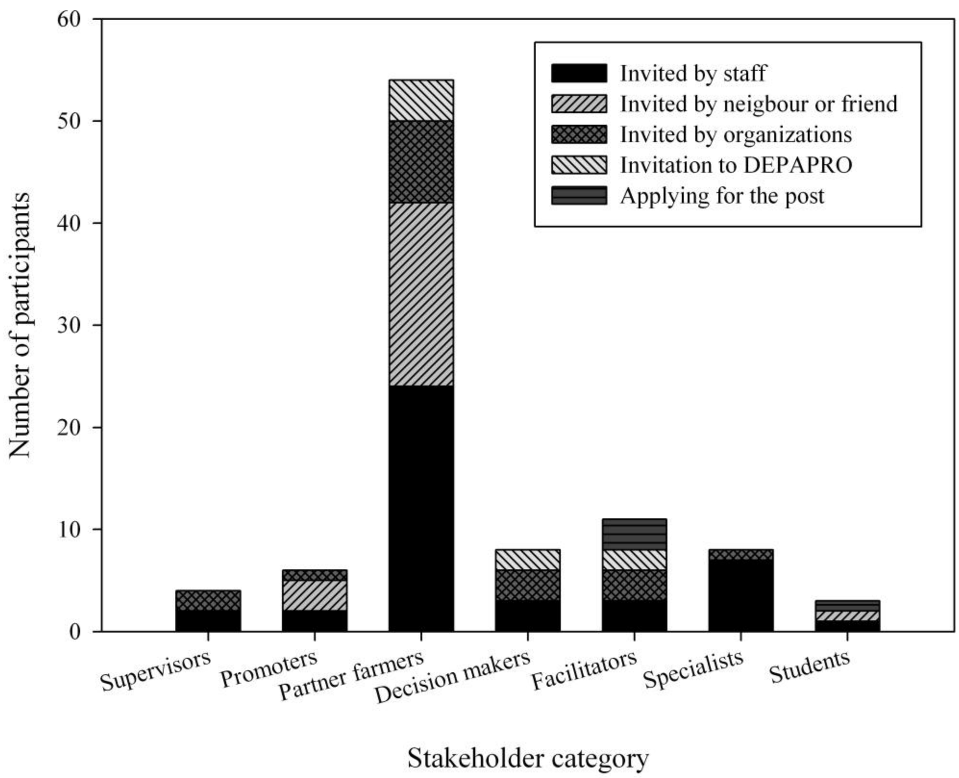

Figure 4.6. Sources of stakeholders which participated in DEPAPRO.

A peculiarity in the group formation process was that some farmers and organizations approached DEPAPRO once they noticed that the project activities matched their interests and did not involve hidden agendas that could affect their livelihoods. This was the case of farmers from Santa Rosita and La Amistad Cooperative in the pilot area of Guatemala, which requested DEPAPRO support in 2005 and 2006, respectively. Similar cases were observed with partner organizations such as COLCAPRO, CAPRO, FUPNAPIB and FUNDEBASE. Representatives of those organizations approached DEPAPRO staff and initiated negotiations for establishing formal agreements of cooperation, starting demand driven partnerships.

After group formation activities, DEPAPRO started a farmer participatory appraisal of livestock production issues. The curriculum for each FFS was developed based on the problems that farmers identified collectively. In Guatemala and Honduras DEPAPRO staff facilitated Participatory Learning and Action techniques (PLA) such as brainstorming, problem tree analysis (Figure 4.7) and paired comparisons matrices for identifying and prioritising relevant issues (CATIE 2005b, Piniero and Aguilar-Støen 2009, Aguilar *et al.* 2010). However, in Nicaragua problem analysis matrices and sub-groups discussions in workshops were the preferred techniques (Aguilar et al. 2010).

Participatory appraisal results showed that some particular production issues such as pests in pastures were affecting a limited number of FFS groups (Figure 4.7). Other issues were affecting several FFS groups and more than one pilot area, such as the lack of technical assistance or the use of large paddocks with limited rotational grazing schemes. Most of the issues identified were associated to pasture degradations processes; and were originated by a lack of financial, biophysical, and human assets that affected farmers' livelihoods. The identification of common issues among pilot areas suggested the possibility of building a general curriculum that could be used as a menu for FFS sessions, from which some could be taken according to specific group conditions. Thus, DEPAPRO encouraged specialists for addressing such task.

The use of PLA techniques and matrices facilitated the identification of livestock production issues that were addressed by DEPAPRO in the FFS. However, issues or interests related to security, lack of credits, or lack of entrepreneurial or transportation infrastructures were also voiced by farmers (Aguilar et al. 2010). Even with the flexibility granted to each of the pilot areas for customizing their strategies according to the local context, the latter issues were not addressed by DEPAPRO, because those were beyond its scope and financial capability (Aguilar et al. 2010). DEPAPRO struggled to incorporate strategies for strengthening the markets, or accessing credits for facilitating the initial investment in environmentally sound livestock production systems. This may have limited the expansion rate of areas with alternative practices for PD.

Following the SLA and the CCF perspective this is not adequate, because they left out important factors that influence farmers' capacity to adapt their productive systems and improve their livelihoods. Focusing just in environmental and productive factors without such integrated approach would raise the yield of livestock products, but farmers would not be able to internalize the benefits of such improvement since this opportunity would be taken by intermediaries and milk buyer companies (Rölling 1988). Collective marketing is a strategy that has been used in FFS from Africa for facilitating farmers' capacity related to marketing (Sanginga *et al.* 2007). Its adaptation to livestock FFS in Central America would enhance farmers' opportunity for obtaining benefits from their investments in environmentally sound productive systems.

Farmers' knowledge of the cause-effect relationships from their limitations was observed, and farmers appreciated the possibility of visualizing and discussing about them. Such behaviour could be explained by the fact that before DEPAPRO, farmers had few opportunities for discussions with their peers or technical staff about these matters, which has been suggested as a cause for the lack of adoption of agricultural technology innovations (Attanandana *et al.* 2008). Participatory techniques such as the "problem tree" technique applied in Petén allowed the integration of opinions of all farmers participating in the appraisal, including those who are usually marginalized because of their low educational background and lack of political capital. This activity is valued positively because it helps to build a collective vision about the issues and the potential solutions by focusing in local necessities identified by the same farmers. Also, it contributes to promote farmers' empowerment to address alternative solutions (Deugd et al. 1998, Sanginga et al. 2007). However, caution should be taken when trees become too big and complex, because those could be difficult for farmers to understand (Aguilar et al. 2010). Conversely, the method of sub-groups discussions applied in Muy Muy favours the dominance of more powerful participants, or those who could better express their own ideas (Ashby and Sperling 1995). Whatever is the choice, it is necessary to count with experienced facilitators for such participatory appraisal sessions, as they can balance the participation of all, or facilitate the discussions among participants for them to understand the diagrams.

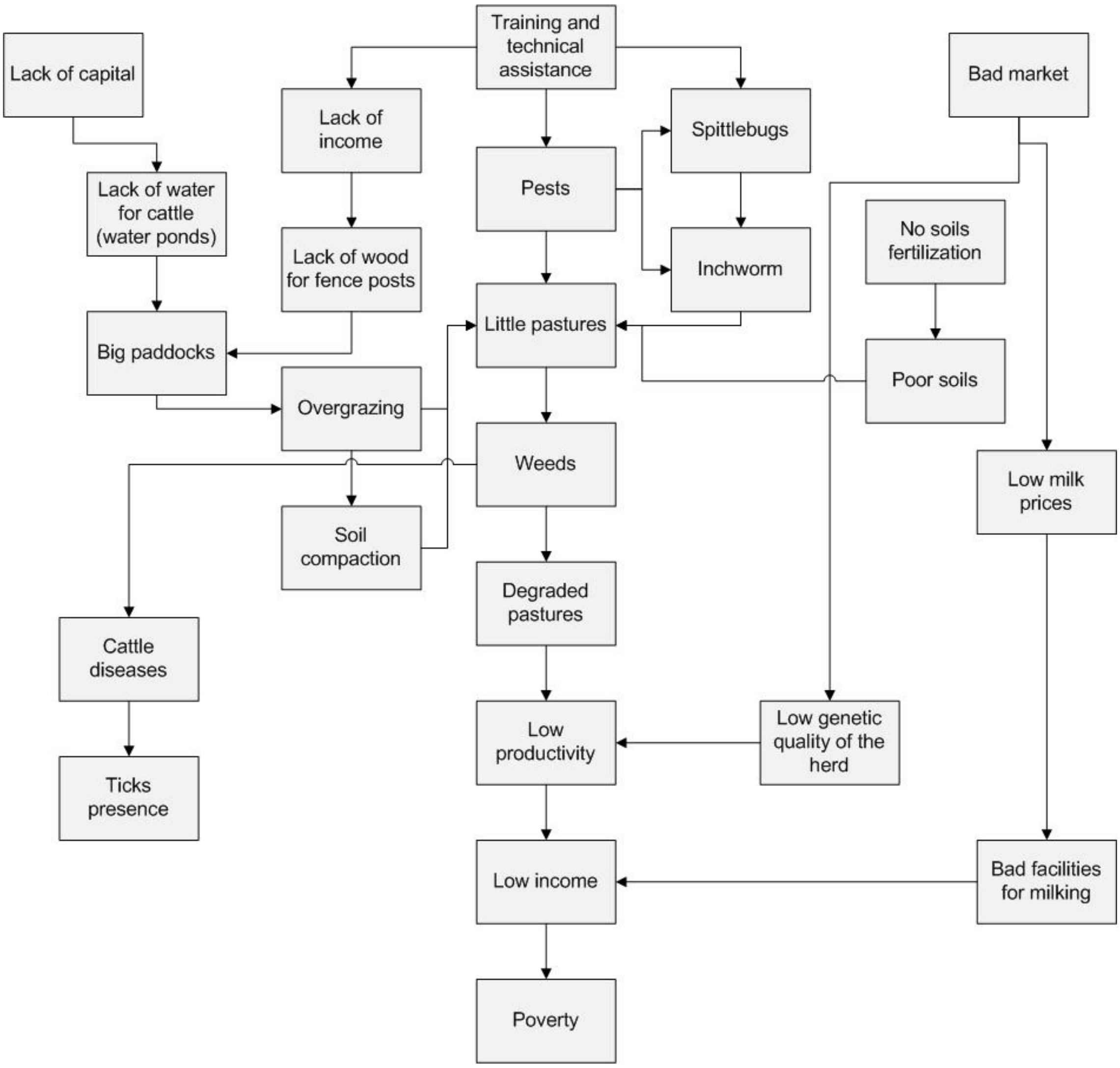

Figure 4.7. Problem tree as identified by El Chal FFS group in Guatemala (Alvarez Godoy 2007).

The following meetings consisted of participatory sessions aiming to identify potential solutions to farmer prioritised issues. The main participatory technique used during this exercise was a solution tree (Figure 4.8), allowing farmers to depict and understand the problems they were facing, the relationships between its causes, the consequences, and potential solutions to be considered (Piniero et al. 2006). Alternative solutions were categorized depending on their complexity on the following: FFS learning sessions, consultancies, on-farm experiments, and special studies (CATIE 2005a). These FFS learning sessions and on-farm experiments led to distinctive activities in FFS that are addressed in detail in other parts of the narrative. Consultancies were meant either to strengthen the capabilities of DEPAPRO staff, or do the work for them in case their time availability or expertise prevented them to accomplish a given task. An example of the latter was the recruitment of consultants to conduct regional studies on how markets and policies affect livestock production in the pilot areas. Special studies were pieces of research carried out by students and experts from partner organizations, with funds provided by DEPAPRO.

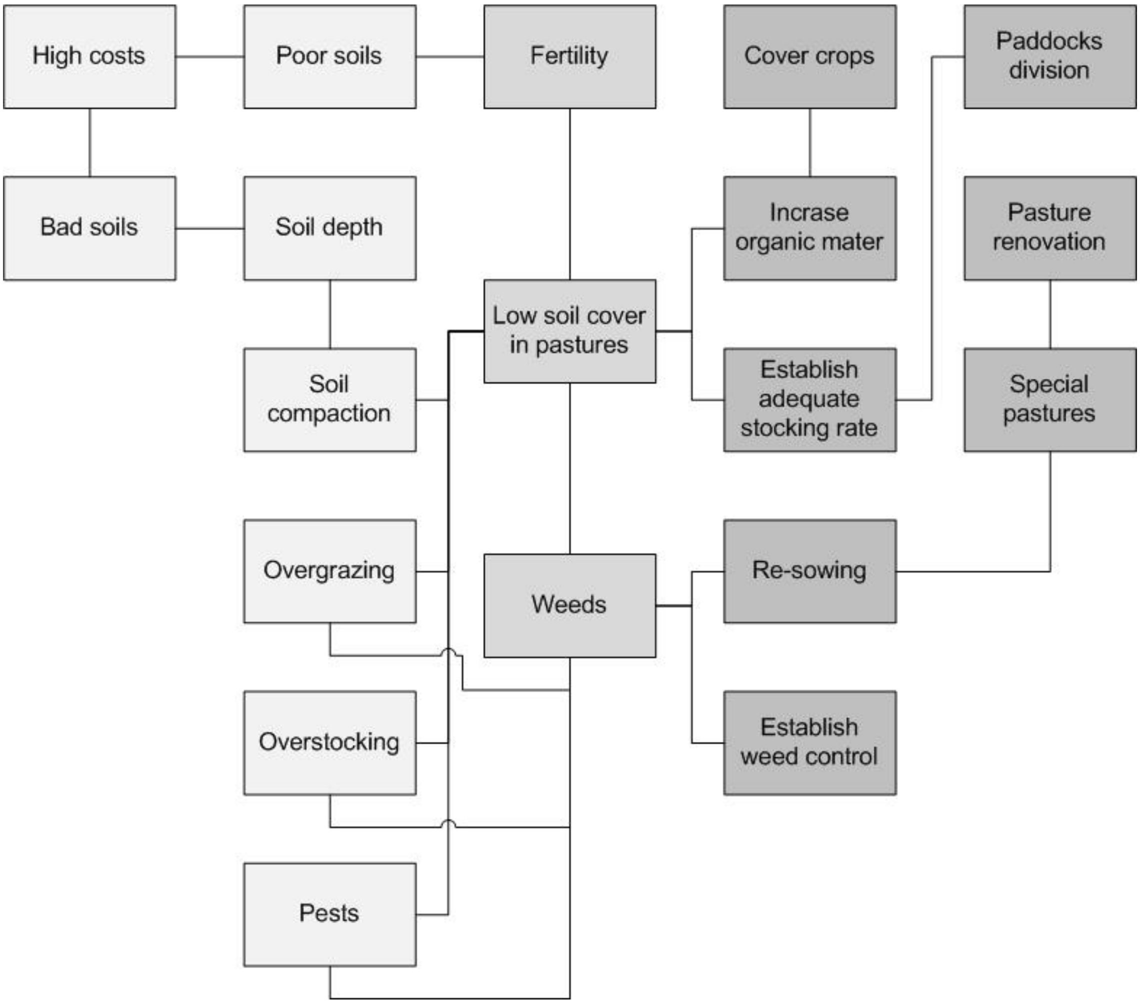

Figure 4.8. Solution tree from El Chal pilot area (Alvarez Godoy 2007).

In the pilot area of Guatemala, the solutions proposed by participating farmers included the use of green manure crops to improve soil fertility, to install smaller paddocks for more intensive rotational grazing division, and the rehabilitation of degraded pastures by replacing with more productive species, just to name a few. In Honduras, the installation of fodder banks for browsing, the establishment of grass-legume mixtures and fertilization trials were some of the solutions identified (CATIE 2005a). Integrated management of weeds, the establishment of grass-legume mixtures and forage conservation as silages were some alternatives highlighted in Nicaragua (CATIE

2005b). The FFS learning sessions carried out during 2004 are presented in table 4.8. Interviewees pointed out that not all solutions were proposed by them, as in some cases DEPAPRO staff or specialists suggested some options. An example of these is the establishment of fodder banks in the three pilot areas, because those are unconventional silvopastoral systems in Central America (See Chapter Two). Hence, farmers were less likely to literally suggest their implementation.

Table 4.8. Farmer field schools sessions carried out in 2004.

Pilot area		
El Chal, Guatemala	***Juncal, Honduras***	***Muy Muy, Nicaragua***
Identification and prioritization of problems		
Potential solutions and needs for training		
Pests control in pastures (spittle bug)	Building milking parlour facilities, and how to produce milk hygienically	Renovation of degraded pastures
Selection of pastures based on their adaptation to biotic and abiotic constraints	Certification of trees in pastures	Common animal diseases and their control
Renovation of degraded pastures	Mastitis control	Estimation of pasture availability
Pasture management strategies	Records to assess farm productivity and economic performance	Weed control in pastures
Woody perennials in silvopastoral systems	Electric fencing for rotational grazing	Silage preparation
Monitoring and Evaluation of 1st year learning and experimentation activities		-------------

Notes: Based on (CATIE 2005a, 2005b).

The documentation process investigated the motivation of stakeholders for participating with DEPAPRO. Interviewees mentioned compatibility of interests or thematic affinity, followed by the membership to organized farmers' groups as the most important factors that motivated their participation (Figure 4.9). Thematic affinity is related to intervention activities such as the baseline fieldwork, the analysis of innovation systems, the criteria for group selection, and the participatory appraisal activities. Such activities allowed identifying areas, farmers and organizations with interests on PD and livestock production.

Membership of organized groups is related to the political and social capitals of the farmers participating in the FFS. As has been described in an analysis of IPM FFS (Feder et al. 2004) farmers with more assets, in this case social and political, are more likely to participate and obtain benefits from rural development projects. This has been criticized because can cause the concentration of rural development benefits in elite families (elite capture), reducing the chances of addressing poverty. On the other hand, personal or professional relationships were pointed out as the third reason for joining DEPAPRO. Some facilitators and promoters were locals from the region where the FFS groups were to be established. DEPAPRO staff's bridging social capital seemed to have helped to motivate the participation of stakeholders, because partner farmers had previous personal or work relationships with facilitators. Conversely, previous negative experiences with members of the DEPAPRO staff interfered with the engagement of farmers in the project. For example, a farmer explained that he first hesitated in joining DEPAPRO because a previous work experience with a member from DEPAPRO staff was not properly concluded.

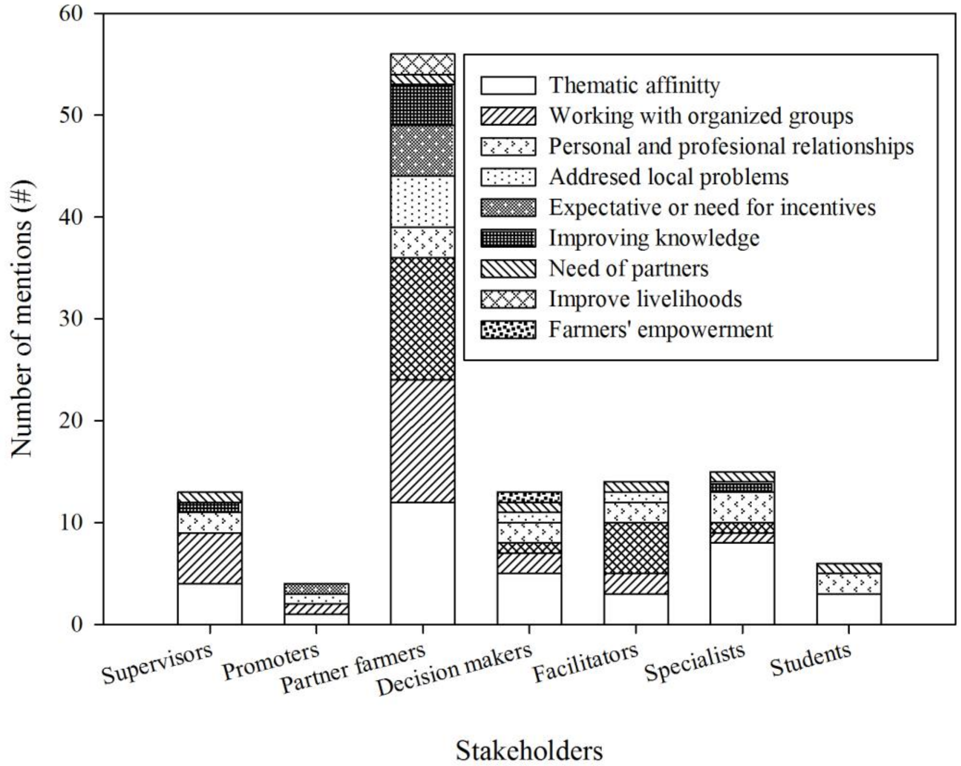

Figure 4.9. Reasons for working with DEPAPRO as expressed by the interviewees.

The participatory appraisal marked the shift towards an inclusive and comprehensive approach. As was pointed out by DEPAPRO staff, top-down oriented initiatives are likely to start their activities even without a previous consultation with farmers, based on plans tailored by outsiders (Pezo et al. 2009). On their part, DEPAPRO invested efforts negotiating with farmers to adapt the programme of activities to farmers' agendas, such as scheduling the FFS sessions to the convenience and availability of farmers. Three important considerations for implementing the FFS emerged:

(i) Programming FFS sessions. Each session was planned taking into consideration the relevance of the activity in a given season (Pezo et al. 2009). For example, forage conservation sessions were scheduled before the dry season, as ensiled pastures were still green and the silage should be used in the dry season.

(ii) Frequency of FFS sessions. There was not a tight chronogram, but on the average learning sessions were held every three to four weeks (Pezo et al. 2009). This interval was arranged considering that farmers had their own farming activities, and had to meet facilitators to monitor the experiments, and DEPAPRO staff needed to hold learning sessions with other FFS groups, required time to plan and prepare the materials needed for the following session, monitor other experiments, and provide support to students participating of DEPAPRO. Also, the nature of the livestock productive cycle influenced the frequency of FFS sessions, being generally less intensive than in the case of annual crops (Aguilar et al. 2010). The frequency applied in DEPAPRO differed from other FFS reported earlier (Rölling and Fliert 1994, Minjauw et al. 2002, Groeneweg et al. 2007, Vaarst et al. 2007a), in which regular FFS sessions were held at least twice a month.

(iii) Timing of FFS sessions. It was agreed that most learning sessions should be held in the afternoons, since the work of farmers in the farm finished around noon (Pezo et al. 2009). In Petén, Guatemala the average number of hours dedicated to farm activities by medium scale farmers was 5.5; but farmers practicing agriculture were more likely to spend more time in the farm than farmers dedicated exclusively to livestock production (Girón 2006). Moreover, in the case of the medium scale farmers sometimes their agenda included non-agricultural productive activities, which DEPAPRO found difficult to integrate with a more intensive livestock FFS programme. Exceptions were those sessions related to activities that had a fixed timing during the day, such as milking in dual-purpose production systems. In that sense, the mastitis control session was held early in the morning.

Other interesting fact observed in DEPAPRO practice is related to the development of the FFS approach. Some of the first meetings were carried out in classrooms of local schools or similar facilities, using unconventional logistics for farmers such as digital presentations, slide projectors and laptops supported by electricity generators (Figure 4.10). However, DEPAPRO realized that the audiovisual "aids" made the session more formal, farmers participated less, therefore they did not contribute effectively to the learning process of adult farmers (Ooi 1996). Instead, farmers preferred open spaces, hands on tasks, and observation on live samples and plots (Pontius *et al.* 2002, Franz *et al.* 2010). These were considered by DEPAPRO, therefore most sessions were held in open spaces on the farms, whether under a tree, a corral or a terrace for introducing the topic, but even in those places simple farm materials or live samples were employed, and were followed by practical field activities.

Regular participants in a FFS learning session were: (a) a group of partner farmers – frequently accompanied by family members; and (b) one facilitator or promoter, usually assisted by other stakeholder depending in the nature of activities to accomplish. In the following paragraphs one of the FFS sessions on the preparation of multi-nutrient blocks is described to illustrate how FFS sessions worked. One week before the FFS session on multi-nutritional blocks, the facilitator scheduled a meeting with the FFS members. This served to schedule the FFS session and to prepare the materials needed for it. Farmers were asked to offer voluntarily the materials needed for the practice according to their possibilities, in this case some of the inputs needed were maize, leucaena and "*madero negro*" (*Gliricidia sepium*) leaves, molasses, lime, cement by-product kiln dust (ckd), fuel, etc. The preparation of dried leucaena leaves, *madero negro* foliage and maize required the participation of all FFS members. They collected the fodder in the field and dried it; however, in the case of *madero negro* the foliage was chopped before drying (Figure 4.11). In the case of maize, kernels were collected and ground to prepare a sort of maize meal. In all cases, FFS members volunteered for those activities, as well as to take all materials needed for continuing the session.

One week later, the facilitator arrived at the village accompanied with one member of DEPAPRO staff member and some students that were interested in the topic of the FFS session. The meeting was dynamic, after an introductory focus group discussion about the blocks and their similarity to commercial concentrates, the practical started. FFS members and students formed sub-groups of three to four people and all of them participated in the making of nutritional blocks (Figure 4.12). At least one block was prepared for every farmer, who agreed to try the block with their cows and observe if it was consumed.

Figure 4.10. Use of audiovisual aids in the FFS participatory appraisal session in El Chal, Petén, Guatemala.

The following week a FFS feedback session was carried out for farmers to share their experiences during the previous learning session and testing if those blocks were accepted by their cows. In general, farmers were impressed that they could prepare something equivalent to a commercial concentrate but using mainly ingredients produced in their own farms, and were surprised that their cows could eat a block containing cement and lime, which are components of ordinary construction blocks. In this FFS session and most of the others it was observed that facilitators did not work as lecturers and the audience as passive receivers; instead all participants (including the students, farmers and other household members) took an active part on preparing the inputs for the FFS session, provided arguments in the discussions, and finished with their hands covered with the multi-nutritional block ingredients.

Figure 4.11. Farmers and their household members, as well as the facilitator participated preparing materials needed for making multi-nutritional blocks in Petén, Guatemala.

The adaptation of the FFS approach implied a change in the stakeholders' attitudes. In the FFS learning sessions, knowledge is built by discovery through observation, or by applying a given practice, monitoring experiments, and participating in group analysis and reflection. This is different to learn from lecture-type sessions, as is common in the Transfer of Technology model and other top-down oriented training models such as the Visit and Training (Rölling 2002, Gallagher 2003). Understanding and practicing this participatory approach was a significant challenge for the stakeholders involved in the

FFS sessions, particularly for the facilitators and specialists, who were used to an attitude of control and power as knowledge providers, because of their educational and professional background (Chambers 1984, Hoffmann *et al.* 2007). In Central America, traditional technical assistance and trainings are like prescribing medicines or offering lectures. A female specialist who participated in the Nicaraguan FFS expressed:

> "*... we wanted to unlearn the old methodologies* (training) *to learn this new one* (FFS). *It was a great step for us, but it was difficult, not easy. Unlearning is difficult* (laughs). *Unlearning is more difficult than learning new things, because you are used to a given way of doing things. You have to forget the old methodologies* (top-down training) *for applying the new ones* (FFS)".

Figure 4.12. Farmers preparing multi-nutritional blocks as part of a FFS session in Petén, Guatemala.

DEPAPRO promoted farmers' experimentation with three main purposes (CATIE 2005b, Pezo *et al.* 2009): (1) for learning by discovering knowledge; (2) for understanding the factors that farmers considered important in technology selection (see Chapter Five), (3) for testing technologies that could contribute to solve the constraints identified by farmers. In early 2003, DEPAPRO staff started to identify potential experimenters among those farmers who wanted to be partners of the project in Guatemala and Nicaragua (CATIE 2005b). The selection criteria of experimenters included: commitment to share experimentation expenses, openness to participate in monitoring the experiments and allowing others to visit those, and willingness to communicate results with other stakeholders.

Among those who fulfilled those criteria, the decision to become experimenters was on a volunteer basis, but in the case of the Nicaraguan pilot zone it was decided that all farmers should have the opportunity to establish one experiment (CATIE 2006b), therefore they were encouraged to select the alternative that they wanted to experiment with. However, when none selected an option considered "relevant" for the project or partner organizations, DEPAPRO staff promoted its evaluation by providing additional explanations about the technology (Aguilar et al. 2010); or by funding the total costs of their establishment in demonstration plots. In the case of Guatemala and Honduras, if farmers volunteering to test a given innovation exceeded the possible number according to the budget, experimental plots were drawn. On the other hand, funds for experimentation were administered by DEPAPRO staff in Guatemala and Nicaragua; whereas in the Honduran pilot zone, in 2005 FFS members were encouraged to manage by themselves the budget allocated for experimentation (CATIE 2006b).

Experiments were chosen from potential solutions to the problems identified by farmers during the participatory appraisal, and the treatments to be tested came from farmers' observations during exchange visits or alternatives proposed by DEPAPRO staff in the learning sessions. The latter included technology innovations and management practices already proved by research in Central America (CATIE 2006b). In late 2004 partner farmers and project staff established 68 trials (Table 4.9) in the three pilot areas (CATIE 2005b). For the evaluation of those trials, DEPAPRO implemented a Monitoring and Evaluation (M&E) System, that included collection of data about establishment costs for each trial, a description of the biophysical context, and economic or productive impacts (CATIE 2005b). Household members –mostly literate children- of the farmers who implemented the trials were involved in the M&E activities including data recording. In exchange they received a monetary compensation for their services. This strategy helped to monitor for example milk yields which were used to assess the impact of improved pastures and fodder banks on milk production. For example, cows having access to browse in *Leucaena leucocephala* (leucaena) fodder banks during the dry season in Petén, Guatemala showed increases in milk yield from 17 to 23% compared to those who only grazed on pastures (Turcios 2008).

Table 4.9. Experiments or demonstration plots established by DEPAPRO in 2004.

Trial name	Pilot area *El Chal*	*Juncal*[*]	*Muy Muy*	Subtotal
Weed control in pastures managed under grazing	0	0	6	6
Fodder banks for cut and carry or grazing	1	1	3	5
Improved pastures in monoculture or mixtures with legumes	14	2	18	34
Forage conservation as silages	0	0	10	10
Grazing management	0	0	2	2
Improved pastures in silvopastoral systems	7	0	0	7
Live-fence posts production	3	0	0	3
Partial replacement of commercial concentrates with local feed resources	0	1	0	1
Total trials (#)	25	4	39	68

Notes:[*] Juncal established fewer trials than the other pilot areas due to the delay in the starting of activities in such area. Adapted from: (CATIE 2005b).

The establishment of on-farm experiments represented a technical and logistic challenge for DEPAPRO (Table 4.10). Some required the introduction of seeds not available in the pilot areas, such as for leucaena and *Arachis pintoi* (fodder peanut). DEPAPRO bought leucaena and fodder peanut seeds from distant regions, and even imported seeds from other countries to cover its demand. This procedure took more time than anticipated, and in some cases resulted in delayed establishment of the trials, which in turn were affected by droughts or poor seed quality. As a farmer from Nicaragua explains:

> "*The project* (DEPAPRO) *brought this peanut fodder material* (vegetative seed), *which was too immature… then the dry season* (makes gestures indicating that the peanut died). *At least this has no roots* (showing immature peanut fodder stolons) *and it is not good for planting. You know, business is business! If you come and tell me -I want to buy this material, I say yes!* (Even though I know it does not have roots). *To me as a seller, it does not matter if the seed is immature or mature, what I want is my money* (referring to the attitude of seed sellers)...

Today I am not going to plant an immature material, without roots, because I know it will die, I will rather plant a material that has roots. Then all this is knowledge that we both the project and I acquired".

Farmers were responsible for monitoring and managing the experiments in coordination with facilitators and in some cases with students doing their thesis. However, sometimes farmers and facilitators were not familiar with the management of some technology options resulting in failures, therefore all learned about what proper management is, or which land was not adequate for establishing a given pasture. Such experiences contributed to the knowledge of the stakeholders involved, but also increased the costs of the FFS. The costs per experiment in DEPAPRO ranged between US$70 and 200 dollars[14] (Aguilar et al. 2010).

Table 4.10. Farmers' perceptions on causes of failures in some experiments.

Cause	Pilot areas (%)	Anchoring and expansion areas (%)	Average (%)
Lack of rain	30.8	20.0	25.4
Poor establishment practices	30.8	10.0	20.4
Inadequate soils	15.4	30.0	22.7
Poor seed quality	15.4	0.0	7.7
Lack of propagation materials	7.7	10.0	8.8
Complex management*	0.0	10.0	5.0
Excess of rain	0.0	10.0	5.0
Lack of familiarity with species	0.0	10.0	5.0
Totals	100.0	100.0	100.0

Note: Pointed out by 13 stakeholders in the pilot area and 10 in the anchoring and expansion area from 106 participants. *Not described in detail.

In late 2004, DEPAPRO and partners carried out an annual monitoring and evaluation (M&E) meeting in the FFS from Guatemala and Nicaragua. Those meetings consisted of annual sessions where farmers and their families shared, discussed and analysed FFS experiences, using group dynamics and participatory activities. The activity was also used for planning sessions and identifying promissory experiences to experiment with (CATIE 2006b). In early 2005, planning sessions were carried out with most of the FFS groups in the three pilot areas, and those served for scheduling the themes to be covered

[14] Not considering transportation and the salary of facilitators or other stakeholders.

in the year by each FFS, according to the context and challenges of each FFS area. In Guatemala for example, milking hygiene sessions were incorporated in the curricula because of a new market demand in El Chal, which required better milk quality for the product to be received (Aguilar et al. 2010). M&E and planning sessions became part of the annual programme of the FFS in the subsequent years.

In 2005 there were some changes in the conformation of some FFS learning groups in the three pilot areas. In Nicaragua, the NITLAPAN and CETA groups were merged, due to the reduction in number and similarity of participants (CATIE 2006b). In Honduras, a similar strategy was applied merging the two CREL's groups, applying the same reasoning than in Nicaragua (CATIE 2006b). Several factors may explain why some farmers did not continue. The interviews showed that experiments were considered as incentives by farmers, and some were unsatisfied for not being selected as experimenters. Few farmers in Guatemala left DEPAPRO or reduced their participation arguing that the ones selected as experimenters were those with more political and financial assets (Alpízar Ugalde 2007). One of them said:

> "*DEPAPRO staff defined the people they wanted to help (by establishing experiments or demonstration plots). I think the beneficiaries should be the ones who really need help (low assets households). However they choose that farmer (one with experiments and demonstration plots) who has money. I wish all those projects (experiments) were instead given to me…*"[15].

In Honduras DEPAPRO identified three reasons that caused farmers desertion: (a) internal conflicts related to the CREL administration, (b) false expectations of incentives such as the request for funding equipment for a feed mill, and (c) lack of interest to participate by more technologically advanced farmers (CATIE 2006b, Aguilar *et al.* 2010). One underlying cause of desertions in the Juncal pilot zone was previous farmers' experiences receiving a dole-out type of support granted in 1998 - after hurricane Mitch. Additionally, during the first year of activities in Juncal all FFS principles could not be followed, because the sessions were performed jointly with an institutional partner, whose training methods were more top-down oriented (CATIE 2005a).

[15] Informant details intentionally omitted for granting anonymity.

Most of the interviewees indicated that the FFS approach worked better for small-scale farmers, rather than with those who have more assets, as shown by the apparent less constant participation in those groups dominated by medium size farmers. Actually, the conformation of groups with the two types of farmers was made on purpose, but in the case of Honduras the groups initially formed were basically of medium size farmers, therefore in 2005 two new groups constituted mainly by smallholder farmers were organized in La Hoya and Carbajales communities. Also, in the same year a new group was established in Santa Rosita (Petén, Guatemala) formed by both medium and small scale farmer participants (CATIE 2006b). These decisions helped to balance the representation of small scale and medium size farmers in DEPAPRO activities, because the pioneer groups were comprised by five groups of medium scale farmers and only two groups from small farmers.

The DEPAPRO proposal considered the involvement of organizations related to the agricultural sector as essential for addressing PD issues (CATIE 2002). Therefore, in 2003 DEPAPRO started to search for organizations that could be potential partners in this endeavour. Presentations about DEPAPRO's aims and the importance of the PD issue; invitations to FFS sessions; field visits to the pilot areas for observing experimental plots; training opportunities and funding research projects on a competitive basis; and even the provision of funding for organizing new FFS were used as strategies to involve partner institutions. However, in the early stages organizations responded to the invitation with caution, being the participation in DEPAPRO activities more of committed individuals than of the organizations as such. A number of reasons could explain such response, among those are: (a) bureaucracy that slowed down the signing of formal agreements of cooperation; (b) resistance to the use of outsider's training methodologies; (c) lack of previous experiences of inter-institutional cooperation, and (d) as a measure of caution, not embarking in a new approach before assessing some results of DEPAPRO. A Guatemalan specialist who participated in DEPAPRO pointed out:

"*The institutional bureaucracy stops us a lot. Too much paper work is needed for any action to be taken! It is something inherent to us. We indicated to the authorities our interest to participate in DEPAPRO activities, and got no response for three months. Everything takes too long, people do not have time to read, do not make decisions and do not have time to go. Therefore, our work becomes too slow*".

Nevertheless, the perception of a different attitude from DEPAPRO staff and a high rate of performance in the commitments acquired with organizations facilitated the incorporation of partners to DEPAPRO. Around 40 specialists from Guatemala, Honduras and Nicaragua participated in the design of a general FFS curriculum in the preparation and testing of guidelines for learning sessions (Pezo et al. 2009). In early stages, such participation focused mostly on research topics relevant to DEPAPRO, tutoring of students sponsored by the project, and attendance to regional or national strategic courses. In the first year of FFS operation most participatory learning sessions were facilitated by DEPAPRO staff (except in Honduras), causing an overload in their work (CATIE 2006b, Pezo *et al.* 2010). Given that none of the 15 partner organizations collaborating with DEPAPRO in that period were involved in FFS activities, each DEPAPRO field staff had to attend 46 farmers, plus his other responsibilities, such as monitoring experiments, assisting students with his/her thesis, etc (CATIE 2006b). This changed in 2005 when institutional partners started to become involved in FFS activities. For example, INFOP in Honduras agreed to facilitate the FFS activities with the groups in La Hoya and Carbajales, helping to reduce the workload for DEPAPRO staff (CATIE 2006b).

By 2005, the FFS structure was consolidated and included the use of the zig-zag learning model and seven main activities: (1) session's guidelines, (2) experiments, (3) discovering exercises, (4) group dynamics, (5) exchange visits, (6) demonstration plots and (7) the facilitation of special topics (Groeneweg et al. 2007). The topics covered and attendance in FFS sessions carried out during 2005 are presented in Table 4.11.

The zig-zag model of learning was adapted from the model generated by a participatory CATIE initiative on Integrated Pest Management in Nicaragua (Staver 2005). DEPAPRO adapted it as follows: based on the alternatives of solution identified jointly by farmers and DEPAPRO staff, specialists developed guidelines for the FFS learning sessions. The guidelines were written in simple words, using farmers' language to facilitate their comprehension. Once the guideline was prepared, the specialist(s) responsible for it led a participatory learning session held in a farm, with a group of facilitators, DEPAPRO staff, and sometimes leader farmers as participants. Facilitators played the role of farmers asking questions, and along with DEPAPRO staff evaluated the session and provided the necessary feedback to improve the guideline. The specialist(s) then incorporated the suggestions and the guideline was tested again. Once all participants were satisfied with the new version, each facilitator carried out a learning session with farmers groups, using the guideline. There was not a rigid assignment of roles for DEPAPRO stakeholders, therefore each could play more than one role in the zig-zag model. It should be indicated that the specialists who developed the session guidelines were members of partner institutions and DEPAPRO staff as well.

Table 4.11. Number of participants in the learning sessions carried out in 2005.

Topic	Pilot area			Subtotal
	El Chal	Juncal	Muy Muy	
Annual planning meeting	22	81	42	145
Body condition score evaluation in dual-purpose cattle	32	41	40	113
Feeding strategies for dual-purpose cows	31	18	81	130
Integrated weed management strategies	102	72	44	218
Breeding options for dual-purpose cattle	0	17	26	43
Farm planning and participatory tools	57	43	0	100
Establishment and management of pastures	96	237	0	333
Evaluation of farmers' perceptions on PD	0	41	0	41
Animal health management practices	100	0	0	100
Forage legumes: Adaptation and uses	46	19	0	65
Design and building of milking facilities	22	0	0	22
Establishment and management of leucaena	36	0	0	36
Use of electric fencing for intensive grazing	24	23	0	47
Monitory and evaluation meeting 2005	134	0	72	206
Total participants[1]	***702***	***592***	***305***	***1599***

Notes: [1]Considering multiple attendance of sessions by the same farmers. PD=Pasture degradation. Adapted from: (CATIE 2006b, 2006a).

Guidelines were compilations of suggested activities and key technical information to be taken into consideration in FFS sessions. They were written using farmers' language to facilitate an easy use of the learning instrument and could prevent differences in the approach and quality of facilitations. Guidelines also included a list of suggested materials, logistics and previous considerations before performing the FFS session. This tool was appreciated and used by facilitators particularly when some FFS sessions covered topics that were not in their expertise. As quoted by a male facilitator from Nicaragua:

> "*With our project (previous one, name omitted) we just had a chronogram of activities, but every technician had their own way to do it* (training). *Some had more experience than others, but we did not have a standard model. Conversely with DEPAPRO, we attended a training* (guidelines testing)*, and later the project provided us a session guideline, describing how to do step by step… and at the end we applied the guideline while giving our trainings. If there were wrong things that did not work well, we improved it, or we said –look the farmer does not like this and that. Finally we ended with an improved guideline, and everyone followed it as a model*".

FFS sessions also included "discovering exercises", which were practical and observational activities designed for facilitating the learning of potentially complex concepts (Groeneweg et al. 2007). For example, to facilitate the understanding of the importance of leguminous crops for improving the livestock diet and soil fertility, a discovering exercise was used (Cruz and Nieuwenhuyse 2008, Nieuwenhuyse et al. 2008). The exercise included the identification of morphological features of legumes species by comparing live samples of contrasting plant families (e.g. Poaceae versus Fabaceae). Then based on the absence of root nodules in pastures, the concept of nutrient fixation was introduced in the discussion using the observations and experiences of FFS members.

Group dynamics were game-like activities that helped to improve communication, participation, rapport, and attitude change among FFS participants (Pretty et al. 1997, Groeneweg et al. 2007). There were different kinds of dynamics, some of them helped to raise participants' attention while others enhanced organizational skills and even helped to identify and solve conflicts (Groeneweg et al. 2007). Unfortunately, guidelines published by DEPAPRO to date do not include many references to group dynamics employed in the FFS (Cruz and Nieuwenhuyse 2008, Nieuwenhuyse et al. 2008, Palma and Cruz 2010). However, there are some compilations from other authors available in Spanish (Pretty et al. 1997, Pumisacho and Sherwood 2005, Groeneweg et al. 2007) and English (Chambers 2002, Ortiz 2002, Khisa 2004).

In one FFS graduation ceremony in Olanchito, Honduras the “*repollo*" (cabbage) group dynamic was carried out (Groeneweg et al. 2007). This consisted of preparing sheets with a series of questions, energizing activities e.g. dancing, singing and even gifts. The sheets were formed like a ball (cabbage), and during the event, participants continuously passed the ball to each other until the music stopped. The participant with the ball then unwrapped one sheet and followed the instructions written on it. This technique was meant to evaluate in a funny and informal approach the knowledge acquired by the participants about a given topic. It was dynamic and it served to energize and motivate the participants as well.

Learning sessions also included the facilitation of special topics. This was accomplished using focus group discussions and participatory exercises to facilitate the transfer of theoretical information to farmers (Groeneweg et al. 2007). In a livestock FFS, addressing topics related to animal health and animal nutrition require technical information before making trials with live samples. More so when experimenting with issues such as zoonotic diseases that could represent a threat for the health of participants (Minjauw *et al.* 2002). For example, sessions in animal health such as mastitis control required at the beginning the involvement of a veterinarian. However, before such specialist facilitated the session, he or she had to attend a training course on FFS methodologies, or at least he or she was introduced by DEPAPRO staff to the FFS approach and methods, and was assisted in preparing the guideline, for the session not to be different from others.

Demonstration plots were a strategy used by DEPAPRO to observe the performance of a given innovation that farmer partners were not open to test, investing some of their resources, either because they could not afford the installation costs, or they were not convinced of the value of such innovation. Some examples of technologies incorporated as demonstrations in Guatemala were leucaena, fodder banks, improved water reservoirs, and electric fences (Pezo et al. 2009). In contrast to the on-farm trials, demonstration plots were 100% funded by DEPAPRO. The most outstanding example of replication from demonstration plots occurred in Guatemala with leucaena fodder banks (Pezo *et al.* 2010). Two years after the establishment of the first hectare of leucaena in a demonstration plot, its use was followed by more than 130 farmers, who established 84.5 ha in total (Pezo et al. 2009). The other innovations managed as demonstrations, such as electric fences and improved water reservoirs were not replicated at a similar rate than the leucaena fodder banks (see Chapter Five in this thesis).

Exchange visits were one of the project strategies more positively valued by farmers. Those were used to introduce farmers to technology innovations already in use, for example, pioneering FFS groups in Petén visited the Experimental Farm of the Regional Centre of San Carlos University in Petén (CUDEP-USAC), where they observed several pasture genotypes of recent introduction to the region. From this visit and another to a large farm that had more than 12 genotypes of grasses in their paddocks, farmers took decisions on which grass species to test in the on-farm trials (Cruz *et al.* 2007). When pioneer FFS participants established experimental or demonstration plots, farmers from new FFS groups, students, and staff from other organizations visited those plots to identify potential alternatives to implement in other areas. Exchange visits were also used with other stakeholders such as facilitators, specialists and decision makers. In all cases exchange visits were cited as a key element that convinced stakeholders to participate in DEPAPRO.

As mentioned before, the on-farm trials were partially funded by DEPAPRO by providing seeds and/or some other agricultural inputs or materials needed for their establishment. On the other hand, farmers provided land, labour, field monitoring and management or maintenance. Pasture trials and others were used to facilitate several learning sessions, for example: how to establish pastures, pasture management and the association of grasses with legumes (CATIE 2006b). Exchange visits of experimenters' were promoted to encourage the communication among those working with similar trials to obtain feedback and increase their knowledge about the innovations they were experimenting (CATIE 2005b). After listening or observing the experience of their peers, some farmers decided to vary some management practices to improve the performance of their trials (Pezo et al. 2009).

4.4.2.4. Participatory learning validation, anchoring and scaling up

In March 2005, DEPAPRO presented a proposal for the anchoring and scaling up of its interventions (CATIE 2006b). The strategy implied the formation of new FFS groups under the responsibility of partner organizations, but partially funded with DEPAPRO resources. The aim of this effort was to encourage the involvement of local partners in organizing new livestock FFS. As a result of this step the FFS approach was disseminated among other institutions working with livestock farmers in Central America, contributing to the development of skills for practicing more environmentally sound livestock management practices (CATIE 2006b). The anchoring and expansion phase started in 2006 with 300 new farmers, and the celebration of 176 FFS sessions in Guatemala, Honduras and Nicaragua (CATIE 2007a). When DEPAPRO finished its activities by the end of 2008, were recorded 1,743 participants and 55 facilitators from 10 partner organizations in the anchoring and expansion phase (CATIE 2009).

The commonwealth of municipalities from the South of Petén (MANMUNISURP) became the pioneer partner organizing livestock FFS in the anchoring and expansion phase in Petén, Guatemala (CATIE 2007a, Pezo *et al.* 2010). It started its activities with three groups in late 2006: El Porvenir, La Cumbre, and La Compuerta. Additionally, the NGO named Foundation for the Development and Strengthening of Grassroots Organizations (FUNDEBASE) based in Poptún, Guatemala expressed its interest in participating in the anchoring phase. This emerged after its technical staff visited the FFS groups working in the El Chal pilot area and some of its staff participated in one week training course for FFS facilitators. The staff who attended the course improved their skills to work with farmer groups, thus their supervisor requested additional training for FUNDEBASE field staff, as shown in the following paragraph:

> "*We agreed that few people from our staff attended one training* (on FFS) *offered by them* (DEPAPRO). *It was interesting for me to observe the improvement shown by those promoters who attended such training… I observed the dynamism and enthusiasm they brought* (empowerment after FFS training), *and their work on new proposals. So I got interested on what DEPAPRO was*

doing with the FFS approach and asked the project National Coordinator the possibility of offering another course, especially for the field promoters of FUNDEBASE, but at the end all the technical staff of FUNDEBASE also attended".

In 2007 FUNDEBASE and DEPAPRO signed a formal agreement and together they managed to implement FFS in eight communities of Poptún Municipality, in coordination with MANMUNISURP. The partnership with FUNDEBASE produced the involvement of a new stakeholder in the FFS: the field promoters, who were farmers who belong to the community where the FFS operated. As a result of this joint effort, the Farmer to Farmer approach used by FUNDEBASE became one of the new experiences for DEPAPRO. The farmers who facilitated the FFS sessions in FUNDEBASE groups were named "promoters", because they did not receive any salary and had no formal agricultural education. The participation of promoters made possible organizing FFS groups in remote communities, with limited access to extension services and where most of the members were *Q'eqchi'* native speakers. Such process was also facilitated by students from the *Q'eqchi'* cultural group, whom helped in the translation of FFS guidelines prepared for non-Spanish speaking farmers.

The NGO Pro-Petén also implemented FFS in Petén, working with women groups engaged in raising small animals (CATIE 2007a). Also, the Faculty of Veterinary Medicine and Animal Husbandry from The University of San Carlos (FMVZ-USAC) carried out their first experience on FFS organizing one on forage conservation in 2007. This experience showed positive changes in the attitude and knowledge of farmers from La Gomera, Escuintla. Based on this, the FMVZ-USAC decided to further encourage the application of the FFS approach, in 2008 other members of their faculty were trained in such participatory methodologies, established five new FFS in the Patulul Municipality, and modified their academic curricula incorporating the FFS approach in the courses of sociology and agroforestry. Considering FFS was a more effective methodology for farmers and undergraduate students learning (Pezo *et al.* 2010). Similar experiences were carried out by other universities such as the FACA-UNA and FCE-UNAN-Managua in Nicaragua and ESNACIFOR and DPA-UNAG in Honduras.

In Honduras, the experience gained through the facilitation of two FFS in the Juncal pilot area, drove INFOP to promote in 2006 the organization of seven FFS under its own responsibility (CATIE 2007a). Similarly, other organizations such as The Programme for Access to the Land (PACTA), The National Park Pico Bonito Foundation (FUBNAPIB), and the CATIE-FOCUENCAS project implemented one FFS each. In 2007 the Animal Production Department from The National Agricultural University (DPA-UNAG) joined in the development of new FFS; and the number of FFS implemented in the anchoring phase of DEPAPRO in Honduras reached 22 (CATIE 2007b). INFOP incorporated the FFS approach as one of their official methodologies for training farmers. This decision would facilitate the use of the approach in other topics (including non-agricultural) and in new territories, as now it is considered a "from the house" approach. Similar cases occurred in Guatemala with FUNDEBASE, and TECHNOSERVE in Nicaragua (CATIE 2009).

In Nicaragua, NITLAPAN started its participation in the anchoring and expansion phase with two new FFS groups in 2006. Moreover, The National Institute of Agricultural Technology (INTA) coordinated one FFS, and the NGO TECHNOSERVE[16] was responsible for the participation of three new additional FFS groups. The performance and confidence observed with facilitators and farmers from pioneer expansion groups, helped to promote the formation of new FFS. By 2007, 1500 farmers participated in 88 learning sessions, from 14 FFS that were conducted by the previously mentioned organizations (CATIE 2007c). The responsibility for monitoring the newly formed FFS group activities was assigned to regional coordinators of the partner organizations who were in charge of supervising the extension activities conducted by such institutions.

Partner organizations working with FFS groups in the anchoring and expansion area, reported in 2007 high attendance to the FFS meetings, with an average of 90% of the members (CATIE 2007a). Moreover, more than 60% of the 651 farmers participating in the FFS established in the anchoring and expansion area have at least one experiment in his/her farm. Both results were considered as indicators of good performance that reinforced the local capacity, the confidence on the FFS approach and resulted in the formation of new FFS groups. The use of local and regional courses on methodological

[16] TECHNOSERVE was an NGO hired by the Ministry of Agriculture and Forestry (MAGFOR), whom trough the Fund of Agricultural Development (FondeAgro) supported a Livestock Development Project.

aspects of FFS and monitoring and training meetings coordinated by DEPAPRO supported those developments.

As a strategy for supporting the anchoring and expansion phase DEPAPRO promoted the training of specialists in FFS through regional and local courses, which helped them to develop the necessary skills for practicing the FFS principles. In 2006, 44 specialists from 24 partner organizations worked together to develop a general curriculum for livestock FFS and its guidelines (CATIE 2007a). The curriculum was considered a knowledge base from which stakeholders could choose sessions for addressing specific issues affecting farmers in a specific area. Specialists were grouped in thematic groups according to their field of expertise or work interests: (1) Trees, Soils and Water; (2) Pastures and Animal Feeding; (3) Animal Health, Reproduction and Breeding; (4) and Farm Management and Administration. The majority of the 45 guidelines prepared corresponded to the thematic groups two and three, which responded to the issues more frequently voiced by farmers (CATIE 2007a).

In 2007 DEPAPRO also encouraged the formation of Steering Committees with representatives from organizations related to the livestock sector and partner organizations. The formation of Steering Committees was meant to encourage dialogue with decision makers for facilitating the communication about livestock FFS activities and favouring the allocation of resources for its development (CATIE 2008). Moreover, the activities carried out in the Steering Committees promoted the M&E of the FFS by professionals linked to the livestock sector. Steering Committees in Guatemala and Honduras were established and carried out periodic meetings, whereas in Nicaragua a temporary committee had to be established mainly formed by staff from partner organizations (CATIE 2008). The inclusion of elected FFS farmers' representatives in the Steering Committees is desirable to improve the communication of authorities with farmers. This would allow a better knowledge about the real issues that farmers are facing.

The activities with the pioneer FFS groups started to decline in 2006, because most of the topics of interest were already covered with them, and DEPAPRO staff efforts have to be focused on supporting activities in the anchoring and expansion areas, as well as with the groups of more recent formation in the pilot zones (CATIE 2007a). All those activities intensified the workload on DEPAPRO staff, therefore one additional field technician was hired in Guatemala (2007) and Nicaragua (2006), to improve fieldwork affectivity (CATIE 2007a). In the case of Honduras an office assistant was hired (2007), because the involvement of more facilitators from INFOP created more demand in the administration (CATIE 2007a).

In 2006 no new technology innovations were established in the pilot areas, only the M&E of those tested on-farm continued. However, the most promising alternatives were replicated with the new FFS groups (CATIE 2007a). DEPAPRO promoted the establishment of forage multiplication plots, only in Nicaragua 112 of those plots were established (CATIE 2009), and those facilitated the implementation of trials in the anchoring and expansion areas (CATIE 2006b, 2007a). In 2007, the activities with the pioneer FFS groups continued to be less frequent, and the main purpose with those groups was to reinforce or validate some of the experiences gained in previous years by performing FFS sessions to analyze lessons learned and carrying out exchange visits (CATIE 2007a). New FFS sessions were carried out in themes related to animal feeding strategies for the dry season, the use of leguminous fodder species in association with pastures and the incorporation of trees in livestock production systems (CATIE 2008).

In mid-2007 a special exchange visit to CATIE headquarters in Turrialba, Costa Rica was organized. Five farmers from each pilot area were selected to assist, based on their outstanding performance in FFS sessions and management of on-farm trials (CATIE 2007b). Each participating farmer, with the assistance of DEPAPRO staff, prepared a poster describing the trials conducted by them. Those were presented and discussed in a plenary session with the presence of a few Costa Rican farmers, municipal authorities from the pilot areas and CATIE staff. The confidence and knowledge demonstrated by all farmers who made the presentations was considered indicative of capacity building and empowerment obtained through their participation in the FFS. As part of the visit, participants also visited different smallholder farms in Costa Rica and other projects led by CATIE, and got new ideas for trials on their farms.

The total cost for implementing a livestock FFS in the anchoring and expansion area including individual experiments by household, twenty FFS sessions during two years, monitoring costs and the training of facilitators and specialists was estimated in US$500 dollars per participating household (Aguilar et al. 2010). However, those costs can be overestimated, because they did not consider that the investment in testing methodologies, developing training materials and preparing facilitators could be used for many other FFS groups. In DEPAPRO pioneering FFS groups the average number of households was 20, thus the costs per FFS group are estimated at US$10,000 dollars. This is considerably higher than costs reported in previous IPM FFS in Asia, or livestock FFS in Africa (Khisa 2003, Berg and Jiggins 2007). Such an increase is related to the following factors: (a) the use of individual experimental plots, because FFS are organized with group experiments, rather than with individual ones; (b) the use of the zig-zag approach, because this implies the participation of highly educated staff whose salaries and transportation costs are higher than those from field staff; and (c) the longer duration of each FFS, because all the salaries have to be paid for a longer period (two years), rather than one year or less typical in agricultural FFS. Even when the estimation of the FFS costs should be reviewed because there are no details about its calculation, it is clear that changes should be encouraged for reducing the costs of the FFS. This may include the use of group experimental plots and the encouragement of promoters' formation as facilitators. Moreover, additional strategies for the financial sustainability of livestock FFS should be tested such as self-financed FFS groups, the establishment of crops or raising of livestock for funding FFS groups, or even with rules of the game well established the sponsorship of the industrial private sector related to cattle products (Khisa 2003).

Graduation ceremonies of FFS members were accomplished at different times in Guatemala (2007), Honduras (2007) and Nicaragua (2006). These events consisted of meetings where farmers received a diploma that recognized their participation in the FFS. During these sessions some of the formalism proper for a graduation in formal education was observed such as a table reserved for representatives from partner organizations and other authorities. However, the events also included FFS activities organized by farmers, facilitators and specialists such as participatory exercises, dynamics that reinforced their learning, relationships with their fellow FFS members and other stakeholders. It was also observed that these events allowed the appreciation of some of the achievements and procedures from the FFS approach to external stakeholders not related to DEPAPRO.

Most of the farmers in the pilot areas and DEPAPRO field staff were concerned about the potential end of DEPAPRO, and this possibility was communicated in late 2007. However, due to the existence of remnant financial resources DEPAPRO could extend its lifespan until December 2008 without additional funding (Wiig et al. 2008). The exception was the pilot area of Honduras that ended activities in December 2007, but the activities from the anchoring and expansion areas in this country remained. During that year DEPAPRO activities continued to be more sporadic with the pilot area FFS groups in Guatemala and Nicaragua and were focused in supporting the organization and monitoring of FFS groups in the anchoring and expansion areas. Thus, while in the pilot areas a climate of passivity and concern was observed for the ending of DEPAPRO, in the anchoring and expansion areas dynamism and enthusiasm were observed because the funding of DEPAPRO and partner organizations granted in some cases one extra year of activities with FFS groups.

The main activities accomplished in the anchoring and expansion areas related to FFS in 2008 corresponded to (a) the FFS support and monitoring, which consisted in providing logistic and human resources for facilitating the FFS sessions in the anchoring and expansion areas. For example, DEPAPRO sometimes was requested to provide vehicles for the transportation of FFS members, facilitators and materials to be used in the FFS sessions. Furthermore, in some cases DEPAPRO staff also facilitated some sessions in the anchoring and expansion FFS groups, especially those carried out with promoters in Petén, Guatemala. (b) Training on the FFS approach, national and regional crash courses about the FFS approach and livestock technical matters were developed in Guatemala, Honduras and Nicaragua. These were complemented with periodic meetings with facilitators, where the FFS approach was discussed and the guidelines were practiced following the zig-zag approach. The latter supported the strengthening of livestock technical knowledge and on the FFS approach. Moreover, a training of trainers course on FFS was carried out with the objective of consolidating the capacities of 25 experienced facilitators and specialists to facilitate the formation of new FFS stakeholders (CATIE 2009). (c) Finally, exchange visits to the pilot areas were carried out. This consisted of visits to the on-farm trials in the pilot areas that encouraged the exchange of knowledge among farmers and the observation of implemented practices for addressing the degraded pasture issue.

DEPAPRO activities in the pilot areas included (a) FFS M&E, DEPAPRO staff performed internal evaluation studies that aimed to estimate the impact of the FFS on the farmers' social environmental and economic levels. During 2008 DEPAPRO also received the visit of the external evaluators appointed by the donors, which visited the pilot areas and carried out consultations with farmers and key stakeholders in the three countries (Wiig et al. 2008). (b) Communicating the results to policy makers and other relevant stakeholders from the livestock sector, these consisted in the presentation of DEPAPRO results in specialized conferences and panels organized by DEPAPRO with national authorities, decision and policy makers for presenting its main results. In some cases key FFS members were invited to these meetings. (c) FFS ex-post activities, these included exchange visits, experimenters meetings and field days where FFS members got the opportunity to remember the practice of some of the technologies promoted by DEPAPRO such as multi-nutritional blocks and grass silage.

4.4.2.5. Completion of training documents and other materials

The activities of this stage were integral to the intervention of DEPAPRO and included the development of the following training materials: (1) policy guidelines; (2) technical bulletins which included FFS session guidelines; (3) and technical handbooks. Following the purpose of the documentation process technical bulletins and handbooks were addressed in this narrative. Technical bulletins aimed to improve the performance of facilitators during learning sessions and enhance their technical capabilities (CATIE 2006b). Conversely, technical bulletins were directed to support the implementation of certain technologies by facilitators and farmers. Training materials elaboration was headed by specialists from DEPAPRO and partner organizations, both shared the authorship and the potential publication of these materials represented an incentive for the participation of specialists from partner institutions. In 2006 drafts of 45 FFS session guidelines were prepared, however not all were tested yet with farmer groups (CATIE 2007a).

The development of FFS session guidelines implied additional work for the specialists involved. In some cases after completing their own drafts, those had to be consolidated with the ones prepared by other colleagues who worked in the same topic but in a different country. Regional and national strategic courses served as venues for identifying topics to be covered in the training materials, and for working in their design and the refinement of those already prepared (CATIE 2007a). Some of the local specialists managed to implement their own schedule of work that included meetings and periodic communications using the internet. However, in general the process was slow and this delayed the completion of training materials for publication. Until 2010 most of the published training materials corresponded to technical bulletins (Cruz and Nieuwenhuyse 2008, Nieuwenhuyse *et al.* 2008, Aguilar and Nieuwenhuyse 2009, Fariñas *et al.* 2009, Reyes *et al.* 2009, Palma and Cruz 2010), one technical handbook about how to build milking parlour facilities (Quezada 2008), and one book with methodological procedures and recommendations for the adaptation of the FFS based on the experiences of DEPAPRO (Aguilar et al. 2010).

4.4.3. DEPAPRO stakeholders' perspectives about the intervention

4.4.3.1. Changes induced by DEPAPRO intervention

Changes in human factors were emphasized more than those related to material elements, both were coded in 20 categories according to the answers of interviewees (Figure 4.13); and later aggregated in the seven capitals according to the Sustainable Livelihoods Approach (SLA) and the Community Capitals Framework (CCF) (DFID 1999, Flora *et al.* 2004). Human capital changes were observed mainly by farmers, promoters and students and it included changes categorized as: "knowledge", "facilitated learning", "learned FFS approach" and "more motivation". Farmers and promoters observed changes in terms of acquiring or strengthening their technical knowledge about pastures and livestock management. These were encouraged by their participation in the FFS, especially by testing alternative solutions to degraded pastures.

Facilitated learning was pointed out mainly by farmers and is related to the recognition of the FFS approach as promoter of learning rather than lecturing or imposition. Stakeholders such as facilitators and decision makers stated that they learned about the FFS approach through their participation in strategic courses, visits to the FFS groups, the preparation of FFS session guidelines, and by their membership of DEPAPRO national steering committees. Some farmers and facilitators expressed that participating in the FFS enhanced their motivation for improving their production systems. Farmers expressed that observing the changes in their knowledge and in the farm made them proud and augmented their feeling of happiness; which according to the facilitators made their work easier. As the result of interviews and the review of documents, it is clear that DEPAPRO managed to build capacity of the different stakeholders in the three pilot areas by applying the learning by doing approach (Groeneweg et al. 2007).

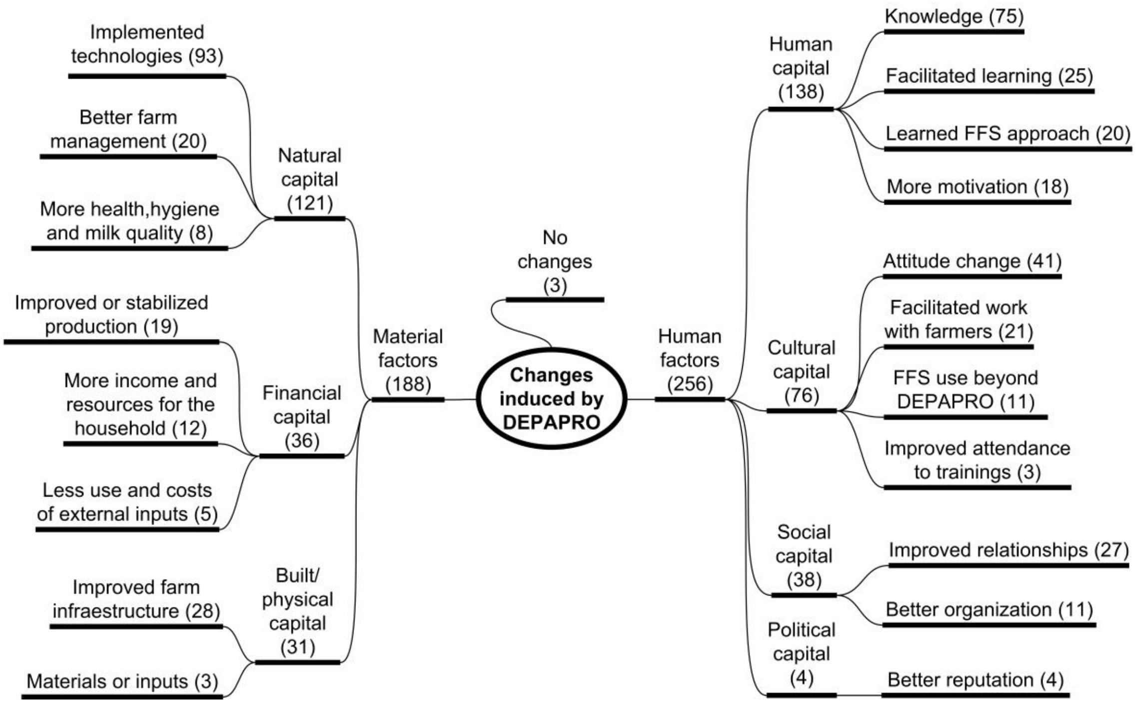

Figure 4.13. Main changes induced by the DEPAPRO Farmer Field Schools.

The second most mentioned changes were observed mainly by farmers and promoters, and corresponded to natural capital aspects such as: "implemented technologies", "improved farm management" and "better cattle health, hygiene and milk quality". Most of the technologies corresponded to on-farm trials with fodder options that included cultivated pastures, woody and herbaceous legumes and multi-purpose trees. Although, there were other technologies that can be considered contributed to built/physical capital changes because they were related to improvements in farm infrastructure such as: the arrangement of small paddocks which required the establishment of live fences, milking parlours built for improving milk hygiene, biodigestors for obtaining methane gas for cooking, improved water reservoirs for water storage in Petén and fish ponds in Juncal. The improvement in the farm management described by farmers was mainly related to the use of intensive grazing rotations which allowed a better use of the available pastures. Some farmers, especially those from Honduras, described changes in animal health, milk hygiene and quality. These were related to the changes in milking management that they implemented after attending to the FFS and conventional trainings offered by CRELs, among those are washing or sanitizing hands before milking, monitoring mastitis incidence and performing preventive measures for mastitis control.

Changes related to the cultural capital such as: "change in attitude", "facilitated work with farmers", "FFS use beyond DEPAPRO" and "improved attendance to trainings" were the third most mentioned. Cultural capital changes were mainly referred by facilitators and specialists who found in DEPAPRO the support for challenging their behaviour as professionals (Chambers 1996b). The former considered that the use of the FFS approach facilitated their work with farmers; whereas the latter mentioned that their participation in DEPAPRO helped them to change their attitude as professionals, towards a more humanistic approach where farmers are considered people, not just numbers. This has been identified as a key element for real learning, which is generated from a communication process based on the interaction between subjects (Freire 2007). Moreover, DEPAPRO also motivated specialists to re-establish contact with rural areas and farmers, because most of them were based in capital cities (i.e., Managua or Guatemala City) or urban areas; and to use a more practical and bottom-up approach, using farmers' expressions.

A remarkable aspect among the changes in the cultural capital was the use of the FFS methodologies beyond DEPAPRO. Partner organizations such as FMVZ-USAC, ESNACIFOR, INFOP, NITLAPAN, FCE-UNAN-Managua, FACA-UNA and INTA introduced the FFS approach in their organizations and are using it in university courses and trainings. This is considered the most promising change for the sustainability of the FFS approach, because those institutions incorporated FFS or some of their principles as part of their training methodologies; and even modified their usual lecturing for using the learning by discovering (Pezo *et al.* 2010). After all as Paulo Freire pointed out, learning is demonstrated only when stakeholders appropriate and adapt knowledge to change their reality (Freire 2007). In Nicaragua, it was reported that up to 40% increased in farmers' attendance to trainings by the use of the FFS in the anchoring and expansion areas. The partner organization responsible of these FFS groups was having an average attendance of 30 to 50% when the trainings were carried out with the traditional approaches.

Changes in the social capital such as: “improved relationships” and “better organization” were the fourth most mentioned change; partner farmers and specialists were the stakeholders who mention those more frequently. Some partner farmers considered that their participation in the FFS helped them to establish links with other farmers, agricultural professionals and authorities. Similarly, decision makers stated that they established cooperation alliances with other local and international organizations and farmers. DEPAPRO completed, such type of cooperation continued among specialist resulting in the preparation of new agricultural development projects, additional research, and technical consultations. On the other hand, facilitators and specialists reported that their participation with DEPAPRO changed their organization by influencing better management and new learning methodologies.

The fifth capital with more changes mentioned was the financial. Farmers were the stakeholders that reported most of the effects denominated as: “improved or stabilized production”, “more income and resources for the household” and “less use of external inputs and costs”. Some farmers stated that their participation with DEPAPRO improved their milk or beef yields, or stabilized production along the year. This was a result of changing cattle management by using practices and technologies that they learned in the FFS, such as more rational rotational grazing, silage preparation, use of supplements (mineral salts mixtures and others). Some farmers also mentioned that the latter generated not only more income but more food for their households as well. Finally, other farmers stated that income generation was also influenced by a reduced use of external inputs, as a Guatemalan farmer explained:

> “*This season I have almost not invested (in pesticides), just in “chapias”. Two years ago I sprayed for pests, bought chemicals and herbicides, but this year I did not buy a liter of anything, therefore did not spray chemicals. I just have been making chapias, cutting everything with machete twice a year. Then, I have invested less and all that money that I used to invest in agricultural inputs… … now I am using to cover family needs and we have more resources* (in the household)”.

4.4.3.2. Elements of the intervention preferred by stakeholders

Stakeholders described their favourite elements from DEPAPRO which were grouped in 22 categories using *in vivo* coding and later grouped into seven capitals according to the SLA and the CCF. Moreover, one special category for grouping characteristics from DEPAPRO was considered: "project features" (Figure 4.14). The most preferred intervention elements are related to the human capital and corresponded to effects of the FFS on human capital such as "knowledge and better understanding"; and to the "FFS" or "learning model". Knowledge was appreciated by all the stakeholders categories involved in DEPAPRO, especially by farmers and facilitators. Some of the former explained that their technical knowledge about livestock and pasture management improved; and the latter considered that their technical and methodological skills to offer trainings in livestock production were enhanced.

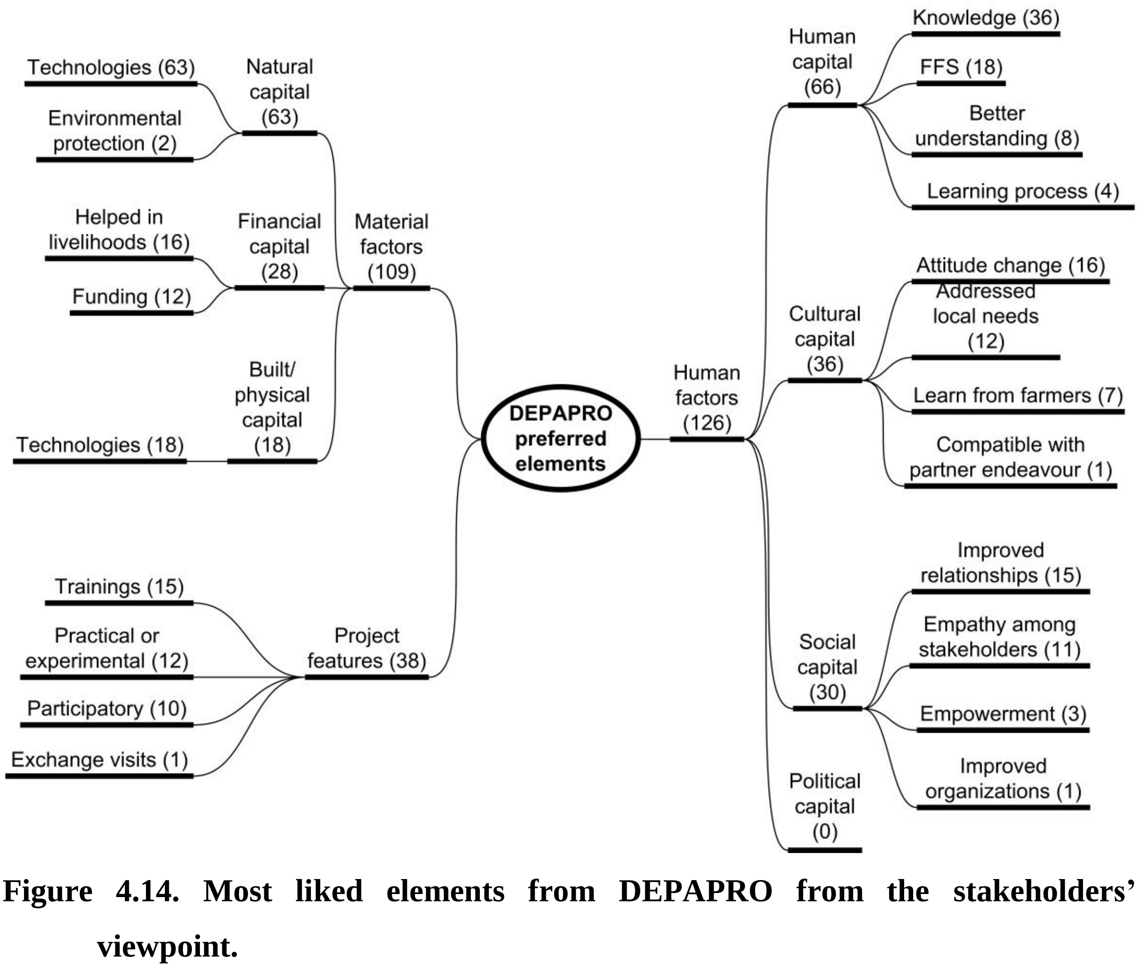

Figure 4.14. Most liked elements from DEPAPRO from the stakeholders' viewpoint.

Supervisors preferred the "FFS" approach because it provided a model for improving the communication with farmers, it produced practical results that were easier to report and such results were considered as indicators of good performance by partner organizations. Specialists preferred the FFS because it allowed a better coordination of the training efforts. Some facilitators, specialists and decision makers considered that they liked the fact that FFS allowed a better understanding of both: (a) the factors constraining farmers' livestock production; and (b) the changes needed in the training approach to improve communication with farmers. Finally, few stakeholders mentioned that they liked the learning process that DEPAPRO encouraged.

The second most preferred elements from DEPAPRO were related to the natural capital and corresponded to "technologies" related to natural assets. However, the importance of "environmental protection" was mentioned just by two from the 106 participants in the study. Both categories were stated mainly by farmers and promoters because they owned the benefits of the trials established on their farms while experimenting such as higher availability of fodder, and seeds or vegetative material. This was facilitated by the DEPAPRO decision of encouraging individual experiments, rather than the usual group experimentation plots frequently used by other promoters of the FFS work.

The most preferred alternative practices changed according to the characteristics of the farmers. The most mentioned practices were related to fodder alternatives such as fodder banks (leucaena mainly), improved pastures, multi-nutritional blocks, grass silage and reforestation as fences or plots. Leucaena was preferred because it improved soil fertility and/or nutrient quality of the livestock diet, provided additional products and services such as firewood, shade or fence posts. Improved pastures were chosen because their management is familiar to farmers who have been using naturalized and cultivated grasses for feeding cattle. Multi-nutritional blocks was a technology pointed out as preferred but not being practiced. Its use is foreseen as an alternative in the future when there is scarcity of pastures, or the costs of commercial concentrates (increases in price) would create the opportunity for implementing such technology (See Chapter Five). Conversely, silage is an alternative to fodder supplementation that is preferred and practiced mainly by medium scale farmers who struggle when there is pasture scarcity during the dry season. Reforestation was preferred for the material benefits that farmers perceived such as improving soil fertility, providing firewood, potential commercial products such as Jamaica pepper (*Pimenta dioica* L. Mer.), one alternative tree planted or naturally regenerated in pastures in Petén that has a high price in the spices market.

Characteristics from FFS such as: “trainings”, “practical or experimental”, “participatory”, and “exchange visits” were the third element most preferred from DEPAPRO. Partner farmers pointed out that they liked the “trainings” carried out by DEPAPRO because they helped to improve their knowledge and their lives. Some of them valued trainings over material incentives because they considered that the latter are likely to be consumed in a relatively short period. In contrast, knowledge, skills and abilities do not have time limit in terms of use and have shown to go beyond the lifespan of technologies and projects (Bunch 2002).

In contrast to non-practical training efforts, FFS included the opportunity of experimenting and practicing in real farms, thus, facilitators and specialists mentioned that they preferred the “practical or experimental” approach used by DEPAPRO because this facilitated their learning. On the other hand, at least one member of the partner organizations and DEPAPRO staff declared that they liked the participatory approach used in the FFS, because it offers farmers the opportunity to participate in the planning and execution of the training activities, which increased their interest in FFS activities. Finally, just one partner farmer described the exchange visits as his preferred element of the FFS. This contrasted with the importance reported by DEPAPRO written reports, maybe because exchange visits were considered by farmers as a tool for facilitating the identification of alternative technologies to experiment on, and not as a key activity for generating knowledge or improvements in the household.

The fourth most preferred elements observed in DEPAPRO intervention are related to the cultural capital and corresponded to categories such as: “attitude change”, “addressed local needs”, “learn from farmers” and “compatible with partners’ endeavour”. Specialists were the stakeholders that appreciated most the changes in attitude. Three main types of changes in attitude were identified: (1) reduction of the specialists or facilitators protagonist roles in the FFS sessions; (2) the use of participatory horizontal communication instead of the traditional top-down approach in trainings; and (3) more interest from farmers in participating in the FFS, despite of the predominant non-participatory culture. Students, decision makers and partner farmers considered that addressing local needs was the element of DEPAPRO that they liked most, because it allowed to identify and address critical issues of livestock. A male decision maker from Guatemala expressed:

> "*... there is some top-down approach* (in DEPAPRO) *but it is not too much, the horizontal communication is dominant. Hence people discover, people propose, people build proposals based on their own knowledge and necessities, mainly from the core of their necessities*".

Finally, learning from farmers was mainly described by facilitators and supervisors. They stated that the FFS allowed them to combine their knowledge with the farmers' local knowledge; this facilitated the development of new technical and methodological skills in the FFS participants. Finally, one decision maker observed compatibility between DEPAPRO endeavour and his own organization; this favoured the establishment of formal collaborations that differ from the previous scenario with lack of communication and cooperation among organizations working in the livestock sector.

The fifth most preferred elements from DEPAPRO intervention are related to the social capital. Farmers, facilitators and specialists were the main stakeholders mentioning social capital elements as their favourites. These corresponded to categories such as: "improved relationships" or opinions stating that their participation with DEPAPRO created and enhanced the relationships of a given stakeholder with other individuals or organizations. As a male specialist from Nicaragua commented:

> "*Other thing that I liked was the possibility of interacting with other Central American colleagues, and the network we created is for me a tremendous product from DEPAPRO, because it functioned as a platform to establish relationships with colleagues from countries not covered by DEPAPRO like El Salvador, which enlarged and strengthened our network. Through DEPAPRO we had the chance to work in regional publications which is important because sometimes we focus only in our national problems. But the truth is that we belong to small countries with similar conditions, and then addressing the problem at the national level could be considered a reductionist vision...*".

The next most liked categories included: "empathy among stakeholders", corresponded to opinions showing the emergence of friendship relationships among stakeholders involved in DEPAPRO; “empowerment”, that were commentaries showing the preference of stakeholders for the appropriation of some of the elements promoted by DEPAPRO; and “improved organizations”, that corresponded to one opinion stating that DEPAPRO work influenced the strengthening of participating organizations.

4.4.3.3. Limitations perceived by stakeholders

Participants were asked about the constraints they faced while participating in DEPAPRO, and their answers were grouped in 30 different categories (Figure 4.15). The most frequently mentioned constraint was the lack of financial capital to replicate the innovations promoted by the project. Farmers and promoters considered that they needed more financial assets to expand the practice of alternatives solutions to degraded pastures learned as DEPAPRO participants. Decision makers and supervisors pointed out that the limited budget allocated for trainings constrained their capacity to implement FFS and promote on-farm experimentation. A few facilitators, specialists and students identified the lack of financial capital for replicating the FFS experience. They considered that FFSs could operate because of the funds DEPAPRO had, and considered that few partners would be able to continue expanding the FFS efforts without additional external funding. An exception to this position was the case of those who belong to educational institutions, such as the FMVZ-USAC, DPA-UNAG, FCE-UNAN-Managua, and ESNACIFOR, who considered that the human and physical/built assets they have could be combined with the limited financial resources available for livestock extension, and in that way could continue promoting FFS.

The second most mentioned limitation is the lack of time. The promoters were sensitive to this issue because they are smallholders whose farms activities rely almost entirely on family labour, especially that provided by them as household heads. Working as promoters in DEPAPRO required to attend trainings about the FFS approach and specific technology innovations, to invite the members of their FFS groups, and to lead the FFS sessions as facilitators. Thus, they spend at least three days per FFS session, and that time was not compensated with any salary. The only incentive they received was a travel allowance that covered transportation and food, which was granted only if they had to travel outside their villages. Future initiatives working with farmers as promoters should consider the potential overload for them, as well as to reduce their workload such as more involvement of farmers in support groups; and even to compensate in cash or in kind for the days invested in training, logistics, planning and carrying out FFS sessions.

Three subgroups of farmers also mentioned the lack of time as one of the most important limitations. Those groups were: (i) mature male farmers affected by poor health; (ii) male farmers with limited labour availability in the farm who had time conflicts for attending farm work and the FFS sessions; and (iii) female farmers that struggled to combine FFS sessions and their daily work in the house or the farm. As a female farmer from Honduras pointed out:

> "*As I do not have a man in the house I sent a daughter to attend the trainings. I did not because I could not find the time to go to the FFS sessions*".

Even though DEPAPRO scheduled the participatory sessions at times farmers' already finished work in the farm, apparently it was not enough for ensuring the participation of all male and female farmers. The monetary compensation for the time spent by participants was an strategy applied in Indonesia by a rice-IPM project to promote the attendance of farmers (Rölling and Fliert 1994). A similar strategy could contribute to the inclusion of women farmers, who could use that money to pay for the labour needed to replace them while attending FFS (Hoffmann *et al.* 2007). However, such strategy could be considered inadequate for participatory processes because setting such a precedent can difficult the work of other programmes with less financial resources; or those who encourage participation without material incentives. In the case of mature or farmers with health issues who have difficulties to attend the FFS sessions, a suitable strategy could be to encourage them to allow the participation of other members of the household or persons who work with them in the farms.

Some decision makers considered that it was difficult to guarantee the time of specialists for collaborating with the FFS as they also had to carry out tasks related to their organizations. Similarly, specialists mentioned the latter issue as a factor that limited their participation in the FFS. To overcome such limitation, FFS initiatives should negotiate and stipulate in formal agreements of cooperation that the time to devote by staff of partner organizations working as specialists, facilitators or supervisors must be part of their responsibilities in the organization. In that way the time assigned to other responsibilities will enable them to spend more time in participating in the FFS. Conversely, facilitators observed lack of time in two different ways either as a cause for discouraging farmers' to attend FFS sessions or as a factor that limited the time devoted to the FFS work.

The third most important limitation was related to failures in the establishment of experiments observed exclusively by farmers and facilitators. This has already been addressed in the development of methods for participatory learning section. The next category identified corresponds to stakeholders pointing out that there were no limitations in DEPAPRO, a position mostly cited by farmers. Most of the participants who did not identify limitations had a positive attitude towards participation in trainings; they associated FFS with learning and learning with potential improvements for their household, as a Nicaraguan male farmer expressed:

> "*No* (limitations). *I like any participation, because the one who asks questions wants knowledge. If someone offer trainings you always have to attend with punctuality because it is an opportunity to access experiments and new knowledge which could be useful in the future*".

The fifth most mentioned limitation were paternalistic attitudes in farmers and organizations that were incompatible with the FFS approach. These were observed by all the stakeholder categories, except for the students. Paternalism was generated by dole-out approaches in rural development projects or government programmes that worked in the study areas before DEPAPRO. Consequently, in early stages of DEPAPRO intervention even some of its activities such as the provision of inputs for experiments, refreshments, and even exchange visits were considered as simple incentives followed by paternalistic projects. Nonetheless, as DEPAPRO activities advanced, farmers realized that the purpose of those inputs was to support their learning process through testing innovations and exchanging experiences with other farmers.

Previous experiences in rural development projects with a paternalism approach influenced weak participation in some FFS groups, such as medium scale farmers. For example, promoters and farmers from the anchoring and expansion areas in Guatemala emphasised their FFS peers "needs" for more agricultural inputs such as pasture seeds, herbicides, barbed wire, and even money for buying cattle. A previous project in the area provided funding for such purposes, thus, farmers associated "any project" with free money for acquiring cattle or inputs. As a male promoter quoted:

> "*The only thing that people expects* (from rural development projects) *is the money for buying animals* (cattle) *or for having the fruit of a project* (material incentives). *They have no patience to starting almost from scratch. That is the problem we have, people get disappointed because they say –Why planting grass if we do not have enough animals? -Where am I going to get the money for buying animals? If the institution gave them money to buy animals then they will value the project and will participate with enthusiasm...*".

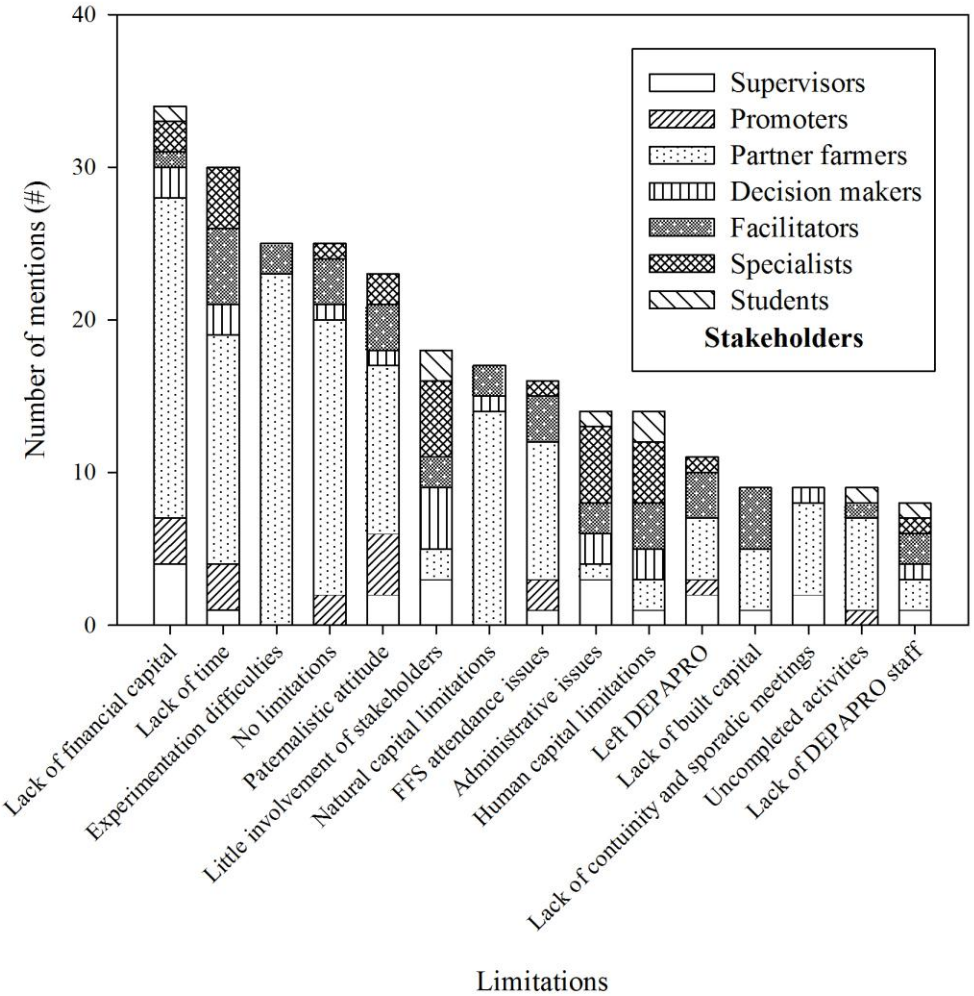

Figure 4.15. Top 15 DEPAPRO limitations observed by stakeholders.

Moreover, other organizations were working with some of the FFS members using incentives or dealing with topics such as land regularization, electrification projects, or the commercialisation of cattle products. Some stakeholders observed that the strategies employed by other organizations reinforced paternalism, and sometimes interfered with the attendance to the FFS sessions, especially when meetings were scheduled at the same time. As a Nicaraguan facilitator expressed:

> "*Here is not only this organization, there are many organizations working with the same farmers. Thus, sometimes conflicts occurred. If we are working on orientation or technical matters* (Human Capital) *in the FFS; and others are providing funds to buy cows* (Financial Capital), *and a milk collection centre schedules a meeting where they are showing the money! Then those things sometimes limited our activities, therefore we had to postpone the FFS sessions*."

4.4.3.4. Stakeholders' suggestions for improving performance

Participants were asked to reflect about their experience with DEPAPRO to provide suggestions on how to improve the performance of livestock FFS initiatives. Their answers were grouped into 28 categories that included the seven capitals and an additional category: "project features" (Figure 4.16). The most mentioned suggestions were related to managerial features. These were referred by all stakeholders, although farmers, facilitators, supervisors and specialists and decision makers provided more comments about it. Farmers suggested expanding the use of FFS for addressing more training related to livestock management and the planting of trees. They also commented that a different attitude towards participation in rural development projects was needed, leaving behind the paternalistic fingerprint and the non-participatory culture.

Facilitators pointed out the necessity of addressing other topics during the FFS such as marketing, waste water management and livestock health. They also mentioned the necessity of an improved planning in the selection of farmers, incorporation of techniques for the exchange of experiences and organization to assure availability of inputs for experimentation. Supervisors proposed better coordination and delegation of responsibilities to improve monitoring, facilitate the participation of stakeholders and the level of commitment with the FFS. Moreover, they considered the opportunity of scaling out the FFS toward other territories. Specialists suggested a different role of the partner institutions in the FFS, mainly by participating from the early stages of the FFS planning, curricula development and the selection of alternative technologies. They also proposed better coordination between their institutions and the project to officially reserve time for participating in the FFS. This will help to reduce the absence of some stakeholders from the FFS activities because of conflicting agendas.

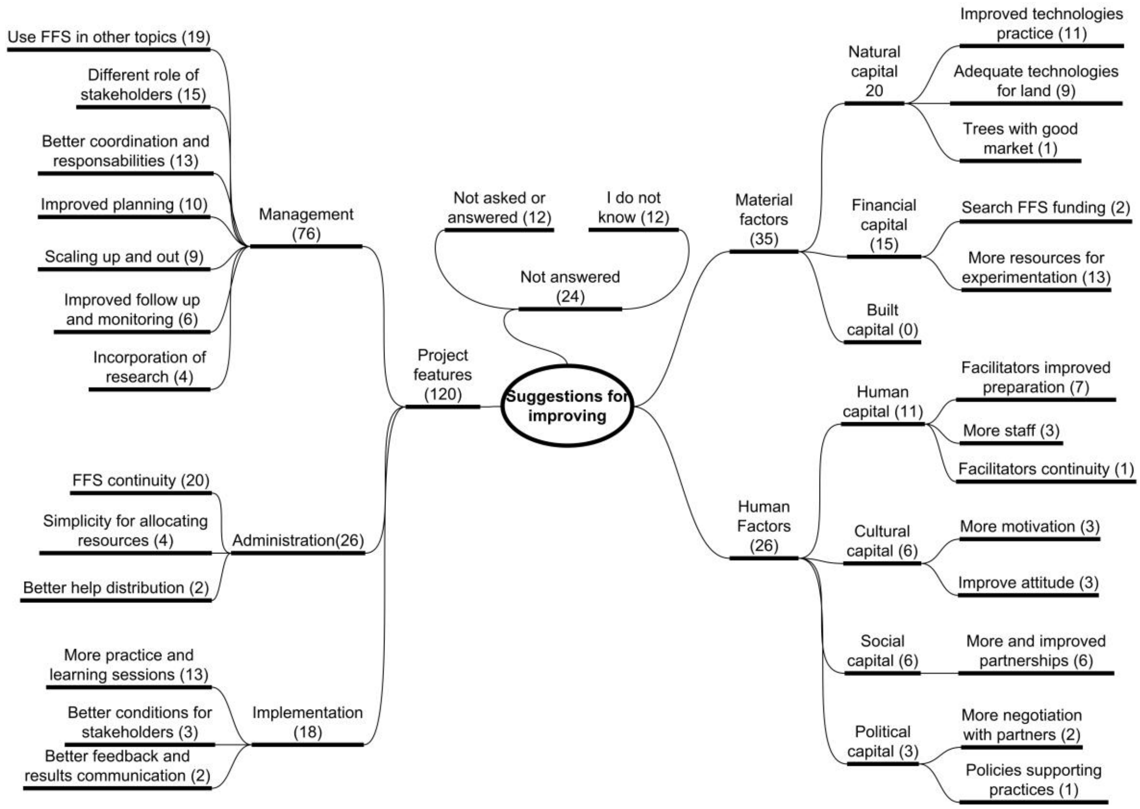

Figure 4.16. Stakeholders' suggestions for improving the practice of livestock farmer field schools.

The second most mentioned suggestions were related to management aspects such as: "FFS continuity", "simplicity of procedures for resource allocation", and "better help distribution", which were mentioned mainly by partner farmers and facilitators. Farmers stated their wish to participate in more training using the FFS model; this was also mentioned by promoters and facilitators. Facilitators mentioned more about the improvement of resource allocation because during the first year of experimentation, groups from the anchoring and expansion areas had difficulties in getting some inputs. The third most observed reaction after being asked to provide suggestions for future FFS initiatives was "not to provide an answer". This was observed principally with farmers and specialists. Specialists who did not provide any answer in this matter expressed that they had too limited involvement with the FFS to provide suggestions.

Farmers argued that they are not usually asked about "these things", thus, they could not provide an answer because they have not thought about it. They also mentioned that they would not change a thing because everything worked well. Moreover, in a few cases it was perceived that not pointing out suggestions was related to do something that could affect their relation with DEPAPRO staff, as a Nicaraguan male farmer explained:

> "*Into the project? (*limitations in DEPAPRO*) Eh... look like we always… we the farmers do not like to point out some things, because it is not worth it*".

The fourth most mentioned suggestions were related to the natural capital feature such as: "improved technology practice" that implied the adaptation of more technologies with changes proposed by farmers; "adequate technologies for land", which was related to the need of technologies for steep and low fertility lands, need of new technologies supported by technical knowledge, more training in alternatives for fodder supplementation and the use of naturalized pastures; and "the use of trees with good market value", voiced by one Guatemalan farmer that considered this as essential for planting more trees in his farm:

> "*Talking about other things* (in FFS sessions). *There are timber trees, fruit trees which their products are sold, their seeds are in the market. For example: Jamaica pepper, cinnamon. I have heard that these products generate high income. These could be the case of other products that could have market, and which in small area of land could provide enough money to maintain the household*".

The fifth most mentioned suggestions were related to the project implementation features such as: "more practice and learning sessions"; "better conditions for stakeholders"; and "feedback or dissemination of results". These were mainly suggested by partner farmers and facilitators. Farmers explained that the learning sessions were important elements for acquiring ideas and changing their mentality about their production systems. However, "trainings without practices do not work", thus, they considered that an FFS initiative should be as practical as possible. Similarly, one facilitator pointed out the need of changing the non-participatory culture, to a scenario where farmers apply the technologies addressed in the trainings; whereas other facilitator expressed that FFS should be more practical, and adapted to the local conditions. The improvement of the conditions for stakeholders was suggested by one promoter, facilitator and student according to their role in the FFS. As was reviewed in the limitations section, promoters did not receive a salary for their work in the FFS, thus one promoter suggested incentives for continuing their work. One facilitator proposed the improvement of the transportation units, because sometimes it was difficult to carry inputs using motorcycles for example, or it was more difficult going to the field during the rainy season.

Finally, equity for communicating DEPAPRO results was suggested by a decision maker and a farmer. This is because most of the DEPAPRO published guidelines have been directed and distributed among the technical staff and not to farmers, which sometimes produced their own records about the sessions in notebooks. Moreover, a farmer suggested the elaboration and distribution of written materials with the topics addressed in the FFS sessions to help them remember the details of each session. DEPAPRO included summaries for each session in the FFS guidelines, but their distribution was left to the criteria of each facilitator. For example, a project working with coffee FFS used leaflets for summarizing their FFS learning. The latter were prepared by farmers, based on their language, inputs and design, thus farmers were empowered and obtained a tool for reinforcing their learning (Belder *et al.* 2006). In another example that would work for literate households The Central American Cocoa Project from CATIE has produced printed materials similar to comic books about the main FFS sessions supporting the integrated management of cocoa production (Somarriba and Quesada 2009). These materials are attractive for the literate younger members of the household and could contribute to disseminate the learning to other illiterate members of the household.

4.5. Discussion

4.5.1. Documentation as a tool for learning from rural development initiatives

Documentation is a useful method for learning about rural development initiatives. In the present study, such method has helped to reconstruct the history of DEPAPRO by describing some of the processes involved in the organization of livestock FFS. Documentation was facilitated by three main factors:

(i) The recognition of the stakeholders' knowledge as a key source for learning from the DEPAPRO experience. This helped to establish the points of view about DEPAPRO of all stakeholders' groups. However, it must be recognized that documentation of processes is not a common practice for rural development agencies in Central America. Some stakeholders (especially farmers) were surprised of being consulted, but in the end they valued the opportunity of providing their inputs.

(ii) The positive attitude of DEPAPRO and most of their stakeholders for conducting this study. With few exceptions all stakeholders approached responded positively, and shared their thoughts about DEPAPRO, and some supported their arguments providing written reports or showing experimental plots. On the other hand, few initiatives would voluntarily allow an external actor to investigate their actions, processes and impacts for the fear of being criticized or exposed to peers, supervisors or donors. DEPAPRO considered this effort an opportunity to learn about the strengths, weaknesses and challenges of the FFS approach applied, and to share the lessons learned.

(iii) The availability of reports. The documentation process was facilitated by the quality of the information produced by DEPAPRO. Annual reports, records of events and publications served to contrast the information provided by interviewees with the vision of the staff, and facilitated the reconstruction of DEPAPRO processes and actions even by an actor –the author of this study- who witnessed those just for the last one and a half years. The fact that an outsider led the documentation process facilitated stakeholders to feel free of sharing their viewpoints about DEPAPRO.

The approach used in this documentation effort can be considered static, therefore it is likely that it captured a "snapshot" of the livestock FFS promoted by DEPAPRO and partner organizations. However, as the author of the documentation observed the FFS mostly in the last two years, their observations and comments could not reflect effects and issues observed in the earlier stages of the project. To reduce such potential bias, the documentation strategy included literature reviews and the recall of early activities, but of course it cannot replace the advantage of encouraging documentation as a dynamic process that starts in the early stages of any rural development initiative, having it as part of the design of rural development programmes (Borja 2004). In that case, documentation is part of a monitoring system which would enhance the opportunity for identifying successes and failures, and correct the latter if necessary. Stakeholders are likely to correct their own actions if they are part of the monitoring process, and use the abilities gained in this process to be empowered and change the course (Jiggins 2002, Belder et al. 2006). Using documentation as a monitoring strategy requires more financial resources and time from the different stakeholders involved, thus, these should be considered as part of the projects' annual planning and budgeting.

4.5.2. DEPAPRO Farmer Field Schools

The FFS approach strengthened the human capital of participants, and seems to be an adequate strategy for building the capacities needed for practicing knowledge intensive agroecosystems such as silvopastoral systems. The context in which DEPAPRO worked differed from the one described in the pioneer Integrated Pest Management (IPM) FFS implemented with rice farmers in Asia (Rölling and Fliert 1994). The latter emerged after severe shocks resulting in a decline of rice production that threatened the livelihoods of an entire country. Most of the livestock farmers that participated in DEPAPRO experienced low livestock productivity, but were still producing enough income to make a living. This indicates that the FFS approach can be used to address important issues, even when those have not reached a critical level.

The experience described by Rölling and Fliert (1994) was based on the IPM approach as the framework for structuring the FFS programme. DEPAPRO efforts were built on participatory appraisals; and the zig-zag learning and experimentation model where farmers experimented with silvopastoral options and other environmentally sound livestock practices with the assistance of facilitators and experts. An environmentally sound framework similar to IPM was not explicitly used by DEPAPRO, as there is not an "Integrated Management of Degraded Pastures". However, principles for an Integrated Livestock Management Approach were observed (Groeneweg *et al.* 2007), which comprises not just the implementation of silvopastoral systems, but also the integrated management of cattle pest and diseases, integrated management of companion plant species, etc. In Central America, the strengthening of human capacities done by DEPAPRO is expected to facilitate the consolidation and expansion of such integrated framework in the future.

Some issues related to the vulnerability context such as weak markets, lack of built/physical and financial capitals were not addressed because DEPAPRO's focus, capacities and budget were exceeded. This has been suggested as a gap that may hinder the real necessities from farmers under the "umbrella" of participation (Dahlmann-Hansen 2007). However, it has to be considered that DEPAPRO was a pilot research-oriented project, which tested the potential application of FFS for contributing to the rehabilitation of degraded pasture lands. The challenge for future FFS programmes in the region is to address factors beyond the natural capital because these are being proposed in the agenda by medium scale farmers (see Chapter Six). Moreover, FFS experiences addressing organizing, collective marketing and conflict resolution activities in the FFS curricula showed additional developmental impacts that may encourage FFS sustainability (Khisa and Heinemann 2005, Karanja-Lumumba *et al.* 2007, Settle and Garba 2011).

Little evidence was found of DEPAPRO effectively influencing national or regional policies oriented to the application of environmentally sound livestock management in Central America. The exception was the development of a Project by MAGA based on information generated by DEPAPRO that will promote the establishment of silvopastoral systems in Petén, Guatemala (CATIE 2009). Supportive policies are a key factor observed in the pioneer IPM FFS, as the Indonesian government banned pesticides, reduced the subsidies for such products and promoted the FFS approach as the official strategy for addressing the rice pests outbreaks (Rölling and Fliert 1994, Ooi 1996). DEPAPRO hired consultants for carrying out policy and market studies in the pilot areas; organized forums for analyzing the regional policies discouraging tree establishment in cattle farms; and events for discussing their results with authorities, partner organizations and other stakeholders. However, the staff with expertise in policy making could have devoted more efforts for lobbying the local and national governments. Further dissemination of DEPAPRO results to stakeholders with political capital that can promote policies is also desirable. Partner stakeholders, staff from agricultural research and extension organizations and authorities at the local and national level are actors that would have a chance to influence policies if they had access to the proper information and are empowered to do it.

In the setting up phase, the integrated use of baseline studies, participatory appraisals and the analysis of innovation systems from the livestock sector facilitated the familiarization of DEPAPRO staff with the work areas and the degraded pastures issues. The documentation showed that those diagnostic approaches can complement each other for supporting the planning and organization of FFS in Central America. On the other hand, this phase also exposed challenges related to the project management arena that should be taken into account as they can interfere with overall FFS implementation: (a) delays in the processes for staff recruitment, thus affecting the starting of activities in one pilot area; (b) the gender equality of professional staff, one woman hired from nine technical-professional positions; (c) background of professional staff, one social and one economist scientists from nine technical professional positions; (d) total number of DEPAPRO staff, where 15 to 18 people led the intervention.

The organizations in charge of research and extension efforts in Guatemala, Honduras and Nicaragua face financial, social and human assets restrictions that limit their intervention in rural areas. DEPAPRO showed that the use of a mixed approach between local and expert knowledge and based on the creation of capacities (Rölling 2002, Zanetell and Knuth 2002), rather than on the provision of inputs or the transfer of technologies may help to reduce those limitations. The livestock FFS were supported by alliances with key organizations and livestock farmers that despite of their own limitations provided organizational, technical, logistic and budget support. These helped to overcome DEPAPRO staff and financial limitations, and extended the outcomes of livestock FFS beyond the lifespan of DEPAPRO (Pezo *et al.* 2010). Nowadays, the Mesoamerican Agro-environmental Programme led by CATIE integrates several projects organizing FFS in Central America, new organizations are joining these efforts and FFS are being organized in topics such as coffee, cacao and sustainable livestock production.

The multi-stakeholder approach use was facilitated by the capacity of negotiation of DEPAPRO stakeholders, the identification of a shared vision and mission about the future of livestock production systems in Central America and a sense of commitment from partner organizations or their staff. In some cases, apparent “ideal” partners could not respond to DEPAPRO invitations because there were incompatibilities with established job schedules or budget. Nevertheless, their place was taken by organizations or individuals that observed in DEPAPRO an opportunity to carry out their mission or improve their work. They invested their time for strengthening and expanding the establishment of environmentally sound management of livestock FFS in Central America even when this did not offer access to direct incentives such as monetary compensations or a reduction of workload in their organizations.

The livestock FFS encouraged by DEPAPRO and partner organizations were implemented in a context dominated by a “non-participatory culture”, which usually had a negative influence in the interactions between rural development agents, authorities and farmers. FFS seemed to have addressed such challenges supported by the established relationships of trust, reciprocity and power among farmers; and by practicing a constant dialogue and commitment among stakeholders. Such commitment implied not creating false expectations about DEPAPRO among the stakeholders involved; but reinforcing their technical and methodological capacities. A previous study analyzing DEPAPRO FFS in Petén, Guatemala reported a similar explanation, suggesting that a combination of inputs and knowledge exchange were the key factors that facilitated the FFS development (Alpízar Ugalde 2007).

Other differences between the livestock FFS carried out by DEPAPRO in pilot areas and those reported by other studies were related to: (1) a relatively low frequency in the FFS sessions (one per month); and (2) the establishment of individual rather than group experimental plots. Both could have reduced the possibilities of developing social capital, capacities for group observation and understanding the livestock agroecosystem, because the time invested in observation has been pointed out as a key factor for developing analytical capacity, common knowledge and informed decision making (Rölling and Fliert 1994, Tripp et al. 2005). Some of the FFS led by partner organizations used group experimental plots and is necessary to evaluate if the FFS effect in the social capital of such farmers is different than that of FFS individual experimenters. Moreover, IPM FFS have referred the use of comparisons between plots with conventional management and those managed following the IPM principles. It must be stated that the latter was rarely observed in the FFS groups developed under the influence of DEPAPRO because experiments costs would have increased considerably.

Nevertheless, DEPAPRO gave the farmers the chance to decide on the frequency of FFS sessions and encouraged their participation in additional activities such as experimenter groups where they developed participatory evaluations through focus groups discussions (Cruz et al. 2007, Aguilar et al. 2010). Reports from livestock FFS carried out in developed countries have used a similar frequency in their sessions (12 sessions/year), because farmers need time to observe and analyze the effects from the alternative practices (Vaarst et al. 2007b). Moreover, establishing conventional management “plots” to be compared with the innovations in livestock is difficult because they usually require more space (DEPAPRO worked with plots of at least 0.7 ha); or can even compromise cattle health, which are risks that small farmers usually are not willing to take (Minjauw *et al.* 2002). Considering this, some “experiments” were established individually by farmers without “control” plots; or when some farmers established the latter these were funded by DEPAPRO (demonstration plots). In both cases farmers provided some inputs and monitored the development of trials, while other farmers were invited to observe and analyze the results in field visits, guided by experimenters. These activities intended to replace to some extent the use of a more intensive FFS schedule and group experiments and at the same time were based on the context and the decision from the farmers.

The anchoring and scaling up phase permitted the involvement of partner organizations in leading the development of new livestock FFS. This permitted the adaptation of the FFS principles to the context of each area, the organizations and the farmers. For example, livestock FFS organized by the Faculty of Veterinary Medicine and Animal Husbandry from The University of San Carlos in Guatemala (FMVZ-USAC), encouraged efforts in the early stages of their FFS for organizing support groups. These were observed to promote positive interactions among college students and farmers, because they helped to create a sense of responsibility and competence that encouraged participation and reduced the dependence on facilitators for carrying out FFS sessions.

In the anchoring and expansion area DEPAPRO staff were in charge of initial trainings on the FFS approach for specialists and facilitators; and shared monitoring responsibilities from FFS activities in the new groups. Due to the limited number of DEPAPRO staff, the involvement of partner organizations in FFS activities created the opportunity for expanding and applying the work developed in the pilot areas on a larger scale. This encouraged the appropriation of the FFS approach in partner organizations, the formation of new alliances with farmers and partner organizations, and the expansion towards other territories. The anchoring and expansion phase was facilitated by funding provided by DEPAPRO, however, partner farmers and organizations also provided human, financial or material assets that facilitated the livestock FFS implementation. Thus DEPAPRO promoted the integration of organizations and financial resources for implementing FFS in an environment dominated by the lack of coordination among organizations.

4.5.3. FFS impacts on stakeholders assets

The documentation suggests that most of the changes induced by the livestock FFS were observed in human factors, rather than in material ones. Their identification was possible by structuring the analysis under an integrated framework based on the Sustainable Livelihoods and the Community Capitals Frameworks (DFID 1999, Flora *et al.* 2004, Gutiérrez-Montes *et al.* 2009a). The stakeholders pointed out changes related to human capital, which are consistent with the aims of DEPAPRO about increasing the regional capacities for an environmentally sound livestock management. Interviewees stated examples about how their participation in the livestock FFS encouraged by DEPAPRO and partner organizations strengthened their technical knowledge about livestock production in the case of farmers, promoters, students and facilitators. Moreover, students, facilitators, specialists, decision makers, and in general the partner organizations involved in the FFS organization observed that using the discovery learning approach was a key factor for strengthening their human and cultural capital related to addressing RD projects. This is important because the context of Central America is characterized by limitations in formal education (Handa *et al.* 2009), especially of poor households located in rural areas. Thus, non-formal education strategies such as FFS are necessary for complementing the capacities of rural households.

If non-aggregated responses are considered implemented technologies related to the natural capital were the most cited and observed changes by interviewees. These were induced by farmers' participation in the livestock FFS, specifically by the establishment of on-farm trials encouraged by the decision of supporting the establishment of individual experimental plots rather than group ones. This is controversial because it increases overall livestock FFS costs and individual experiments can be considered as practices that reinforce paternalism or patronage relationships. However, it also encouraged the practice and knowledge of environmentally sound practices by providing the financial assets necessary for assimilating the risk and initial investment that the establishment of some practices require. The latter has been pointed out as a limiting factor for silvopastoral systems and agroforestry systems in Central America (Alonzo *et al.* 2001, Dagang and Nair 2003, Pagiola *et al.* 2007).

Cultural, political and social capital related aspects have been usually underestimated in the planning, functioning, M&E of rural development initiatives. However, the documentation showed that the latter factors have an important role in determining the livestock FFSs effects in Central America. Cultural capital changes varied according to the perspective from each stakeholder category and were mainly related to attitude changes towards rural development initiatives and training. Especially facilitators, specialists and partner organizations that traditionally had the power and were used to set the rules of the game in livestock trainings, changed their attitude towards an inclusive approach based mainly on the farmers' voice and action. Using Calabrese and Yang words (2000), DEPAPRO showed that livestock FFS can be build on a "middle ground" between technical and scientist knowledge. This also contributed to make the FFS more accessible to illiterate farmers and diminished the effects from the non-participatory culture.

Regarding social capital, the livestock FFS facilitated the formation and strengthening of relationships between and among DEPAPRO stakeholder categories. For example, farmers in Petén, Guatemala established bridging alliances with staff from the CUDEP-USAC where they could take manure samplings of their cattle to get them analyzed for the proper identification and treatment of diseases. In exchange, staff from CUDEP-USAC and the FMVZ-USAC carried out visits with students to some of the farmers that participated in the FFS for learning about the FFS approach and the performance of the experimental plots. Despite this and other examples of reciprocity among stakeholders, most of the FFS groups stated that they would not be able to continue working as an organization after DEPAPRO departure. This is because they lack the financial assets necessary for their implementation and in some cases the scattered location of their residence difficult their transportation (David 2007), but also because the curricula of most of the FFS rarely integrated FFS sessions for strengthening organization among FFS groups.

Furthermore, during the documentation process around 100 FFS sessions were observed during 15 months of fieldwork (most of them in Guatemala); these were carried out with the facilitation of at least 13 different persons that included DEPAPRO staff, partner organizations staff and promoters. Most of the livestock FFS sessions observed were participatory and based on the learning by a discovering and experimenting approach. However, some of them also were similar to conventional top-down approaches where the FFS sessions were lectured rather than facilitated. This challenge has been reported before in previous studies in Ecuador (Schut 2006, Sherwood 2009), suggesting that stakeholders are tempted to return to the predominant approach, after all most of the technical and professional staff were raised, lectured and paid by a system based on it. This has been shown to hinder the development of local abilities, the formation of identity, responsibility and empowerment with the FFS groups (Schut 2006, Dahlmann-Hansen 2007).

A promising result in partner organizations is the incorporation of the FFS approach as part of the learning methodologies in Universities such as FMVZ-USAC in Guatemala, ESNACIFOR and DPA-UNAG in Honduras; and FACA-UNA and FCE-UNAN-Managua in Nicaragua. In Central America the top-down paradigm in agricultural extension has been embedded in most of the current formal education programmes and especially in agricultural professional education. There students are lectured and conduced to believe that technical knowledge is superior to the traditional or experiential knowledge from farmers. Most of the students become passive receivers, expecting simply to be given knowledge and neglecting their opportunity to develop skills for their discovering through observation or experimentation. Thus, agricultural professional education usually reinforces a dominant paradigm that has shown weaknesses while working with poor farmers located in areas with limited assets; and for encouraging the practice of knowledge intensive approaches (Rölling 1988, Chambers 1996b).

If agricultural professionals are given the opportunity to discover early in their formation that alternatives exist to the top-down paradigm, the shift toward such alternatives should be facilitated. For example, since 2007 students from the FMVZ-USAC have been applying and learning the FFS approach, this means that five generations of students have had the opportunity of experiencing the FFS approach before graduating from their university studies; and in some cases during their Professional Supervised Practice (EPS). A similar integration of the FFS approach into Agricultural University and Technical Education was reported in El Salvador, Honduras and Nicaragua during the first adaptation of IPM FFS in Central America led by PROMIPAC (López Montes et al. 2003, Angulo 2006). Regarding graduate education, since 2010 CATIE includes the FFS approach in the curricula of the Qualitative Methods for Participatory Research and Action Course; and open training courses were organized by DEPAPRO in livestock FFS since 2005. As suggested by a decision maker from Nicaragua, organizations working in Rural Development now have the opportunity of integrating the learning experiences from Agricultural and Livestock FFS adapted to the Central American context.

4.5.4. Are FFS an affordable approach to facilitate better livestock management?

As described during the documentation some of the strategies adapted by DEPAPRO for implementing the FFS increased their overall costs. In this respect further analysis involving cost/benefit estimations are needed. The documentation process did not include the latter, however, based on literature available and the information of this research a discussion on the matter will be presented below. The aim is to provide factors to consider in cost/benefit studies when analysing the profitability of FFS.

First, the context of the region must be considered. In the three countries where DEPAPRO worked the state has limited resources for creating and strengthening the local capacities on livestock farmers. Furthermore, shocks such as the civil war from Guatemala and Nicaragua produced drastic impacts in the human and material assets from rural areas (see Chapter 6). Finally, policy reforms (structural adjustment) have reduced the budget devoted by local governments in Central America for agricultural research and extension. This is expressed not just in the lack of opportunities for public formal education in rural areas, but also in limited agricultural extension services. In this context, the value of alternatives for strengthening capacities through non formal education such as the FFS is pronounced (Hall *et al.* 2003).

Secondly, as the documentation and other studies have showed, many of the positive effects from the FFS approach are immediate changes on human assets (Duveskog *et al.* 2011). This represents a challenge for assessing the impact of FFS in economic terms, because the real value of such impacts is difficult to be estimated in financial terms. However, some authors have suggested that measuring impact in economic terms does not provide an opportunity for further learning from experiences undertaken in organizations (Hall *et al.* 2003). Moreover, developmental effects may take longer periods to be capitalized because of the nature of the livestock activity, which has longer periods of recuperation than crops, suggesting the necessity of long term evaluations.

Thirdly, as has been discussed in the documentation outcomes on other stakeholders are rarely considered in impact assessments. In the process of DEPAPRO for example, how could the effects on human, political and cultural capital observed on facilitators, specialist and students be estimated in economic terms? Thus, integrated cost-benefit evaluations addressing impacts on other stakeholders rather than just those from farmers are required. Finally, this research and other studies (Davis *et al.* 2012) have found differentiated effects according to the characteristics of the farmers, i.e., more political capital on women and small scale farmers (Chapter 6). This indicates the necessity of further disaggregation of beneficiaries for a proper assessment of the FFS impacts.

4.6. Conclusion

The livestock Farmer Field Schools (FFS) organized by DEPAPRO and partner institutions were one of the first documented adaptations of this approach for addressing livestock production issues in the Central American context. The history of DEPAPRO highlighted aspects that can improve the implementation of new FFS experiences. As it has been pointed out, DEPAPRO managed to strengthen human capital in most of the

FFS stakeholders. The documentation also contributed to reveal elements from the Central American context that make livestock FFS implementation difficult, and such aspects should be considered by future FFS experiences to anticipate potential bottlenecks and facilitate the transition towards sound and sustainable livestock production.

4.7. Acknowledgments

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Chapter 5. What do livestock farmers think about their learning on practices for recuperating degraded pastures land in Petén, Guatemala?

5.1. Abstract

Livestock Farmer Field Schools (FFS) were organized in Petén, Guatemala to address problems related to degraded pastures. FFS consisted of at least two cycles of learning where livestock farmers experimented and discovered knowledge on sustainably sound livestock management practices. The aim of this chapter was to document the farmers' learning and perceptions of practices to intensify livestock production in a sustainable manner. A multi-stage design with mixed methods was used for the study: (1) semi-structured interviews were carried out with FFS groups to obtain basic information about the farmers and their livestock systems, as well as their perceptions of the activities promoted by DEPAPRO. (2) These were followed by focus group discussions with FFS participants and non-participants to document learning. (3) Finally, literature review, field observations, and a logistic regression analysis were triangulated to identify factors that favoured and constrained *Leucaena leucocephala* fodder banks testing. The results obtained suggest that it was not possible to find a practice that was suitable for all the biophysical and socioeconomic variables that influence livestock production in Central and Southern Petén. Every single option tested showed advantages and disadvantages that changed according to the characteristics of the farm and household, as well as of exogenous factors such as policies, markets and input prices. The FFS approach was successful in promoting farmers' willingness to test forms of systems' intensification. However, the effective appropriation of such practices by participating and non-participating FFS farmers in Petén will require further work for adapting such practices to the local livelihoods objectives, farm conditions and exogenous context.

5.2. Introduction

5.2.1. Livestock production and natural resources in Petén, Guatemala

Cattle production arrived in Guatemala during the Spaniard colonization, and specifically in Petén it was initially established in the natural savannas present in the municipalities of Dolores, San Francisco and Santa Ana (Macz *et al.* 1999). The Caste

War of Yucatán[17] severely affected the cattle market in Southern Mexico. In addition, the relative importance of livestock as a livelihood strategy declined in 1850 when the extraction of wood and non-timber products from the forest gained importance (Schwartz 1990, Macz *et al.* 1999, Grandia 2009). In contrast, nowadays Petén livestock production occupies an important place in the overall economy of Guatemala and Petén itself, because beef and cows' milk were ranked in 2008 as the fourth and sixth Guatemalan main agricultural products by value (FAO 2010). Cattle population in Guatemala was estimated around 3.13 million heads by 2010, from which at least 594,700 (19%) were raised in Petén (MAGA 2010). Regarding milk production, Petén contributes 22.8 million litres of milk (6%) of the national production which is estimated about 381 million litres (MAGA 2010).

Even as recently as the 1980s it was common to find in Petén extensive livestock systems based on natural savannah pastures, with no paddock divisions, raising of slow growing non-improved animals, maintained only in one group, not separated according to age or sex, and the only equipment and infrastructure found in the farms were manual sprayers and rustic corrals (SEGEPLAN and UNEPET 1992). More recently those systems have changed to the use of a combination of sown pastures and natural grasses, with paddocks divided by dead and live fences[18], weeds are controlled manually twice a year, animal diet is supplemented with common salt, and some producers also provide mineral supplementation. Farms may include water reservoirs, manual sprayers, corrals and chutes as infrastructure (SEGEPLAN and UNEPET 1992). Nevertheless, livestock production systems in Petén are usually still considered to be extensive, with low stocking rates, minimal investment in infrastructure or inputs, and with low profit (SEGEPLAN and UNEPET 1992, Barquin 1997, Morales 1999, Rivera 2007, Grandia 2009).

Despite low profits and the relatively under developed state of the sector, livestock production is one of the preferred livelihood strategies in Central and Southern Petén, although it has been identified as responsible for much of the deforestation and soil

[17] The Caste War of Yucatán (1847-1901) was a separatist movement encouraged by Mayan population in Southern México.

[18] In Central America are used two main types of fences in livestock farms: (i) dead fences, where the barbed wire is established on poles made from wood or concrete; and (ii) live fences, where barbed wire is fixed on trunks of living trees. In Petén these trunks or stakes are called "*brotones*" in plural and "*brotón*" in singular.

degradation. More than 50% of forestland in Petén was cleared after the 1960s (Carr 2004), in the period 2000 to 2008 49,800 ha of forest were lost, then the deforestation rate was 0.33%/year (Manoharan *et al.* 2009). As most of the land in Petén is suitable for forests or conservation, the establishment of crops and even sown or naturalized pastures may create land use conflicts, and pasture or soil degradation. Such processes are aggravated by significant increases in temperature and the reduction of soil moisture during the dry season (Manoharan *et al.* 2009), poor pasture and crop establishment and management practices, lack of technical assistance or assistance which is biased towards outsider's interests, and lack of local organization (Shriar 2001). All those factors resulted in the abandonment or selling of the degraded land to farmers with more assets, and small farmers migrate and create pressure on forestland located in protected natural areas (Sader *et al.* 1997, Shriar 2002, Grandia 2009).

The intensification of livestock systems applying conventional practices such as silage, hay making, and the use of cut-and-carry grasses or silvopastoral practices such as fodder banks, live fences and scattered trees in pastures are the most cited options to deal with pasture and soil degradation (SEGEPLAN and UNEPET 1992, Ferguson and Griffith 2004). Since the 1970s, several public organizations, NGOs and universities have explored the use of such intensive practices in Petén (Cano 1977, SEGEPLAN and UNEPET 1992). However, previous conditions in Petén such as: abundance of forestland to be cleared for practicing slash and burn agriculture, the low population density and limited labour availability among other factors, rendered intensification non-attractive (Schwartz 1990). In fact, intensive practices require more investment in infrastructure, knowledge, labour and financial resources, a decision that many farmers did not want to take.

In addition, the scarce efforts promoting intensification have used a top-down extension approach with limited effectiveness of uptake, as those tried to impose techniques that were not compatible with the interests and the learning style of farmers. For example, the use of *Leucaena leucocephala* as a fodder alternative was initially proposed in Petén in the 1990s by a NGO (SEGEPLAN and UNEPET 1992), but the extension staff in some villages only explained the reason for use as being: "you must plant it because is good for cattle". Because of the lack of explanation, demonstration and discussion, most of the farmers decided not to plant the leucaena seeds, and the few who did, planted only a very small area because many believed they were tamarind seeds. Practical experiences in Petén and Central America with the use of fodder banks, including leucaena in silvopastoral systems, were limited outside of research stations (Ferguson and Griffith 2004).

Shriar (2001, 2002) proposed that any efforts toward conservation and development in a sustainable manner for Northern Petén should be based on holistic and participatory approaches, to have them become incorporated within the predominantly agricultural livelihoods of the local society. This implies that the voice of farmers should be included in conservation plans, rather than simply considering them as a threat to natural resources, and excluding them from conservation or development planning and projects. In this context, the Multi-stakeholder Participatory Development of Sustainable Land Use Alternatives for Degraded Pasture Lands in Central America project (DEPAPRO) organized Farmer Field Schools (FFS) on livestock production as a strategy for improving farmers' capacities for practicing sustainable livestock production systems and improving their livelihoods. The FFS included opportunities for participating in on-farm trials of several practices that were suggested by both farmers and technical staff.

The purpose of this study was to investigate the learning and perceptions of farmers about alternative practices for degraded pasture lands in Central and Southern Petén, Guatemala. Emphasis was given to the study of leucaena fodder banks established by FFS farmers, as they and DEPAPRO technical staff identified those as one of the more promising silvopastoral practices. Results reflect the opinions of farmers about the alternative practices for recuperation of degraded pasture lands and how those fit in the current livestock production systems. Thus, the study can provide lessons for the implementation and refinement of sustainable sound livestock production intensification practices in Petén.

5.2.2. The process of on-farm testing of leucaena fodder banks

The genus *Leucaena* originated in Mesoamerica and according to historical information its main pre-Hispanic use was for human consumption (Zárate 1997). Leucaena fodder banks and hedgerows have been suggested as an alternative for cattle feeding in tropical and semitropical regions around the world, and especially in developing countries of Latin America, Asia and Africa (Lascano *et al.* 1995). Nevertheless, there are few reports of success using such technology innovations (Shelton *et al.* 2000), and its adoption by livestock farmers has been rather limited in Latin America and the tropical world (Lascano *et al.* 1995, Argel *et al.* 1998, Casasola *et al.* 2007, Calle *et al.* 2009). Despite those reports, leucaena was one of the innovations most commonly tested on-farm by DEPAPRO farmer partners in Petén (Aguilar *et al.* 2010, Pezo *et al.* 2010).

The idea of establishing Leucaena fodder banks came out of the FFS curricula development sessions held in 2004, under the leadership of technical staff from DEPAPRO and partner institutions, where fodder banks were identified as a potential forage alternative for the dry season. Even though there were previous research experiences in Petén on the use of fodder trees for feeding livestock (Hernández and Benavides 1995, Hernández 1997); and on grazing under pine forests in Southern Petén (SEGEPLAN and UNEPET 1992), in the beginning farmers did not believe that cattle could obtain benefits from a "tree with small leaves". Therefore, project staff had to put in additional efforts to encourage farmers to test such technology innovation.

Discussions and video presentations in special topic FFS sessions were used to promote the establishment of leucaena plots. However, those did not result in much farmer interest. With the collaboration of one farmer, DEPAPRO decided to finance the establishment of one hectare of a leucaena fodder bank as a demonstration plot in Santa Rosita community, and FFS farmer members were encouraged to participate in learning sessions covering key topics associated with leucaena establishment such as: propagation, transplanting and direct planting, as well as on its utilization as fodder (Aguilar *et al.* 2010). It was only after farmers verified that leucaena maintained green leaves during the dry season and that cows consumed those leaves (Aguilar *et al.* 2010) that more farmers became interested on experimenting with leucaena in their own farms.

For those experiments, DEPAPRO provided the seeds for the pioneering experimental plots, and farmers provided the land, labour, and some inputs required for proper establishment. After the first year of testing leucaena fodder banks some farmers gave back to the project a portion of the seeds harvested in their plots for others who might be interested. DEPAPRO also encouraged exchange visits to farms with leucaena fodder banks, in which FFS farmers shared their learning with other farmers. As the demand for leucaena seeds increased, DEPAPRO bought these seeds from FFS farmers to respond to the needs of new FFS groups, and even for partner organizations in other regions of Guatemala. This was an incentive for some farmers to increase the area allocated for leucaena because seed production became an additional source of income. Five years after the establishment of the first demonstration plot, around 160 farmers had established more than 100 ha of leucaena plots in the pilot area (Pezo *et al.* 2010).

Partner farmers in Petén established leucaena in two main systems: (a) fodder banks for browsing; and (b) plantations for firewood and poles, with a lower herbage stratum managed under grazing. The former was the most commonly practiced, planting leucaena at high density, animals were allowed to browse for few hours each day, and pruning was applied when the height was too high to favour browsing. These fodder banks did not consist of leucaena in monoculture, because many farmers decided to associate it with pastures creating layouts similar to alley farming (Cruz and Nieuwenhuyse 2008, Turcios 2008). However, the latter implied a higher risk because there was no prior experience associated with such practice. Lack of synchrony in the re-growth of grasses and leucaena was observed, that increased the pressure on leucaena because such species requires longer resting periods (at least 45 days in Petén) than the pastures (Cruz and Nieuwenhuyse 2008). The leucaena plantation option was practiced by only few FFS members.

5.3. Materials and Methods

5.3.1. Study Area

The study area was located in Dolores, Santa Ana, Poptún and San Luis municipalities from Central and Southern Petén, which are located in Northern Guatemala, Central America (Figure 5.1). Petén is the largest department[19] of Guatemala with a land area of 35,854km^2. Petén remained sparsely populated, isolated and with large forested areas until the 1960s (Schwartz 1990, SEGEPLAN 1999). Its location close to the borders with Mexico and Belize, and at the agricultural and human settlement frontier produced

[19] Equivalent to state used in the political division of Central American countries such as Guatemala, El Salvador, Honduras and Nicaragua.

uncertainty in the livelihood strategies of the population, especially because agricultural production was affected by lack of labour, land tenure insecurity, weak and distant markets, poor infrastructure and limited agricultural support from researcher and extension agencies (SEGEPLAN and UNEPET 1992, Shriar 2000). More recently, the presence of drug cartels involved in land acquisition and livestock production has increased in importance because of insecurity and pressures for selling land over regular farmers (Grandia 2009, Paz y Paz 2010).

Such conditions have influenced the social, financial and natural capitals, being the latter consider as the most important and affected asset in establishing livelihood strategies in Petén (Schwartz 1990, Gould 2006). Spontaneous and state directed colonization have increased population since colonial times but that drastically increased in the late 1970s and 1980s (Peckenham 1980, Fiedler 1983, Schwartz 1990, Grandia *et al.* 2001). Such a trend is explained by the immigration of distinct ethnic groups that include *Q'eqchi'*, Mopán and Itzá, "*ladinos*[20]" "*peteneros"* or "*sureños"* (include Eastern *ladinos*), *garifunas* and creoles (Fiedler 1983, Macz *et al.* 1999, Grandia *et al.* 2001). Every group that migrated brought along their own farming practices such as swidden agriculture and extensive livestock production that were not suited for most of the socioeconomic, climatic and soil characteristics of Petén (SEGEPLAN and UNEPET 1992, Macz et al. 1999).

The climatic regime in Petén is warm and humid with an average annual temperature of 25.5°C, the annual average rainfall is 2006 mm and the relative humidity is 84% (SEGEPLAN 2003). These indicative data vary according to exact location (Table 5.1). In general terms the local population distinguish two seasons: (a) "*verano*" or dry season that runs from December to May where fodder, as well as water for livestock or human consumption are limited; and (b) "*invierno*" or rainy season that goes from June to December, when fodder availability is abundant (SEGEPLAN 2003, Shriar 2005). There are two short periods without rains in the months of July and August (SEGEPLAN 2003). The altitude ranges from 100 to 1000 masl that give several topographic conditions such as swamps in the lowlands of Dolores and Poptún, natural savannas in Santa Ana, karstic rounded hills observed in the boundaries between

[20] Common term for Spanish speaking inhabitants of Guatemala, equivalent to "*mestizo*".

Dolores and Poptún and steep hills in eastern San Luis (SEGEPLAN and UNEPET 1992). Two ecological zones are present in Petén, the subtropical moist forest (warm) (62% of area) in the north and central portion and the subtropical wet forest (warm) (38%) in the south (SEGEPLAN 2003).

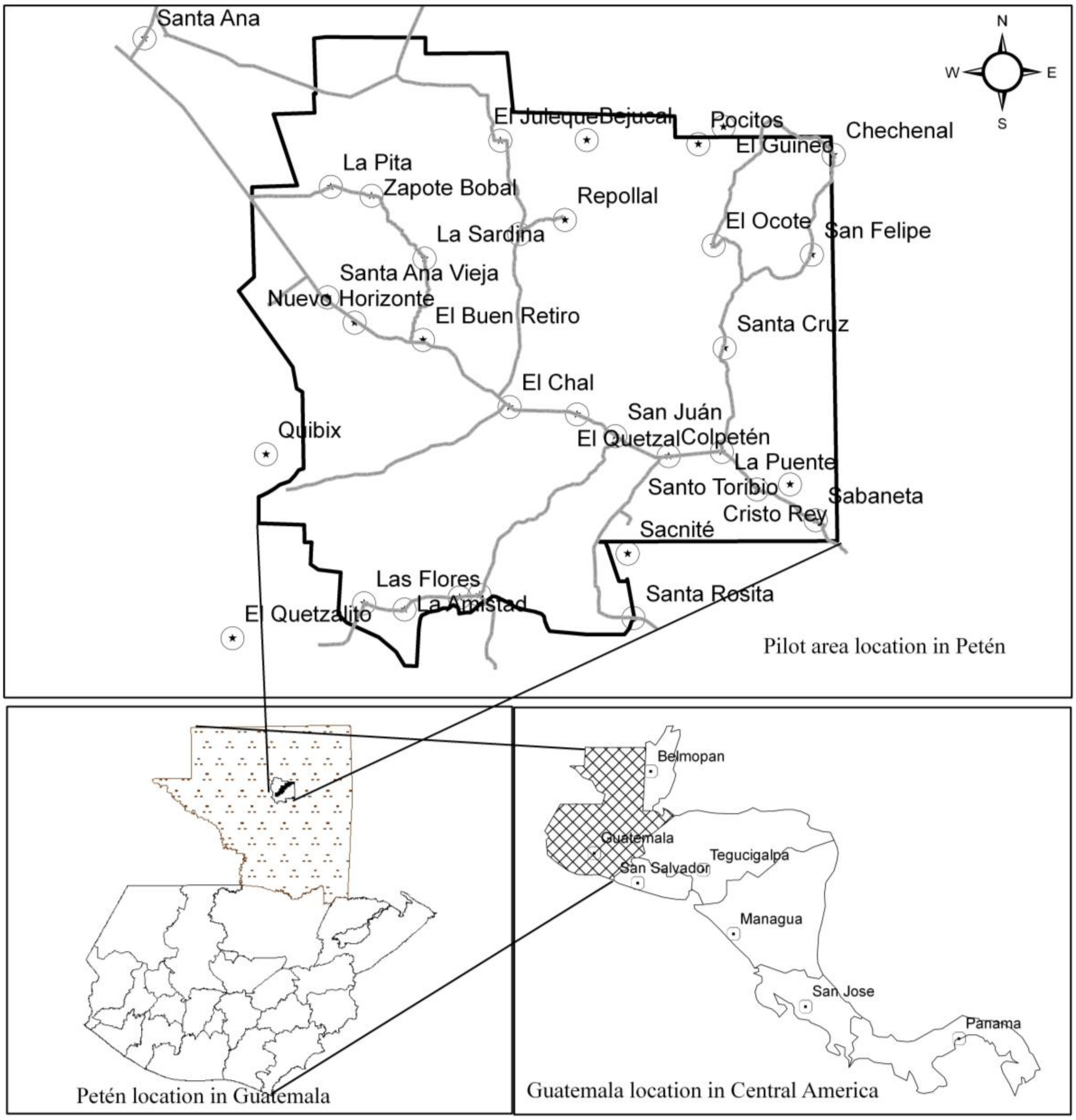


Figure 5.1. Study area location in Petén, Guatemala.

Most of the land in Petén has physical suitability for forest-land and conservation. Macz (1999) mentioned that a FAO study found: 21% of Petén as land suitable for agriculture; 23% for permanent crops, pastures and forests; 42% for forests; and 14% for forests and conservation. Despite this assessment, the land use changes reflect an accelerated trend towards the replacement of natural forests by agricultural uses (annual crops and pastures). Land use reports for 2003 (MAGA 2006) found larger areas under agricultural use than natural forests in Dolores and Santa Ana; whereas Poptún and San Luis still had more area with natural forests, although the difference was less than 6-9%, respectively (Table 5.1). Such trends are resulting in poor land use methods that may lead to the degradation of pastures and soils, due to restrictions in the physical soil conditions combined with inadequate farming management practices.

Table 5.1. Main characteristics for the municipalities located in the study area.

Indicator	DEPAPRO area/municipalities			
	Pilot		Anchoring and scaling out	
	Dolores	Santa Ana	Poptún	San Luis
Distance to Flores (km)*	78	21	100	119
Distance to capital (km)**	420	487	370	381
Population	32,404	14,602	35,663	48,745
Area (km^2)	3,050	1,008	1,716	2,913
Mean altitude (masl)	436	220	510	190
Average temperature (°C)	28	22-29	30	18-35
Average rainfall (mm)	1,116	2,006	1,500-2,000	1,500
Relative humidity (%)	82	84	92	85
Annual crops 2003 (km^2)	147.82	43.19	189.27	386.68
Natural pastures 2003 (km^2)	548.05	124.28	305.27	411.85
Sown pastures 2003 (km^2)	398.74	64.81	80.86	100.41
Natural forest 2003 (km^2)	874.99	201.04	675.07	1,147.85

Notes: * From the municipality centre. ** From municipality centre to Guatemala City. Based on: (UTM 2002a, 2002c, 2002b, INE 2003, SEGEPLAN 2003, MAGA 2006, Mendoza 2008, Luna and Romero w.d.).

Soils in Petén have inadequate properties that restrict agricultural production which include: shallowness, stoniness, low water infiltration, poor drainage and low fertility. Moreover, the combination of high rainfall and thin soil cover leads to erosion (SEGEPLAN and UNEPET 1992, Macz *et al.* 1999, UTM 2002a). Those characteristics limit the use of intensive agricultural practices such as irrigation, mechanization and continuous cropping, resulting just two crop cycles of annual crops following forest or "*guamil*[21]" clearing (SEGEPLAN 2003). Then pastures are established; or the *guamil* is allowed to regrow. Despite their less demanding soil requirements, pastures in Petén also face degradation processes (Kaimowitz 1996, Szott et al. 2000, Betancourt et al.

[21] Natural succession vegetation, also known as *tacotal* or *charral* in other Central American countries.

2007), associated with low concentrations of extractable phosphorus or potassium and topsoil compaction which limits root expansion and the pasture capacity to reach nutrients and water (Fenger 2005).

DEPAPRO facilitated the formation of Livestock Farmer Field Schools (FFS) in Petén. DEPAPRO worked in Petén in two areas: (1) a pilot area between 2003-2008; and (2) an anchoring and expansion area which started in late 2006 (Chapter 4). For this study participants corresponded to: (a) farmers from FFS groups in the DEPAPRO pilot area, with members located in eight villages ("*aldeas or caserios*[22]") from the municipalities of Dolores and Santa Ana; (b) two *ad hoc* farmer groups not related to the FFS and located in two villages from the latter municipalities to compare the perceptions with those of FFS farmers; (c) two FFS groups from the anchoring and expansion area which consisted of farmers from six villages in the municipalities of Poptún and San Luis.

5.3.2. Sample selection

The sampling strategy used was non-parametric convenience sampling where all the active FFS families were invited to participate. Similarly, households suggested by FFS farmers as equal peers were invited to participate in *ad hoc* groups which were used as control for comparing their perception with those of FFS participants. Given such bias, the results are robust for the households that participated in the study, however, they may not represent the rest of the FFS carried out in Petén, or other areas of Guatemala (Laws et al. 2003). The fieldwork comprised three main phases where different stakeholders participated: (1) exploratory semi-structured interview (n_1=70); (2) Ten Focus Group Discussions (FGD) for participatory technology evaluation (n_2=101); and (3) identification of leucaena establishment related factors (n_3=66).

5.3.3. Procedure

5.3.3.1. Phase one

The first phase consisted of visits to the house and farms of the participant families where a semi-structured interview was conducted. This method aimed to obtain basic

[22] *Aldea* is a population with less than 1,000 inhabitants, schools and local authorities subordinated to the municipality (Egenhoff 2009). *Caserio* is a smaller populated centre usually located in rural areas, it could be either a small hamlet or scattered farms with fewer services than *aldeas*. However, both words are used in different official publications for referring to the same populations. Thus, in the present study are referred in English as villages.

data from farmers, their farms, households and FFS activities implemented with DEPAPRO or without it (*ad hoc* groups). The semi-structured interview guide included 29 open questions which were pre-tested with four farmers. Testing helped to change the strategy of how the questions were asked or the incorporation of local terminology related to livestock production, although no major changes were made in terms of the content. Seventy (n_1) interviews were undertaken, from which 43 corresponded to households located in the pilot area (14 from the Ejido group, 12 from El Chal, 12 from La Amistad, five from Santa Rosita); and 27 farmers were interviewed in the anchoring and expansion area (15 from El Porvenir and 12 from La Cumbre).

5.3.3.2. Phase two

The second phase consisted of participatory technology evaluations carried out through FGD. The purpose was to obtain in-depth information to corroborate and/or enhance the results obtained through the semi-structured interviews, with respect to farmers' preferences for some of the practices experimented during the FFS. The FGD procedure was based on guidelines proposed by Bellon (2001) and Guerrero et al. (1996) and DEPAPRO used similar sessions in Nicaragua and Honduras (Piniero and Fariñas 2011). A total of 101 individuals from 85 different households participated in FGD sessions (n_2), each of which had a maximum of 14 participants from seven households for better group management. However, for logistical reasons in one FGD session up to 18 informants were allowed.

The FGD sessions were organized by one facilitator and three or four assistants, the facilitator moderated the focus group discussions and related activities during the session, whereas the assistants distributed materials to the participants, assisted the illiterate to write answers and took notes about the discussions. During each FGD session, farmers were invited to be involved in five participatory exercises that helped to identify their perceptions and preferences for some of the technology-related practices encouraged by DEPAPRO. Nine technologies were evaluated from those described by farmers belonging to the learning FFS groups led by DEPAPRO (Table 5.2). A collage of four pictures printed and laminated for better preservation representing each of the nine technologies was used for identifying the practices.

The FGD sessions started by thanking participants for their collaboration in the semi-structured interviews and for attending the FGD. A simple explanation of the purpose of the FGD meeting followed, after which each participant was provided with an identifier, recycled half letter size paper sheets and colour markers. Identifiers had one single letter from the alphabet (usually A to S). This helped to record participants' perceptions throughout the session by writing the assigned letter with the answers. Each picture was showed to all participants and they were asked to answer two questions about it (Table 5.3). Participants' answers to the first question were used for selecting a name for each picture representing the practice, this was accomplished with group discussions about the answers provided. After this, questions three and four were mentioned, followed by the discussion of positive and negative aspects from each technology. Participants' comments were written on big sheets by assistants while another assistant counted the most common attributes mentioned which then were used for further discussion.

Table 5.2. Livestock practices selected for evaluation in the focus group discussions.

Image	Technology	Description
	Cut-and-carry grass	Use of fodder from grass varieties such as "*Napier*" (*Pennisetum purpureum*)
	Legumes	*Arachis pintoi*, locally known as "*maní forrajero*" (fodder peanut) grown in monoculture or mixed with grasses
	Rotational grazing	Reduced paddock size and intensive rotational grazing

Image	Technology	Description
	Improved water reservoirs	Ponds for collecting rain water, improved by fencing and planting of shade trees on their perimeter, and conducting the water to a watering trough
	Nutritional blocks	Farm made nutritional blocks used as livestock supplements during the dry season
	Silage	Technique used to preserve fodder by anaerobic fermentation, and to be used in the dry season
	Live fences	Use of living trees as posts in a fence (*brotón*). In Petén are mainly used are *Jatropha gaumeri* and *Gliricidia sepium*
	Improved pastures	Cultivated pastures in paddocks, such as *Brachiaria brizantha*, *Panicum maximum* var. Mombasa among others
	Leucaena	Establishment of *Leucaena leucocephala* fodder banks

The session continued with a pair-wise exercise where participants were asked to write which technology was preferred from each possible pair (n=36). Results were presented to the participants in each session for discussion. After a short break for refreshments, participants were asked to score the most frequently mentioned indicators. The scoring exercise was performed by providing participants with small adhesive coloured paper notes. Using those participants scored -with a maximum of 20 points per indicator- those practices that according to their perception corresponded to the indicator mentioned (positive or negative). The latter exercise was not performed with the control groups, because they provided fewer indicators and it was evident their lack of familiarity with most of the practices analyzed.

Table 5.3. First questions in focus groups discussions about perception of livestock practices.

Number	Question	Alternative question
1	What is this?	What do you see in the picture?
2	Is it possible to choose a name for the picture based on all your opinions?*	What is the name of this?
3	Which of these do you like most and why?	None
4	Do you already practice or have implemented in your farm the technology you like most? If not, why?	If yes, please choose a second option that you do not have yet in the farm and tell us why?
5	Which of these do you have in your farm?**	

Notes: *Not recorded in paper just discussed between participants. **Question only for the *ad hoc* (control) groups.

Finally, FGD participants were divided by sex and asked to sort two sets of unordered pictures that showed the process for establishing two practices: (1) leucaena fodder banks; and (2) improved pastures. Those practices were selected because they ranked first in terms of importance and preference during the semi-structured interviews. One set of pictures was given to each group and were asked to order pictures on the way they wanted and discuss about the meaning of each (Figure 5.2). Once both groups finished, one representative was selected by the group to present their work to the rest of the participants. Further discussion was done after each group had presented by asking questions such as: Are there problems in the phases you described? In which phase are the problems that you commented more likely to occur? The FGD ended by expressing thanks to all participants for their contribution along the sessions.

a)

b)

Figure 5.2. Participants during the sorting of pictures exercise: (a) male participants from La Amistad cooperative; (b) female participants from Santa Rosita village.

5.3.3.3. Phase three

The third phase of the study used literature reviews, field visits, and semi-structured interviews to investigate if demographic, farm, household, and land use factors influenced the process of leucaena testing. Leucaena testing was considered as the decision of establishing and managing leucaena plots for at least one year on livestock farms of Petén. Previous studies in agroforestry adoption used sampling strategies that included farmers who were not related to the projects which promoted the agroforestry practices analyzed (Alavalapati *et al.* 1995, Neupane *et al.* 2002, López *et al.* 2007b). However, most of those studies were carried out at least four years after the introduction of the agroforestry practice, and in projects that worked on a larger scale than DEPAPRO. Such an approach was not possible because in 2007 when this study was conducted, most of the leucaena testers were FFS farmers. Therefore, all but one of the 66 farmers (n_3) in the sample for this part of the study were FFS participants.

5.3.4. Data analysis

A database with information from semi-structured interviews and the FGD was established using Access 2003 (Microsoft Corporation 2000). Quality control procedures were applied by checking the validity of outlier values or inconsistencies with the facts observed in the field, or with knowledge about farmers' characteristics. The design of the database helped to export the data into PASW 18, InfoStat and R for statistical analysis (RDCT 2008, SPSS Inc. 2009, Di Rienzo *et al.* 2010). Preliminary analysis included calculation of some variables that were employed in inferential analysis, such as average years in school by household (variable = ProHouseEsco). The statistical analysis included descriptive statistics, Chi-square for independence tests and Mann-Whitney test carried out in PASW 18. Livestock farmers' socio-economic status (variable = FarmerType) status was estimated with field observations based on information from two variables: farm area and herd size that defined two categories: (1) small farmers; (2) medium scale farmers.

The coding of answers from semi-structured and FGD were assisted by NVivo 9 (QSR International 2011). Qualitative analysis included *in vivo* coding where themes emerged from similarities in participants' answers, however, major themes followed categories suggested by the Sustainable Livelihoods Approach and the Community Capitals Framework (DFID 1999, Flora *et al.* 2004). Both approaches consider that the current state of individuals and organizations is determined by internal factors or assets: human, social, political, cultural, natural built-physical and financial. Hence livelihood outcomes result from the interaction of the latter with agricultural practices and external factors grouped in two categories: (1) vulnerability context including trends, shocks and seasonality; and (2) policies, institutions and processes which include elements such as markets and rights (Adato *et al.* 2007).

A logistic regression model was fitted using as outcome variable the decision of whether or not to test leucaena plots (variable = Leucaena). Demographic, farm, household and land use variables were explored as potential predictors of leucaena plots establishment. Predictors were chosen from a dataset with 34 continuous and nine categorical variables. Variables were verified with contingency tables (categorical) and descriptive statistics (continuous) in PASW 18. These helped to identify five cases with missing information because farmers refused to answer such questions or were not available for interviews. A missing value analysis performed with Little's MCAR test in PASW 18 revealed that missing values occurred at random (X^2=113.50, d.f.=131, p=0.862), such cases were deleted and the logistic regression model was built with complete data from 66 cases (Tabachnick and Fidell 2007).

The database was exported to R for running diagnostic procedures before fitting the model (RDCT 2008). Scatter plots from the potential predictor variables were prepared with the function pairs (graphics)[23], from which it was noticed that some predictors were highly correlated. Quantitative estimation of relationships among predictors was accomplished with bivariate correlation, using the function cov (stats) which revealed four pairs of variables with $r \geq 0.7$. Problems in regression analysis related to multi co-linearity and singularity may occur with bivariate correlations $r \geq 0.9$, however, Tabachnick and Fidell (2007) suggest discarding predictors with a bivariate correlation with $r \geq 0.7$.

Most of the variables with highest correlations corresponded to those used for calculating averaged variables such as number of household members and farmer age, thus, it was decided to delete four of those variables from the dataset. Furthermore,

[23]Most of the analyses in R are facilitated by functions, which are grouped in libraries or packages. The name of both is provided in the following format: Name of the function (name of the library).

multidimensional co-linearity diagnostics were performed with the variance inflation index (VIF) (Heiberger 2009) and the tolerance value. The former was calculated with the function vif (HH), and the second was obtained after dividing one between the VIF values. Results suggests no issues with co-linearity because the VIF values were not higher than five (Min=1.50, $\bar{x}$ =2.28, Max=3.58) (Heiberger 2009); or lower than 0.10 for tolerance (Min=0.28, $\bar{x}$ =0.46, Max=0.66).

Logistic regression relies in goodness-of-fit tests which require expected frequencies higher than one, and at least 80% of cells with an expected frequency of at least five (Tabachnick and Fidell 2007). Thus, the assessment of the adequacy of the expected frequencies was carried out through crosstabs between Leucaena and nine binary variables using the function CrossTable (gmodels) (Warnes 2011). Results revealed that none of the cells had expected frequencies less than one, however, all the variables but one (FarmerType) presented one cell (25%) with expected frequencies lower than five. The above and the small size of the sample indicated the necessity of implementing alternative methods for testing the goodness-of-fit (Tabachnick and Fidell 2007); and employing penalized or exact logistic regression models for verifying coefficient estimation (Bull *et al.* 2002, Heinze 2006).

Three methods for logistic regression were used: (i) conventional; (ii) Firth penalized likelihood; and (iii) exact. The conventional and penalized models were fitted in R with the functions glm (stats) and brglm (brglm) respectively (RDCT 2008, Kosmidis 2010); whereas the exact model was fitted with LogXact 9 (Cytel Inc. 2010b). Variables with practical interest for the model were selected according to the literature of agroforestry adoption, and a model with 15 variables (10 continuous, five binary) was tested. However, a warning suggesting linear separation was obtained which is related to the low ratio of cases to variables. Thus, the number of predictors was reduced with a backward stepwise procedure with the function stepAIC (stats), which ended with the selection of four predictors.

Results of the three models were compared and it was decided to use p-values from the Firth penalized method as valid because it provides more precise odds ratio estimates (Cytel Inc. 2010a). The Firth penalized model was validated with likelihood ratio, deviance and the Hosmer-Lemeshow method (Hosmer and Lemeshow 2000), however, because expected frequencies lower than five in the binary variables were detected the diagnostic was enhanced with diagnostic measures obtained from LogXact9 (Tabachnick and Fidell 2007, Cytel Inc. 2010b). Moreover, pseudo R measures were calculated using the functions stat (Design) (Harrel 2009) and ClassLog (QuantPsyc) (Fletcher 2010). Results of the three methods were compared and used to argue about the factors related to the testing of leucaena plots in Petén.

5.4. Results

5.4.1. Farmers characteristics

5.4.1.1. Household

In this study, household was defined as “a group of people united by kinship or other links who share a residence and organize production, consumption, and distribution among themselves” (Nanda and Warms 2002). The household of the interviewed farmers was usually comprised of a husband, wife and children. In some cases, relatives like cousins and brothers were also part of the household. Farming activities are performed mainly by male especially those related to cattle production, whereas women participate more in post-harvest agricultural activities such as removing the kernels of maize cobs, homegardens or poultry production, all performed near their houses. Only six households were headed by women mainly because their husbands had passed away or had migrated to work abroad. There were more families living in villages (46 households) than on the farm (25 households), which could be a consequence of control measures enforced by the military during the civil war when the clustering of inhabitants in villages was imposed (see Chapter Six).

The classification of farmers considering farm area and herd size revealed three main groups: (a) small scale farmers (n_1=42); (b) medium scale farmers (n_2=27); (c) large scale farmers (n_3=2). However, the third group only has two farmers who declared themselves as administrators rather than owners of the large farms. It was decided to merge those into the medium scale farmers group because their limited number in the sample will limit the feasibility of the logistic regression analysis; besides previous comparisons in Nicaragua have found similarities in the assets of both groups (Alas 2007). The main demographic and productive characteristics for the small and medium scale farmers are presented below (Table 5.4). Households of small scale farmers had one person more than medium scale farmers (6.0 vs. 5.2, respectively). Labour in small scale farms is mainly provided by household members, whereas medium scale farmers use more hired labour especially when the household head is already old. Those workers who live in the farm are in charge of cattle management such as milking in dual-purpose systems. Finally, medium scale farmers had higher educational levels and their households had higher average age than small scale farmers.

Table 5.4. Demographic and productive variables by type of livestock farmer.

Variable	Farmer type					
	Small scale (n=42)			Medium scale (n=28)		
	$\bar{x}$	SE	$\tilde{x}$	$\bar{x}$	SE	$\tilde{x}$
Farm area (ha)***	34.2	1.9	33.6	90.6	11.6	73.5
Herd size (#)***	21.1	2.7	19.0	75.0	11.1	63.5
Leucaena plot area (ha)	0.3	0.0	0.4	0.8	0.2	0.4
Household members (#)	6.1	0.4	6.0	5.2	0.4	5.0
Average household schooling***	3.4	0.3	2.9	5.1	0.4	4.9
Average household age*	26.2	1.6	24.1	31.5	2.3	27.8
Average household man-equivalent labour*	2.7	0.2	2.7	2.0	0.3	2.2

Notes: Mann-Whitney tests with statistically significant differences at: *0.10, **0.05, ***0.01.

5.4.1.2. Household head

Most of the household heads are older people with an average age of 50 years (Table 5.5), which is a common feature for livestock farmers in Central America (López 2005, La Roche 2006). In Petén the current opportunity for practicing economic activities in service or industry sectors are limited compared to rural areas from Costa Rica and Panamá. Thus, most of the farmers' offspring are interested in migrating to urban areas or the USA for work; and cattle production as their future livelihood. In terms of educational background, livestock farmers rarely completed primary school, in fact the average level of schooling was 3.1 years. A high proportion (28%) of farmers never attended formal school, which also explained why there were some illiterate farmers. Farmers indicated that in the past opportunities were scarce for accessing formal education. Some farmers learned to write and read by themselves or by attending adult education programmes such as the ones offered by IGER (Guatemalan Institute of Radiophone Education) and CONALFA (National Committee of Literacy).

The livelihood strategies of most of farmers have always been linked to farming activities. Most farmers pointed out that they practiced agriculture ($\bar{x}$=34.8 years of experience) before engaging into cattle production ($\bar{x}$=23.3 years of experience). Exceptions to this were some *ladino*[24] household heads who grew up in crop-livestock farms, therefore, had similar experience in livestock and crop production activities. Almost all the interviewees were *ladino* migrants from other regions of Guatemala, especially from the Eastern Plains and the Pacific Coast. Similar results were reported by other authors (Fiedler 1983, Grandia *et al.* 2001, Shriar 2001) suggesting that people from those regions are among the largest groups of inhabitants in Petén. Farmers arrived in Petén more than two and a half decades ago ($\bar{x}$=28.7 residence years), however, they are still proud and remain connected to their native culture, rather than that of the Petén (Table 5.5).

Table 5.5. Experience variables main descriptive statistics.

Variable (years)	Farmer type					
	Small scale (n=42)			Medium scale (n=28)		
	$\bar{x}$	SE	$\tilde{x}$	$\bar{x}$	SE	$\tilde{x}$
Age	49.2	2.1	48.5	53.3	2.1	53.0
Farmer schooling[§]	2.7	0.4	1.0	3.5	0.8	2.5
Farming experience	37.6	2.3	36.0	39.5	2.7	39.5
Agriculture experience	35.1	2.6	35.0	35.8	3.1	37.0
Cattle experience***	16.4	2.5	11.0	29.9	3.2	25.5
Petén residence[§§]	29.2	1.2	29.0	28.2	1.8	30.0
Farm ownership	17.6	1.5	15.0	19.3	1.8	17.0

Notes: [§]Calculated from 41 data for small-scale farmers. [§§]Calculated from 27 data for small-scale farmers Mann-Whitney tests with statistically significant differences at: *0.10, **0.05, ***0.01.

5.4.1.3. Farms

Most farmers (73%) owned only one farm, whereas 26% had two or more. The average farm size was 59.8 hectares (ha), ranging from 7.0 to 315.0 ha. Large land holdings are an indicator of Petén history which reflects its relatively recent settlement, former abundance of land compared to other regions from Guatemala, and inequities in land allocation (Peckenham 1980, Clark 2000). Efforts for granting land legitimacy included the decentralization of land regularization which started to be promoted in the 1990's by

[24] *Ladino* population is considered a cultural group formed by mixed races between Spaniards and indigenous population.

CARE (Gould 2006). Nowadays, most of the municipalities are responsible for their own land registration system (Lebeau and Erba 2008); and even though 75% of the farmers declared to be owners, a high proportion of them are still processing their land titles. Nineteen percent of the interviewees rent land to the municipality in the Ejido by an annual payment of two USD/"*manzana*[25]" per year, and six percent were administrators of farms owned by relatives. However, in all cases farmers seemed to be confident about land security.

The most common livestock production system is dual-purpose (Figure 5.3), in which the main cattle products sold are fresh milk and its by-products and male calves. In the past, the main livestock production system in Petén was for beef (SEGEPLAN and UNEPET 1992), however, the growing demand of milk by local cheese factories and the milk industry in Guatemala City favoured the growth of dual-purpose production in Central Petén (Búcaro and Batres 2001, Barrios 2008). Among the farmers interviewed, ten bought male calves for development and fattening; and none were involved in specialized milk production. The environmental conditions in Petén are not adequate for dairy breeds which are more adapted to temperate areas where they originated from. Other ten farmers practiced cow-calf systems, referred to as "*crianza*", where the main goal is to expand the herd with calves born and raised in the farm. However, most farmers in such systems also milk the cows in the first three to four months of lactation, and only one farmer also fattens the males.

[25] In 2008 the exchange rate was 7.50 US dollars by quetzal. A *manzana* is a land measurement unit commonly used in Central America equivalent to 0.7 hectares.

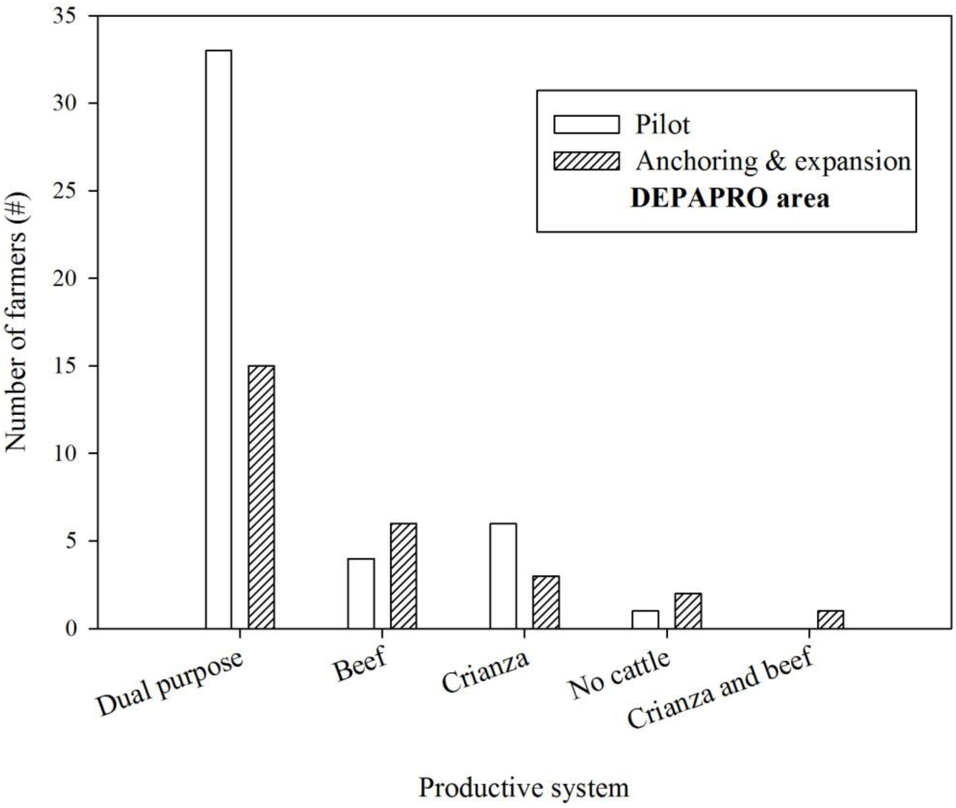


Figure 5.3. Livestock production systems by DEPAPRO area.

5.4.1.4. DEPAPRO innovations inventory

There were a total of 34 innovations tested by FFS farmers (Figure 5.4), of which leucaena was the most mentioned (64 interviewees). It must be pointed out that farmers sometimes considered to have tested a given technology through their participation in FFS practical sessions but not necessarily by establishing such technology in their own farm. Improved pastures was the second technology most practiced, with 58 farmers stating to have participated in trials of at least one of the species of cultivated pastures considered as “improved”. Live fences and legumes were the third most tested technologies with 45 farmers mentioning to have experimented with both.

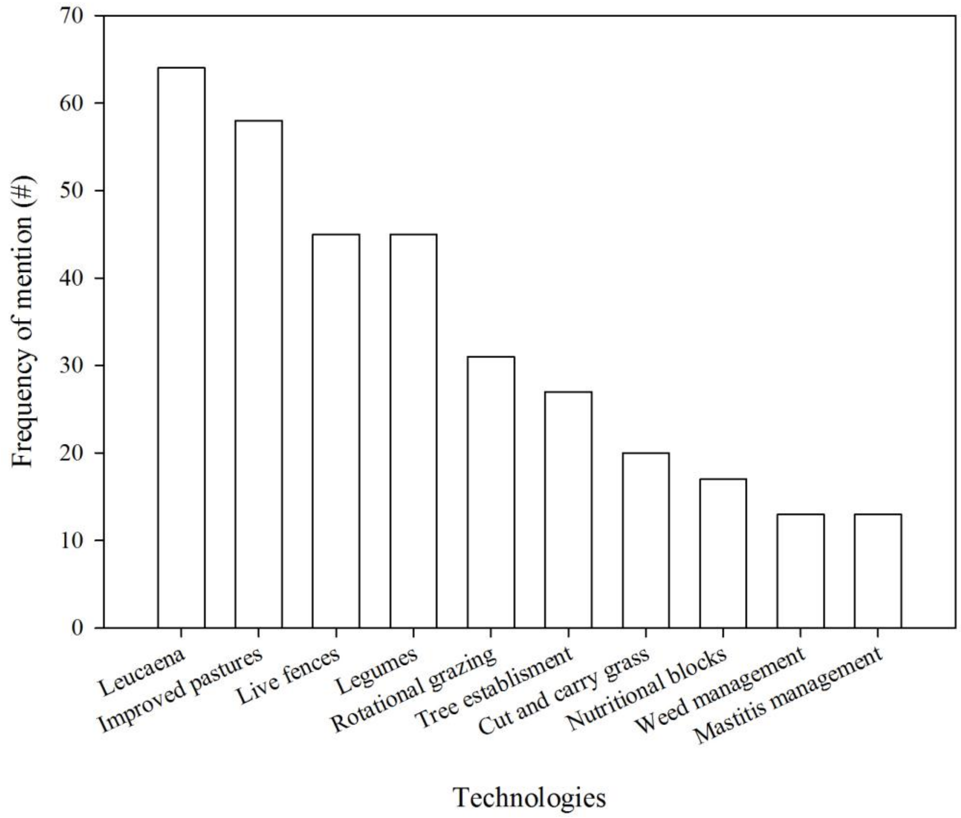


Figure 5.4. Top ten technologies tested by FFS farmers according to semi-structured interviews.

The criteria for selecting the practices to be evaluated during the FGD sessions were: (a) the technologies must be already implemented in the farms; (b) farmers identified the technology as relevant, and in this context farmers reported a total of 22 technologies as important. The most common answer was that all the technologies promoted by DEPAPRO were important for the household, revealing that the FFS learning programme may have changed the vision of farmers towards a holistic and integrated perception about the agroecosystem. Additional probing during interviews revealed farmers' preferences for some options, which are displayed in Figure 5.5. The technologies pointed out to be most important are leucaena and improved pastures with 37 and 30 mentions, respectively. Rotational grazing and live fences were placed as third and fourth in importance, with 16 and 12 mentions respectively.

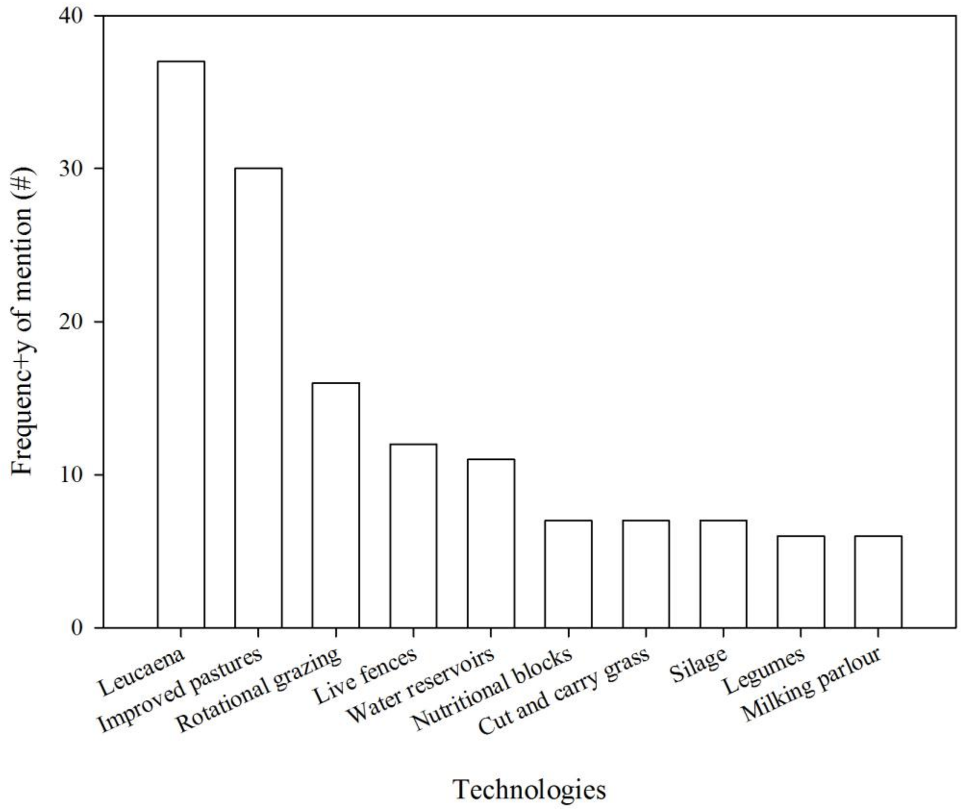


Figure 5.5. Top ten technologies according to FFS farmers' preference.

5.4.2. Participatory technology evaluation

The total number of participants in FGD was 101 informants, from which 61 (60%) were males and 40 (40%) were females. During FGD sessions women's participation in control groups was rarely observed; whereas in the anchoring and expansion area FFS groups were fewer than in the pilot area FFS groups. FGD participants had a total of 909 chances for the individual identification of practices, 779 (86%) attempts were considered valid, and 130 (14%) as missing data. Most of the latter were associated with participants who arrived late at the FGD sessions, as such exercises were carried out at the beginning of each FGD. Among the valid cases, 419 (54%) identification attempts of the technologies were correct and participants managed to identify the evaluated practices; whilst in 360 (40%) attempts participants failed to identify the options. The most recognized practices were nutritional blocks with 63 participants, followed by leucaena and legumes with 59 participants; whereas the less recognized ones were intensive rotational grazing and improved water reservoirs with 26 and 23 participants, respectively.

Several Chi-squared tests to verify associations between practices identification and gender, type of participant[26] and socioeconomic status were performed. Gender did not show significant results. However, associations between practice identification and membership to the FFS were found. Results showed that the following unconventional intensive practices: silage, legumes, leucaena plots and nutritional blocks were recognized more by FFS attendants than by non-FFS attendants (Table 5.6). The latter implies that the learning and experimentation approach encouraged by DEPAPRO had an effect in the human capital of participant farmers that allow them to get familiarized with such innovations. The relationship between socioeconomic status and technology identification was also explored. No differences between small and medium-size livestock farmers in technology identification were detected, except in the case of live fences which was recognized more by participants with higher socioeconomic status $X^2(1, N=88)=3.752$, $p \leq 0.05$.

Table 5.6. Relationship between type of participant and technology identification.

Technology	Pearson X^2	*p*	Fisher (*p*)	Phi	*p*
Grass silage	10.76[a]	0.001	0.001	-0.35	0.001
Legumes[c]	9.81[b]	0.002	0.005	-0.34	0.002
Leucaena plots	23.59[a]	0.000	0.000	-0.51	0.000
Nutritional blocks	37.03[b]	0.000	0.000	-0.66	0.000

Notes: [a]=Zero cells have expected count less than five, the minimum expected counts are 8.80 and 5.52 respectively. [b]=One cell (25.0%) has expected count less than five. The minimum expected count is 3.75 and 4.80 respectively. N=88; except for [c] where N=85.

Differences in success identifying technologies could be explained by the following: (a) some practices were by nature more difficult to display in pictures, such as grazing management and improved pastures. This is because such practices had several components and types that were difficult to be properly represented in four pictures. Technologies with fewer components were more easily displayed and this could have improved the chance of being identified. (b) The pictures were selected and taken by DEPAPRO's staff rather than by participants. It is likely that technical staff and participants differ in their perception of how a certain technology can be represented in a picture. (c) The quality of picture and prints could be another variable that affected the

[26] There were three main types of participants: (a) Pilot area FFS member households; (b) anchoring and expansion area FFS member households; and (c) pilot area *ad hoc* groups without FFS participation.

identification, as two of the pictures were not printed with the same colours as displayed on the computer. (d) Not all households have been testing all the technologies and therefore are not so familiar for the identification of a given innovation.

Despite the constraints mentioned above, picture identification warmed up the FGD and contributed to creation of a more relaxed atmosphere and increased the confidence between participants and facilitators. The participants realized that their interventions were important for developing the session, and that every opinion was considered valuable. Furthermore, the use of pictures for technology identification contributed to ensuring that participants were recognizing each technology. This was reinforced by encouraging participants to choose a "name" and a "last name" for each practice, which were used as identifiers during the entire session.

5.4.2.1. General preference

Participants were asked to choose their most preferred technology and to explain the reasons for selection. Results showed that leucaena was the most preferred practice as shown by 32 participants (35%) who selected it. Reasons for explaining leucaena preference are related to: (1) the natural capital such as providing feed and nutriments for cattle and improving soil quality; (2) the financial capital where farmers mentioned increasing milk production, improving milk quality and saving money; and (3) the cultural capital where farmers considered that managing leucaena was practical, and contributed to providing products used in the household such as firewood. More than a half of the farmers preferring leucaena (55%) mentioned more than one attribute supporting their selection which denotes the interest that farmers have for multipurpose tree species.

Improved pastures and grazing management were the second and third most liked technologies by 16 (17%) and 12 (13%) participants, respectively. Farmers preferring improved pastures valued elements related to: (1) the natural capital such as providing protein for cattle, producing good fodder, with a fast growing, and producing fodder during the dry season; (2) the financial capital by improving milk or beef production; and (3) the cultural capital because farmers considered improved pastures as the best feed for cattle, compatible with farmers traditional management in paddocks, and because the cattle prefers such fodder. On the other hand farmers preferring improved grazing management indicated reasons classified as: (1) cultural capital such as simplifying the management of pastures, facilitating the rotation of cattle and saving the energy of cattle; (2) financial capital because by using it cattle grows faster; and (3) natural capital because the live fences used for fencing provide environmental services such as shade or forage for cattle.

The preferences of male and female participants were similar. It was found that technologies ranked first and second did not differ by gender; whereas there were differences by gender with technologies ranked third to eighth (Figure 5.6). For example, female participants preferred water reservoirs because they prioritized water availability and quality as a means to prevent diseases and help to raise more cows; in contrast, male participants valued rotational grazing based on their perception that it helps to maintain pastures in better condition. On the other hand, participants from pilot area FFS groups selected more options as favourite technologies than the control farmers, or the ones belonging to FFS groups in the anchoring and expansion areas. This difference could be because the farmers who belong to FFS operating in the pilot area participated in learning sessions and experiments for a longer period and this may have influenced their positive perceptions about the technology innovations promoted by DEPAPRO.

Among the non-widely implemented technologies, improved water reservoirs ranked first in terms of preference, with 28 mentions (30%), followed by cut-and-carry grasses and multi-nutritional blocks with 18 (19%) and 13 (14%) mentions, respectively. Seventy six (83%) participants changed their selection, whilst just 16 (17%) participants did not modify their choice (Figure 5.7). This can be explained by the fact that the most preferred technologies such as leucaena and rotational grazing were already being tested in participants' farms. Moreover, pilot area FFS participants showed a more diversified preference than those from the anchoring and expansion FFS and pilot area controls. The latter seemed to choose more conventional options such as cut-and-carry grass and improved pastures; and they showed interest in just two non-traditional options: improved water reservoirs and nutritional blocks.

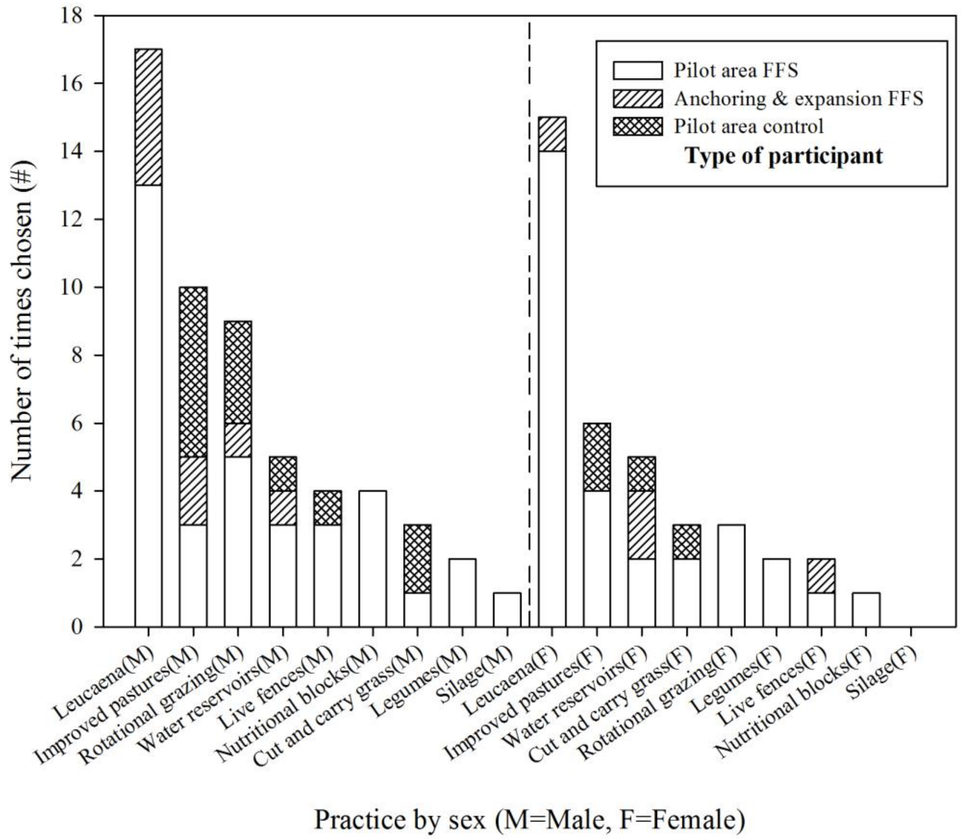


Figure 5.6. Preference of technologies as a function of gender and type of participant.

Reasons for not implementing water reservoirs as described by participants were related in most cases to: (1) the financial capital, specifically lack of money or materials needed for its construction; (2) the cultural capital because farmers recognized a lack of commitment for their building, or incompatibility with the current management of cattle; and (3) the human capital because two farmers stated that they did not know how to choose the location, or one more had not enough time for working for building it. Reasons for not using cut-and-carry grasses corresponded to: (1) the financial capital because farmers expressed that they lack monetary resources for buying the chaff cutter required for chopping the grass, or buying the seed for the establishment; (2) the cultural capital because farmers expressed their lack of interest in establishing this practice, or the perception that it requires more adaptations to the current production system such as fencing and more work; and (3) the human capital because it requires more technical orientation and labour.

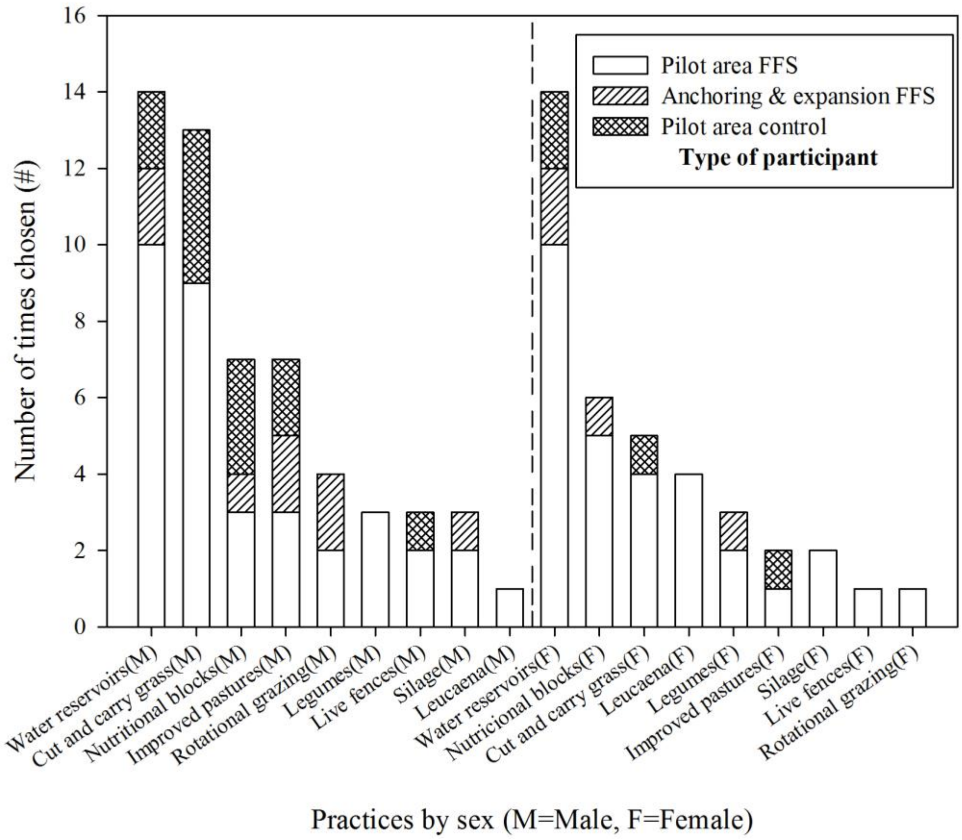


Figure 5.7. Most preferred practices but not yet implemented by sex and type of participant.

Nutritional blocks were mainly associated to: (1) the built capital and financial capitals because participants described the lack of chaff cutters, or presses for preparing the blocks and inputs such as mineral salts; (2) the human capital because three farmers expressed issues related to the lack of time or training about the practice. Even when the former reasons are valid for small scale farmers, it may not apply for some medium scale farmers who could have invested in the infrastructure needed for such practices. Preparing nutritional blocks was not considered as needed because conventional options for supplementing cattle existed such as commercial mineral salts. Elements from the vulnerability context such as higher prices of conventional concentrates would limit their access, and could eventually facilitate farmers' willingness to use nutritional blocks.

5.4.2.2. Indicators for participatory evaluation

Participants were encouraged to mention and discuss advantages and disadvantages of the nine technologies evaluated. The most frequently mentioned comments with respect to those technologies were selected as indicators for a scoring exercise. A total of 39 indicators were identified by the groups who participated in eight FGD workshops; however, some of them were grouped together that resulted to 16 indicators, 11 of those were considered positive or advantageous, and the remaining five were considered as negative or disadvantageous (Table 5.7). Similar indicators were identified in another study carried out in Petén using participatory methods to evaluate improved pastures (Cruz *et al.* 2007). Local indicators should be considered for further efforts in evaluating and adapting the appropriateness of sustainable livestock production technologies in Petén. After all their use has been reported as an opportunity to empower farmers and facilitate learning and developmental effects (Jiggins 2002, Fraser *et al.* 2006).

Table 5.7. Indicators used for the scoring activity.

Indicator (#)	Positive	Indicator (#)	Negative
1	Good for fattening cattle	1	Is costly
2	Enriches the soil	2	Needs many materials
3	Increases milk yield	3	Demands more labour
4	Functions well in the dry season	4	Pests susceptible
5	Nutritious	5	Poor growth
6	Drought resistant		
7	Edible by cattle		
8	Is needed		
9	Helps to get more income		
10	Maintains cattle in good condition		
11	Use as an input for other practices		

Participants from the FFS groups assigned a total of 5120 points to positive indicators and 2820 points to negative indicators. Concerning positive indicators leucaena was the technology with the highest score with 1453 points, followed by improved pastures and cut-and-carry grasses with 970 and 840 points correspondingly. Practices with lower scores related to positive indicators were grazing management with 119 points and silage making with 128 points. Regarding negative indicators the highest score was obtained by leucaena with 499 points, followed by improved pastures and legumes with

470 and 469 points respectively. The lowest scores for negative indicators were obtained by silage making with 93 points, followed by live fences with 197 points (Figure 5.8). The scoring exercise evidenced that all technologies evaluated have both positive and negative aspects (i.e. leucaena). The perception of participants, based on their own experience influenced the decision to test or not test a given option. Furthermore, even though leucaena is one of the most preferred and tested practices, participants identified negative characteristics: slow initial growth, high demand for labour, damages by pests, and high costs for establishment. The latter could be limiting factors for a wider adoption of leucaena fodder banks by livestock farmers in Central and Southern Petén. It must be pointed out that such aspects were emphasized more by participants from the pilot area FFS groups, which had more experience with leucaena management than those from the anchoring and expansion area.

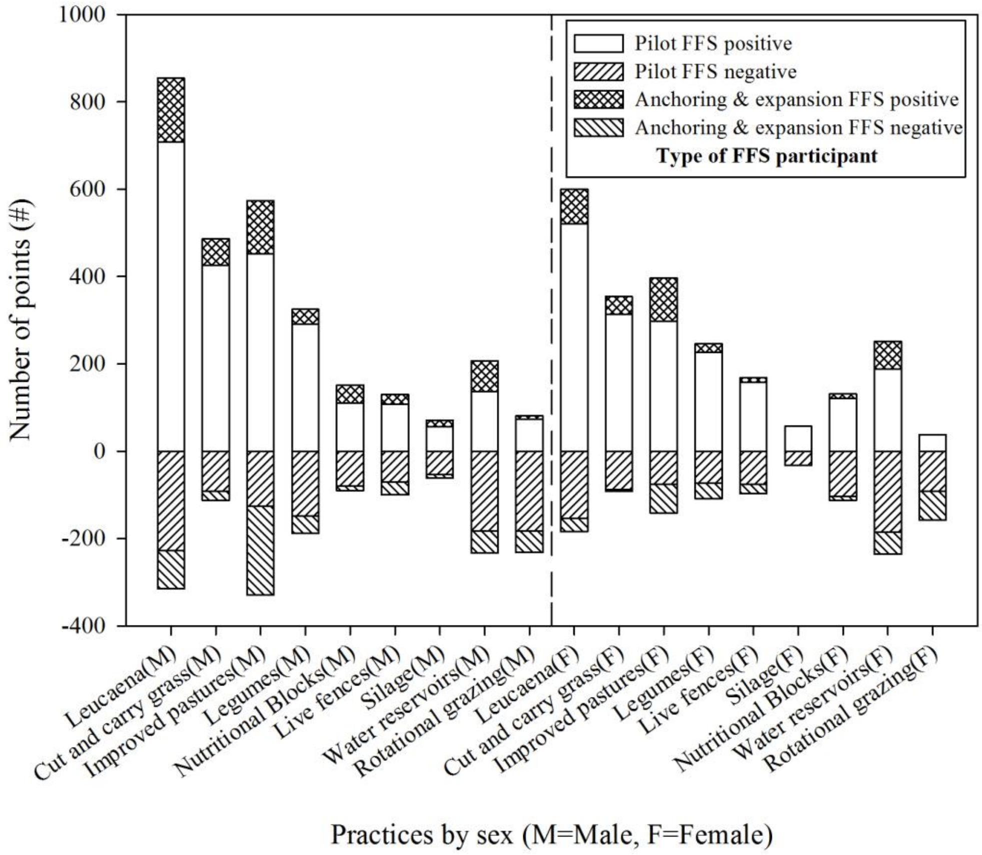


Figure 5.8. Scoring of DEPAPRO technologies as a function of FFS participants' type and gender.

5.4.2.3. Verification of participants' technology preference

The preference for selected technologies was verified trough a pair-wise matrix ranking exercise, in which participants were asked to choose the option they preferred the most from each of the 36 possible comparisons, on a pair by pair basis. Improved pastures with 584 (17%) and live fences 576 (17%) were the most preferred options in the pair-wise activity; whilst the less preferred options corresponded to nutritional blocks 244 (7%), silage 222 (7%) and legumes 117 (3%). Chi-square tests for independence suggested that attendance at FFS influenced the preference of technologies. This is because a higher number of FFS pilot area participants preferred leucaena when it was compared to improved water reservoirs $X^2(2, n=95)=12.10$, $p<0.01$, and rotational grazing $X^2(2, n=95)=14.51$, $p<0.01$.

Gender affected technology preference in two comparisons: (1) cut-and-carry grass *versus* leucaena, where male participants choose cut-and-carry grass more frequently, whereas females preferred leucaena $X^2(1, n=94)=6.93$, $p<0.01$. This could have been influenced by women's participation in the FFS learning sessions, where they learned that leucaena management included cultural practices similar to the ones applied in basic crops. (2) Nutritional blocks *versus* rotational grazing, male participants showed more preference for the latter, whereas female participants favoured nutritional blocks $X^2(1, n=95)=4.00$, $p<0.05$. Female participants prioritized feed supplementation because they felt familiar with the preparation of nutritional blocks, as those could be done on patios where female participants had more chance to participate. A previous study about the women role in urban gardens from the Highland of Guatemala found that Kaqchikel women performed agricultural activities in the proximity of the house because those could be combined with domestic activities (Keys 1999).

In terms of socioeconomic status, three significant comparisons were significant: (1) when leucaena and herbaceous legumes preference was compared, medium scale participants were more often in favour of the latter than small scale farmers $X^2(1, n=95)=7.84$, $p<0.01$. This could be due to the fact that herbaceous legumes performed better in experiments established in medium scale farms, where better conditions for their growth were found such as soil moisture. (2) Medium scale farmers showed a higher preference for improved water reservoirs compared to silages $X^2(1, n=95)=8.36$, $p<0.01$; and (3) medium scale farmers also showed more preference for improved water reservoirs than for improved pastures $X^2(1, n=95)=4.33$, $p<0.05$. Improved water reservoirs were attractive for medium scale farmers because they can afford the investment required for building those. Moreover, medium scale farmers preferred water reservoirs because they prioritized water rather than fodder availability as a main constraint, as they have larger areas with sown pastures and financial resources for buying supplements during the dry season, than small scale livestock farmers.

In general, the results obtained in the pair-wise exercise reflected more the current practice in Petén livestock landscapes with respect to the technologies evaluated. Some differences between the pair-wise ranking and previous preference exercises were observed. Live fences changed from lower preference in the previous ranking exercises to the second place in the pair-wise comparison (Table 5.8). The latter could be a result of the discussions about the positive and negative attributes of each option. Moreover, live fences are among the most implemented silvopastoral technologies in Petén, even prior to DEPAPRO's intervention. Therefore, farmers could have been less likely to express their preference for live fences, because it was considered a common element in the landscape.

Table 5.8. Livestock farmers practices preference by ranking method (n=101).

Most liked			**Most liked not implemented**			**Pair-wise matrix**		
#	***Name***	***Preference (%)***	***#***	***Name***	***Preference (%)***	***#***	***Name***	***Preference (%)***
1	Leucaena	34.8	1	Water reservoirs	30.1	1	Improved pastures	17.1
2	Improved pastures	17.4	2	Cut-and-carry grass	19.4	2	Live fences	16.9
3	Rotational grazing	13.0	3	Nutritional blocks	14.0	3	Leucaena	14.2
4	Water reservoirs	10.9	4	Improved pastures	9.7	4	Rotational grazing	13.3
5	Cut-and-carry grass	6.5	5	Legumes	6.5	5	Water reservoirs	12.5
6	Nutritional blocks	5.4	6	Rotational grazing	5.4	6	Cut-and-carry grass	8.9
7	Live fences	5.4	7	Silage	5.4	7	Nutritional blocks	7.2
8	Legumes	4.3	8	Leucaena	5.4	8	Silage	6.5
9	Silage	2.2	9	Live fences	4.3	9	Legumes	3.4
	Total	***100.0***		***Total***	***100.0***		***Total***	***100.0***

5.4.2.4. Identification of limiting factors for leucaena and improved pastures

In general male and female participants managed to sort the set of pictures representing the procedures for establishing leucaena plots and improved pastures. However, it was evident that female participants from the anchoring and expansion FFS groups had more difficulties doing it most probably because they were less familiar with both procedures, compared to FFS participants from the pilot area. In the Ejido and Santa Rosita FFS groups, female participants showed better knowledge and confidence because they participated in FFS on crop and poultry production, which created self-esteem and facilitated their participation in FFS livestock sessions. Moreover, the Ejido group was formed mainly by smallholder farmers where the role of women in agriculture is more prominent particularly in maximizing the use of household labour. In fact, there was a higher presence of women in the livestock FFS sessions held with the Ejido group than in the rest of learning groups.

More limitations were discussed by farmers for the establishment of leucaena compared to improved pastures. Lack of financial capital was identified as the main constraint for establishing improved pastures, especially for small-scale farmers. This is why some farmer recurred to alternatives such as the "*colono*" system to reduce the costs of land preparation such as forest or guamil clearing (Partridge 1989). The problems identified by participants for leucaena were related to the natural capital such as slow growth and pest attacks (i.e. ants) in early stages of establishment, and the high costs of establishment. Turcios (2008) described similar results, although he also found additional limiting factors related to the natural and financial capitals such as seed scarcity, high labour demand, and limited availability of funds to invest in the establishment. An alternative observed in Petén to reduce establishment costs of leucaena was the association with maize (Turcios 2008).

Literature review and field observations helped to identify additional factors related to the human, cultural and natural capitals that limited leucaena performance in Petén. In the case of the savannas, soil compaction and acidity, low fertility and lack of soil moisture (early stages) affect leucaena growth (SEGEPLAN and UNEPET 1992). Under those conditions it would be better to try other fodder species instead of leucaena. Moreover, phosphorus and sulphur deficiency and inadequate weed management also negatively affected initial growth in leucaena (Pérez-Guerrero 1985). As chemical fertilization is not a common practice in pastures, particularly in Petén, any technology depending on this practice would be less viable. The factors mentioned above, plus inadequate browsing management, contributed to the degradation of some of the leucaena fodder banks. This was not the case for those areas planted with leucaena to produce poles and firewood, because those were seldom defoliated by cattle.

Even though two pictures for each technology were included that represented discussions and work carried out by FFS members, participants hesitated to include those as part of the establishment procedures. This suggests that social capital was not prioritized as a necessary element for testing both technologies. Conversely, the existence of farmer groups has been pointed out as a key factor that allowed the use of fodder shrub species in East Africa, because these helped to distribute the planting materials and to spread information about such practices (Wambugu *et al.* 2011). Only one FFS group pointed out that without organization none of the practices evaluated could have been tested. It must be considered that the area was under civil war until the mid-1990s, and the violence had a negative effect in the human, social, and cultural capitals (See Chapter Six, John 2011). Development and conservation projects conducted in Petén should consider special activities to strengthen social capital and organization as part of an holistic approach that could grant sustainability after the end of a given initiative, and as an strategy for facing material assets limitations.

5.4.3. Characteristics influencing decisions to test leucaena

The practice of dual-purpose systems (FaDual), the presence of forest areas on the farm (FaForest), and the number of practical FFS sessions attended (NumPra[27]) were three highly significant predictors in the three logistic regression methods explored (Table 5.9); whereas the percentage of attendance at FFS sessions (Attend) was significant only in the normal and exact models, at α=0.10. The Firth penalized model differed more in p-values than the other two which yielded similar results. The Firth penalized model indicated that Attend was not significant, however, exact logistic regression provides better p-values estimations for small samples (Cytel Inc. 2010a), thus the four variables are considered to be significant. Since exact p-values are calculated separately for the

[27] Included just practical sessions where on-farm experiments were established by the collective work of FFS farmers.

four predictors, they were validated as set in LogXact 9 using predictor by predictor inferences.

Predictor effects were homogenous among the three models, indicating a negative relationship between testing leucaena and FaDual; and positive relationships with respect to the other three predictors. Lower coefficient values were obtained with the penalized and exact models than with the conventional one, although NumPra in the exact model obtained the highest estimate for such variable from the three models. Exact logistic regression estimates for FaDual and FaForest corresponded to median unbiased points, which have showed deficiencies in predictive probability and classification tables (Cytel Inc. 2010a). Therefore, Firth penalized model estimates were used in the assessment of goodness-of-fit and in further interpretation of the estimates through odds ratios.

Table 5.9. Estimators from the logistic regression model for leucaena plot testing.

Predictor	Estimator by model type								
	B			***SE β***			***p-value***		
	Normal	*Firth*	*Exact*	*Normal*	*Firth*	*Exact*	*Normal*	*Firth*	*Exact*
Intercept	-5.83	-4.65	NA	2.54	2.07	2.54	0.0218	0.0248	0.0217
FaDual	-3.92	-3.11	-2.40§	1.42	1.20	NA	0.0059	0.0094	0.0059
FaForest	3.72	3.05	2.49§	1.20	1.01	NA	0.0020	0.0025	0.0024
NumPra	0.85	0.68	1.00§§	0.29	0.24	0.54	0.0037	0.0043	0.0006
Attend	0.05	0.04	0.04§§	0.03	0.02	0.03	0.0824	0.1035	0.0728

Notes: N=66. §=Median unbiased point estimates. §§=Observed values of sufficient statistics. NA=Not available. Pseudo R^2s calculated for normal model. D^2=0.503. Cox and Snell R^2=0.393. Nagelkerke R^2=0.625. AUC=0.940. Dxy=0.881. Gamma=0.884. Tau-a=0.283. Brier=0.08.

No evidence of lack of fit was suggested by the p-values obtained for the likelihood ratio $X^2(4, n=66)=28.12$, $p<0.0001$; deviance $D_g(59, n=64)=33.15$, p=0.96 and two Hosmer and Lemenshow tests with ten $\hat{C}^1(8, g=10, n=66)=2.31$, and six groups p=0.96 and $\hat{C}^2(4, g=6, n=66)=1.52$, p=0.82. However, X^2 and D_g had low power because they usually do not follow a X^2 distribution when the number of groups in the covariance matrix (g=64) approximates to the total number of cases (n=66) (Hosmer and Lemeshow 2000). Moreover, results from $\hat{C}^1$ and $\hat{C}^2$ were not considered valid because expected frequencies of five or higher were not observed in each of the percentile groups created, especially in those that corresponded to non-testers of leucaena (Hosmer and Lemeshow 2000).

Diagnostics measures complemented the inspection of the goodness-of-fit and five atypical patterns were identified with scatter plots (Figure 5.9). Two corresponded to farmers predicted as non-testers when they were observed to establish leucaena plots (upper left to lower right); conversely three patterns were predicted as testers when they did not established leucaena (lower left to upper right). None of the atypical groups presented a change in estimated coefficients ($\Delta\beta$) value higher than one, which has been pointed out as indicative of major effects in the value of coefficient estimates (Hosmer and Lemeshow 2000). The reduced number of atypical groups and the scale of its values indicated that the data sustains fit.

Practicing the dual-purpose system (FaDual=1) was the only predictor negatively related to leucaena testing, odds decreased 96% conserving a fixed value in the other predictors (Table 5.10). Farmers practicing beef and cow-calf mixed systems (FaDual=0) were 25 times more likely to test leucaena than dual-purpose farmers. This is because dual-purpose farmers allocated efforts in those practices that contributed to improve milk quality and facilitated them to deliver milk to the Petenlac collection centre. On the other hand, the odds of establishing leucaena by farmers with forest (FaForest=1) were 20 times higher than those without it (FaForest=0). Two explanations for the latter are feasible: (i) farmers with forest are convinced of the practical and environmental benefits of preserving trees, and leucaena as a woody species was favoured. (ii) Farmers used forest land as reservoirs for farming expansion, thus farmers with forest were able to allocate *guamil* or pasture land for leucaena establishment, replacing it with available forest land.

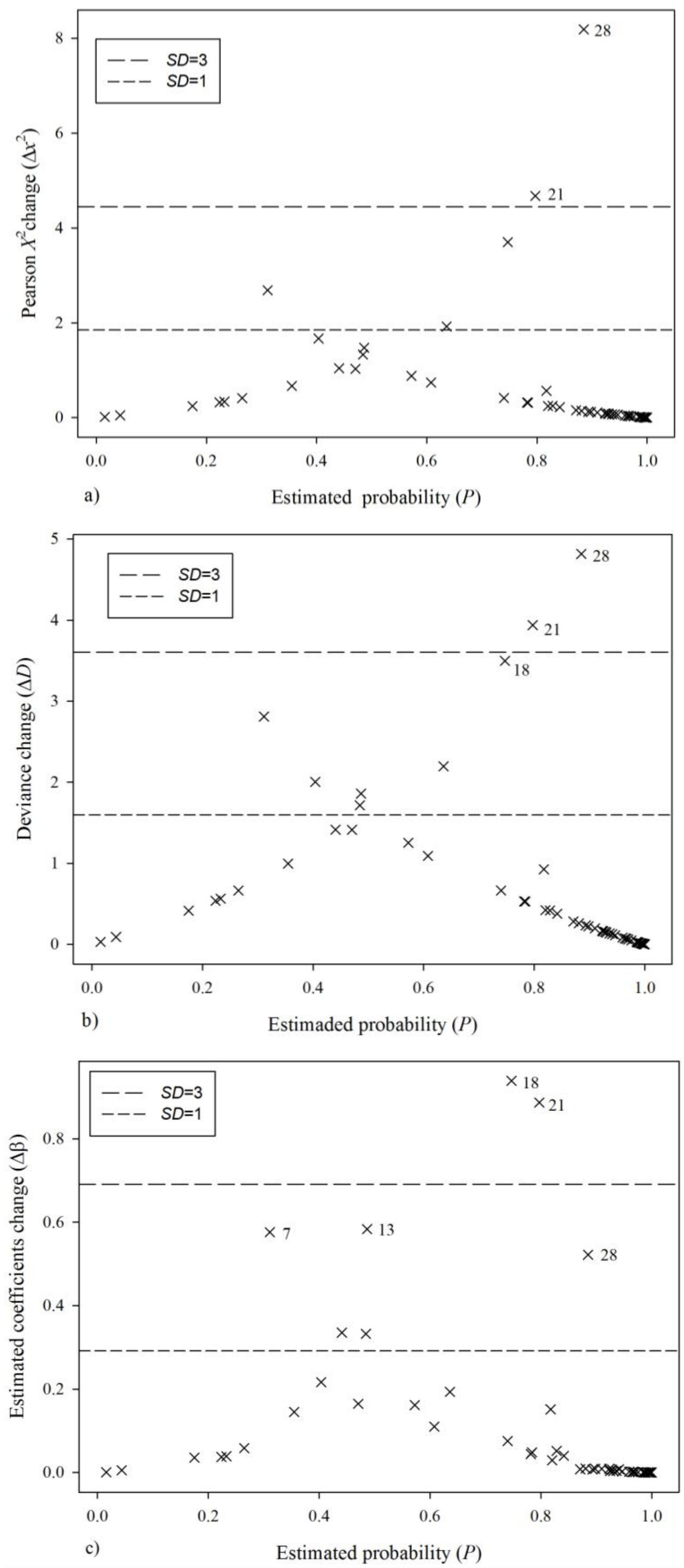


Figure 5.9. Changes in: (a) Pearson residuals, (b) deviance, and (c) values of estimated coefficients *versus* leucaena establishment estimated probabilities.

The number of practical sessions attended (NumPra) was positively related to leucaena testing, with a 97% of increase in the odds of testing leucaena by each unit of increase in the number of sessions attended. Two main explanations for such trends were found: (i) most of the farmers from the pilot area which attended more frequently to the FFS sessions, the practical sessions strengthened their human capital, increasing the farmers' capacities and interest for testing leucaena. (ii) Funds provided by DEPAPRO for establishing experiments incentivized leucaena testing by making the costs of leucaena establishment affordable. The percentage of attendance at FFS learning sessions (Attend) produced a relatively lower effect in the odds of testing leucaena, because it were increased only by 4% per each unit added to the percentage of FFS attendance. Farmers' participation in FFS strengthened human capital, influencing their willingness to test more intensive alternatives for improving livestock production, such as the improvement of the dry season cattle diet.

Table 5.10. Odds ratios from the logistic regression model for leucaena testing.

Predictor	**Odds ratio**			**Confidence interval (95%)**					
				Lower			***Upper***		
	Normal	*Firth*	*Exact*	*Normal*	*Firth*	*Exact*	*Normal*	*Firth*	*Exact*
Intercept	0.00	0.01	NA	0.00	0.00	NA	0.43	0.55	NA
FaDual	0.02	0.04	0.09	0.00	0.00	0.00	0.32	0.47	0.60
FaForest	41.23	21.10	12.03	3.91	2.94	2.14	434.90	151.70	+∞
NumPra	2.34	1.97	2.71	1.32	1.24	1.27	4.14	3.13	15.70
Attend	1.05	1.04	1.04	0.99	0.99	1.00	1.11	1.09	1.11

Note: N=66. NA=Not available.

The importance of human capital has been amply documented in adoption studies. For example, improvements in human and social capital by farmer-led practical training were reported as associated to the adoption of agroforestry (i.e. hedgerows) and conservation practices in Philippines (Cramb and Culasero 2003). Similarly, one study on factors associated to conservation practices in Zambia identified human capital as essential for building management capacities that were needed for implementing such practices (Chomba 2004). Human capital was found to be associated with the adoption and adaptation of alley farming in Nigeria, suggesting that the strengthening of human capital is necessary for the sustainable practice of knowledge of intensive agroforestry practices such as fodder banks (Adesina and Chianu 2002).

On the other hand, the need of financial resources for investing in establishment and development stage costs has been identified as a main factor limiting agroforestry practice (Holmann *et al.* 1992, Jansen *et al.* 1997, Murgueitio *et al.* 2006, Pagiola *et al.* 2007). In Costa Rica high establishment costs for fodder banks were associated with larger requirements of labour, especially for cut-and-carry systems (Sánchez *et al.* 2010). Even though farmers received payments for environmental services and technical assistance, only 3.9 ha of fodder banks were established whereas in Nicaragua farmers receiving similar incentives but with lower hired labour prices planted 155.2 ha (Casasola *et al.* 2007).

Effects of the four predictors on the probability of testing leucaena were investigated with a sensitivity analysis (Figure 5.10). Continuous predictors were fixed to mean values, except for NumPra in the analysis of FFS attendance which was set at the value of the percentile 25; and dichotomous predictors to true values. NumPra suggests that farmers' participation in at least seven FFS practical sessions is needed for favouring the probability of testing leucaena plots beyond 90%, if the farmers have a mean attendance, practice the dual-purpose system and have forest (a). Moreover, FFS attendance of 75% might be required for increasing the probability of testing leucaena to more than 80% for farmers attending five practical sessions, with dual-purpose system and forest in their farms (b). Practicing the dual-purpose system may not represent a substantial decrease in the probabilities of testing leucaena (only 6%) if farmers have forest, attend seven practical sessions and have an FFS mean attendance of 61% (c). Finally, if the dual-purpose system is practiced, and farmers have mean fixed values for NumPra and Attend the probability of testing leucaena is increased from 40 to 93% by having forest (d).

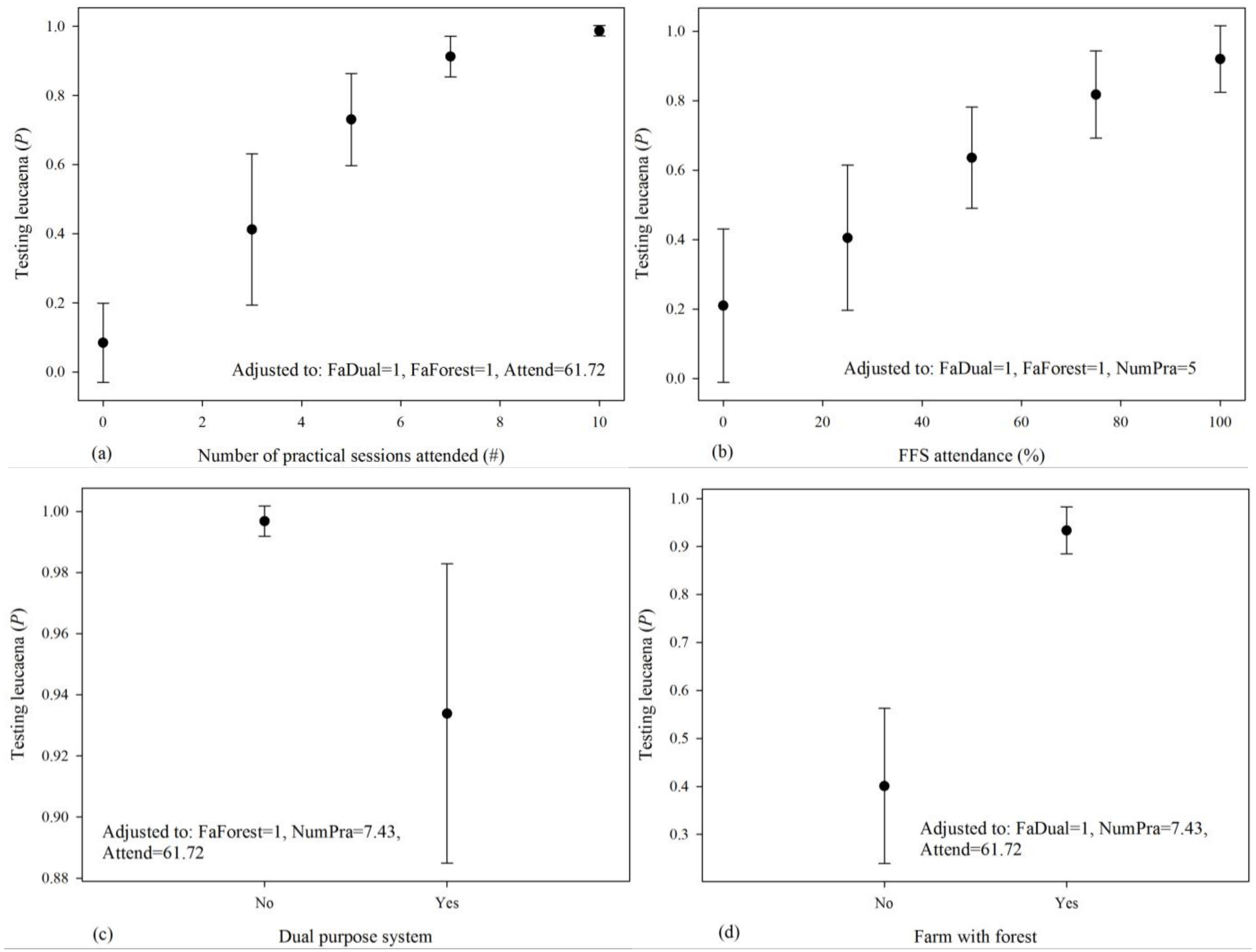


Figure 5.10. Number of practical sessions (a), FFS attendance (b), practicing dual-purpose system (c) and forest land use (d) effects on the probability of testing leucaena.

5.5. Discussion and conclusions

5.5.1. Methodology remarks and constraints

In general the three phases worked well, however, some common limitations were observed in phase two, during FGD sessions. These included constraints that were exclusive to certain types of participants. For example, the methodology required the observation of pictures as a proxy for each of the nine technologies evaluated, and it was evident that some farmers had visual problems which limited their initial participation in such technology identification activity. Furthermore, FGD sessions averaged almost 2.45 hours. Thus, some signs of tiredness eventually occurred particularly towards the end of the session. In this respect is necessary to mention that this varied with the dynamism of the groups, because some were faster than others in performing FGD activities and showed less fatigue symptoms. It was also evident that during activities like scoring or picture sorting, which implied more physical and mental activity, participants showed more interest. Conversely, activities with less physical activity such as the discussions about positive and negative aspects of the technologies, there was less participation from some FGD attendants.

On the positive aspects of the FGD, for some participants who were not familiar with some technologies, those sessions were opportunities to learn from other participants' experiences. This process is called reversal learning, and has been pointed out as an additional benefit of participatory processes (Chambers 2002). Farmers discovered and became interested in different arrangements and variations in practices performed by other farmers. For example, the establishment of leucaena intercropped with maize was an innovation practiced by some farmers in the pilot area that surprised farmers from the anchoring and expansion area (Figure 5.11). FGD sessions also provided a space that encouraged women's participation, therefore it was common to observe constructive discussions between wives and husbands in those groups were female participation occurred.

a)

b)

Figure 5.11. Leucaena plots intercropped with: (a) maize; (b) maize, beans and squash in farms from La Amistad, Dolores, Guatemala.

5.5.2. Evaluation of practices for recuperating degraded pasture lands

Livestock production systems in Central and Southern Petén, Guatemala are shifting from extensive to more intensive practices. Farmers' perceptions about benefits and constraints for using intensive practices have immediate influence in their preference. DEPAPRO managed to increase the interest and knowledge about conventional and intensive silvopastoral practices for rehabilitating degraded lands. This was facilitated by the organization of FFS groups and participatory on-farm experimentation. Both provided farmers and their families the opportunity of a close interaction with practices that revealed positive and negative aspects related to the human, natural, financial and built capitals. Studies in France and Ethiopia reported that a balance between farmers' objectives and local constraints related to the mentioned assets influenced silvopastoral practice (Etienne and Rapey 1998, Mekoya *et al.* 2008).

The background and current context under which livestock production is practiced also influenced practice preference (Ajayi *et al.* 2007). DEPAPRO encouraged experimentation with intensive practices such as silage making, improved water reservoirs, cut-and-carry grasses and nutritional blocks that require higher levels of financial assets, labour and technical knowledge which most of the farmers in Petén did not have. Those practices created interest among FFS participants, however, their application in Petén would be favoured by higher prices for livestock products, increases in labour availability or reduction in their cost, or by increases in the prices of conventional feed supplements, such as the commercial concentrates.

In the meantime farmers will continue prioritizing the use of conventional practices according to attributes they consider desirable. Participants suggested that such attributes were related to the natural capital such as practices that replenish soil fertility, prevent cattle weight losses during the dry season, and provide palatable feeds for cattle. Moreover, desirable attributes were also related to the financial capital such as those which increase beef or milk yield and/or profit. Technologies should also help to overcome biophysical limitations that characterize Petén's natural capital, such as those targeting the drought that reduces fodder availability in the dry season. Conversely, farmers will be cautious about using practices that require more financial and built capitals, those which require more specialized labour, and are affected by local biophysical features such as fodder options prone to be damaged by pests or with reduced growth. At the end, they are trying to develop livelihood strategies that reduce the risk and increase food security for the household.

5.5.3. Leucaena fodder banks use in livestock productions systems of Petén

According to Bravo-Ureta (2006) the factors influencing adoption can be classified into characteristics about: (a) farmers background such as age, gender, schooling and farming experience; (b) farms such as land tenancy, land use, farm size; (c) project characteristics such as agricultural extension methods and incentives provided. In Petén, factors categorized as farmers and farm characteristics such as education, farm area, experience in agriculture or livestock production were not found statistically related to leucaena testing. Instead, the logistic regression model identified two factors related to the project that influenced positively in leucaena testing: the number of practical sessions attended (NumPra); and the percentage of FFS sessions attendance (Attend). Thus, results suggest that in early stages after agroforestry promotion, the learning approach followed by a given programme may determine much of the interest on silvopastoral practices such as leucaena fodder banks.

Moreover, factors identified by farmers during field visits, semi-structured interviews and FGD sessions confirmed that the process of leucaena testing in Petén was highly influenced by DEPAPRO. Inputs provided for experimentation, rapport generated between farmers and DEPAPRO staff, farmers' positive perceptions about on-farm trials, were additional factors that contributed to increase the interest on establishing leucaena in Petén. However, some of the latter factors have been criticized as they could promote the acceptance of leucaena for non-sustainable reasons. In Kenya for example some farmers established improved fallows for selling seeds and gaining social prestige, abandoning the technology when the project stopped buying seeds (Kiptot *et al.* 2007). Hence, a similar behaviour may occur in Petén now that DEPAPRO has ended and the testing of leucaena is not being monitored and supported anymore.

Early observations from leucaena performance in pioneering on-farm trials were positive. Leucaena plots seemed to fulfil the positive attributes described in the literature as a multipurpose tree that would provide fodder, help to replenish soil fertility, and would be used for extraction of firewood and poles. However, when more farmers decided to experiment with leucaena and for longer periods, limitations associated to its use were observed by farmers. Hence, the use of leucaena in Petén in a wider scale would be compromised, if DEPAPRO efforts are not supported with further participatory strategies for adapting leucaena and other intensive practices to the assets, local context and objectives of farmers (Nahed-Toral *et al.* 2010). DEPAPRO used a zig-zag approach for refining FFS learning sessions, a similar process can be followed for participatory technology development (Chapter 4, Minjauw *et al.* 2002).

Chapter 6. Participatory learning and on-farm experimentation effects on the human assets of livestock farmers from Petén, Guatemala

6.1. Abstract

The implementation of environmentally sound cattle production systems is needed not only for environmental reasons. Price increases in commercial inputs and reduced profits are driving the search for alternatives to conventional cattle production management. However, most of the alternatives such as the use of silvopastoral options systems require the understanding of complex concepts and the development of experimentation skills for informed adaptive management. The purpose of this study was to evaluate the impact of Farmer Field Schools (FFS) on the human assets of cattle farmers by using the Sustainable Livelihoods Approach (SLA) in Central Petén, Guatemala. Elements from the vulnerability context and changes in the farmers' assets induced by the FFS were identified using mixed methods that included semi-structured interviews, focus groups with Participatory Learning and Action exercises, systematic observation and literature reviews. A comparative study was accomplished by comparing the assets of livestock farmers for the years 2003 and 2008, which corresponded to the lifespan of the programme that facilitated the FFS. The results showed that the FFS impacts are influenced by the vulnerability context, especially by effects caused by the civil war. The FFS produced important changes related to the human and cultural assets that were in turn expressed in changes in the natural or built/physical assets, however, impacts upon the social and political assets were limited.

6.2. Introduction

The cattle industry in Central America is facing great challenges. On one hand, increases in human population and improvements in income will increase the internal demand for cattle and milk by products (Steinfeld 2002, Thornton 2010). On the other hand, the degradation of the natural capital and its negative impacts on the environment urges the need for sustainably sound farming practices (Steinfield *et al.* 2006). Silvopastoral systems and the use of forage feed sources have been identified as ecologically friendly alternative options (Pezo *et al.* 1999, Pezo and Ibrahim 2002, Murgueitio *et al.* 2011, Phillips *et al.* 2011). However, some of those alternatives are knowledge intensive and their use on a larger scale in Latin America is limited by the lack of adequate strategies for strengthening farmers' skills and knowledge (Murgueitio *et al.* 2006, López *et al.* 2007a, Murgueitio *et al.* 2011).

The farmer field school (FFS) is a participatory approach that emerged in Indonesia in 1989 (Pontius *et al.* 2002). As FFS encourages learning groups participants to observe, experiment and analyse, is considered an approach that facilitates the development of complex skills and knowledge that allows a better understanding of agroecosystems. The most remarkable example of FFS implementation was the work for facilitating Integrated Pest Management in rice in Asia (Fliert 1993, Rölling and Fliert 1994, Ooi 1996). Following this experience many scholars devoted efforts on describing the FFS approach and evaluating its impact. However, in congruence with outcomes that the assessment methods paradigm considered to be valid in impact assessment, FFS impact studies gave more emphasis to immediate material assets, especially the financial and natural capitals (Berg 2004, Berg and Jiggins 2007). Moreover, some researchers (Quinzon *et al.* 2001, Feder *et al.* 2004) have criticized the FFS approach because of its high costs or its lack of impact on material assets. These suggested the need for further research to identify in which contexts FFS provide the best results.

Jiggins (2002) described an impact evaluation case study that used participatory pentagram diagrams based on the Sustainable Livelihood Approach (SLA) for self-evaluating an IPM FFS in Uganda. This study highlighted the relevance of self-evaluations for encouraging developmental effects, because such an approach strengthened the human capital of participants and empowered them to carry out further participatory evaluations. The latter allowed the identification of impacts in the social and political capital of farmers expressed in their capacity for self-funding the FFS through commercial plots, and the use of FFS groups as saving and credit organizations. In another study, Rola *et al*. (2002) used surveys for analyzing the impact of IPM FFS in the Philippines, and found that FFS farmers had higher technical knowledge on sustainable agriculture practices than non-participants. However, farmer-to-farmer diffusion was not evident and immediate and developmental impacts in other assets were not reported in such study.

One of the pioneering studies that included the use of the SLA was carried out in Sri Lanka with rice IPM FFS (Berg *et al.* 2002). By combining quantitative and qualitative approaches the authors identified FFS effects on material or tangible assets such as reduction of costs, higher productivity and income (financial capital), improved housing infrastructure (built/physical capital), less use of pesticides and the incorporation of organic matter from crop residues (human and natural capitals). Moreover, they also reported impacts on non-tangible human assets such as increased collaboration among farmers in agricultural practices or more access to loans and technical services (social and political capitals, Berg *et al.* 2002). Another impact study focused their analysis on the human and social capitals for assessing the impact of sweet potato FFS in Indonesia (Johnson *et al.* 2003). In this case the authors cited as impacts related to the human and social capitals higher experimentation skills and the continuity of FFS groups after the project finished.

A review of 25 FFS evaluations reported changes related to the FFS and described recommendations for FFS evaluations (Berg 2004). Most of the evaluations targeted immediate impacts and consequently a higher number of effects related to material assets were observed. Although the report also described developmental impacts associated with the social and political assets, these were identified just in nine of the 25 FFS projects analyzed (Berg 2004). In contrast to the positive impacts cited in the latter studies, an econometric evaluation on IPM FFS in Indonesia found no significant impacts in the financial and natural capitals factors such as rice yield and pesticides use (Feder *et al.* 2004). The authors argued that results from FFS evaluations reporting significant effects overestimated the FFS impact because of biases in the selection of FFS participants; and higher assets availability before farmers' participation in the FFS.

As most of the impact studies targeted the effects on material assets there is a need for investigating non-tangible FFS effects such as the role of culture and power on farmers' livelihoods. Consequently, the aim of the present study was to investigate the FFS impacts on the human assets of households from Central Petén (Guatemala) who participated of the Multi-stakeholder Participatory Development of Sustainable Land Use Alternatives for Degraded Pasture Lands in Central America project (DEPAPRO). This study is one of the few efforts analyzing the impact of livestock FFS in Central America using an integrated approach. Even though it emphasized the identification of changes in the non-tangible assets, effects on material assets related to the latter were also explored. Moreover, a comprehensive study of the vulnerability context related to cattle production is also addressed. Further information on other elements from the SLA used in the analysis such as the Policies, Institutions and Processes are described in Chapter Four and Five.

The impact evaluation is based on the combination of two holistic approaches which facilitated the use of qualitative and quantitative methods: (1) SLA; and (2) the Community Capitals Framework (CCF). It has been argued that the combined use of these two helps to identify important factors in decision making, unintended effects, and incompatibility between rural development projects and beneficiaries objectives (Adato and Meinzen-Dick 2002, Adato *et al.* 2007, Alene *et al.* 2007, Ali *et al.* 2007). SLA and CCF are complementary because they are focused on people and based on local resources not in blanket recommendations (Gutiérrez-Montes *et al.* 2009a). Both approaches consider that livelihood strategies are based on several types of local resources or assets (Figure 6.1). The strength of using both is that they consider the contribution of culture, power, technologies and external factors influencing the decision making of people for establishing their livelihoods strategies (Meinzen-Dick *et al.* 2004, Adato *et al.* 2007, Gutiérrez-Montes *et al.* 2009a).

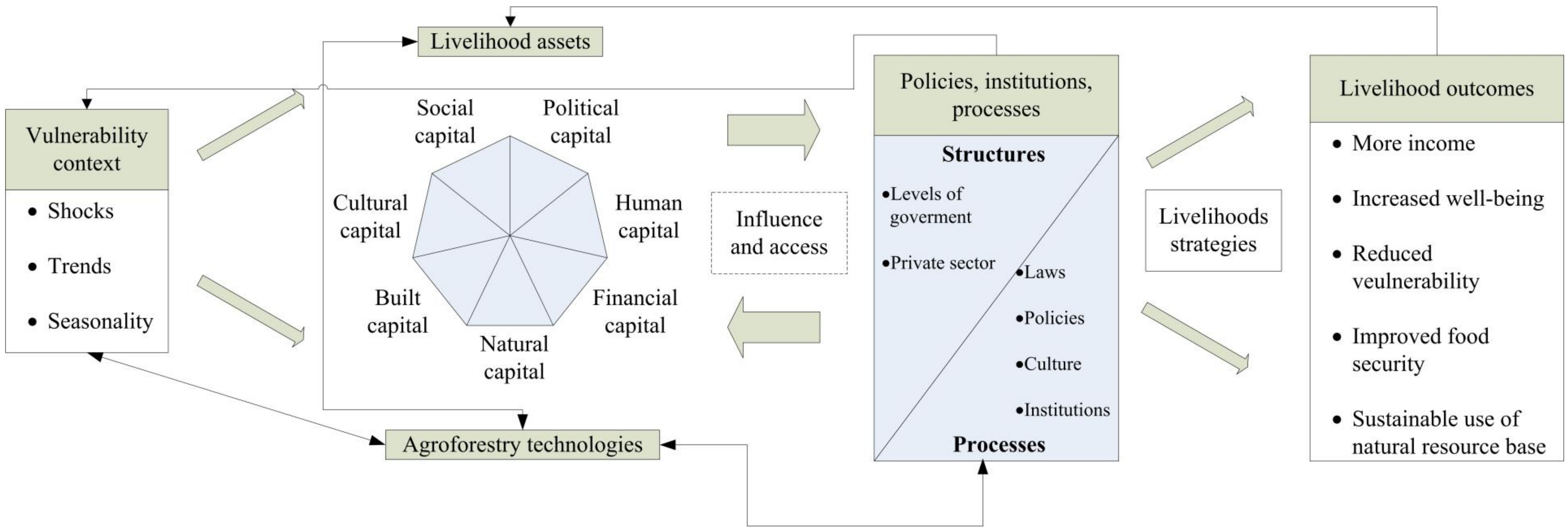


Figure 6.1. Structure of the combination of the Sustainable Livelihoods Approach and the Community Capitals Framework used for the analysis of the effects of FFS (Adapted from: Flora *et al.* 2004, Adato *et al.* 2007).

6.3. Materials and Methods

6.3.1. Study Area

The research was carried out with the participation of livestock households from 10 villages located in the municipalities of Dolores and Santa Ana in Central Petén, Guatemala (Figure 6.2, Table 6.1). The downtown of both municipalities are located to 21 and 78 km South from Flores, respectively (Gramajo 2007, Herrera 2008). Dolores is larger (3,050 km^2) than Santa Ana (1,082 km^2) (SEGEPLAN 1999). The mean temperature ranges between 23 to 33°C in Dolores; and from 22 to 29°C in Santa Ana (Herrera 2008, Luna and Romero w.d.). The rainy season or *invierno* runs from May to January for Santa Ana; while for Dolores goes from June to January. The average annual rainfall for both are 2,006 mm and 1,802 mm, respectively (Gramajo 2007, Reyes 2007).

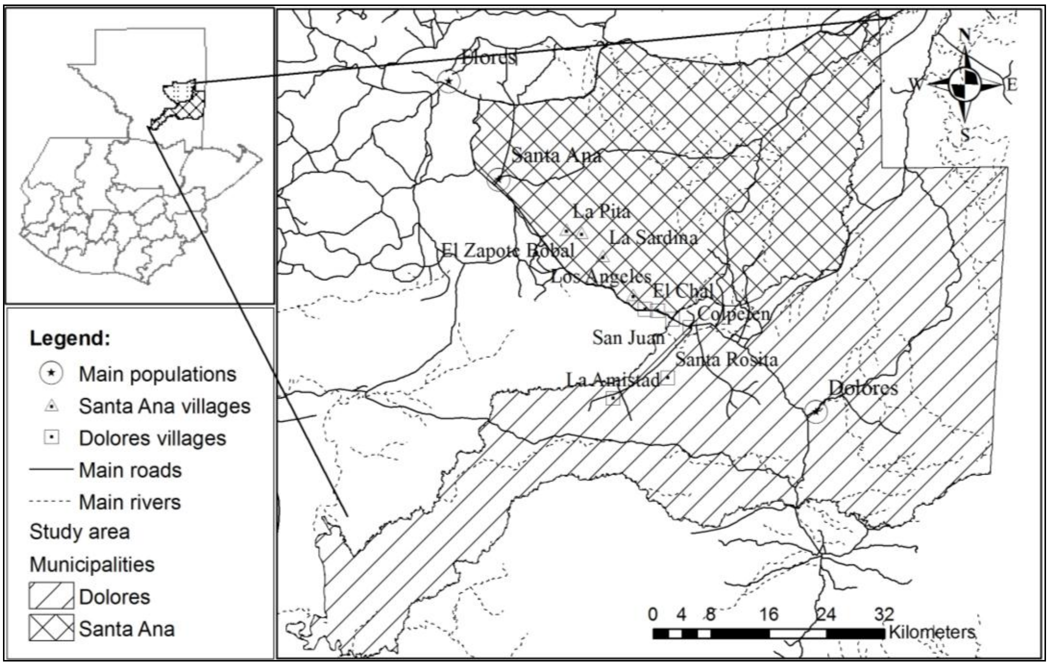


Figure 6.2. Villages from the Dolores and Santa Ana municipalities included in the study.

The livelihood strategies in Dolores and Santa Ana municipalities are related to farming activities, and especially to cattle production. This has influenced the land use change from forests to staple crops and then to pastures, which is the main agricultural land use for both municipalities (MAGA 2006). The soils are usually unsuited for continuous farming due to acidity, low availability of phosphorous and nitrogen, lack of moisture during the dry season, compaction by continuous trampling of cattle, clay texture that may propitiate flooding and difficult mechanization during the rainy season (Bach 2005, CMD and SEGEPLAN 2010b, 2010a).

Most of the participating villages have internal gravel roads connected to the main paved road that goes from Flores to Guatemala City. However, the access to farms sometimes is difficult during the rainy season, because of poor road conditions and prone to flooding. Generally, wealthier farmers live in the towns, whereas small farmers live in more remote villages or in the farms with limited access to health services, potable water systems, higher education and electricity (CMD and SEGEPLAN 2010b, 2010a). Nevertheless, the coverage of the electric service was improved in 2008 when two of the rural villages (Santa Rosita and La Amistad) were incorporated into the electricity network. La Sardina, La Pita and El Zapote Bobal are located in *ejido* land, which means that farmers hire land from the municipality by paying an annual fee of two USD[28]/*manzana*[29]. Farmers from the rest of the villages owned their farms, most of them have land titles or are about to acquire those.

Table 6.1. Number of inhabitants, services and distance from Flores from the villages that participated in the study.

Municipality	Village	Population (#)	Distance to Flores (km)	Health post	Electricity
Dolores	El Chal	4106	48	+	+
	El Quetzal	527	51	-	+
	San Juan	742	54	-	+
	La Amistad	387	93	-	+*
	Santa Rosita	304	84	+	+*
Santa Ana	Los Angeles	1823	47	-	-
	La Sardina	519	45	-	-
	La Pita	229	33	-	-
	El Zapote Bobal	218	35	-	+

Notes: Population data from 2004, compiled by the Ministry of Public Health and Social Assistance from Guatemala (García 2006). + Yes. - No. * Available since 2008.

[28] At an exchange rate of 7.5 *quetzales*/USD. However, in the practice the payment was similar to a tax, because farmers felt secure about their tenancy. In 2008 the municipality of Santa Ana was measuring the land located in the core area of ejido villages ("*sitios*") for processing land use titles.
[29] Common area measurement unit in Central America equivalent to 0.7 hectares.

6.3.2. Sample selection

A non-parametric purposive sampling strategy was used because there were several restrictions that impeded the use of a random sample such as the lack of an adequate sample frame and limited budget. Four types of participants according to their socioeconomic status and participation in FFS led by DEPAPRO were considered in the evaluation: (1) small (SFFS, n_1=23); (2) and medium size farm households (MFFS, n_2=19), both participated in the livestock FFSs organized by DEPAPRO. (3) Small (SCTR, n_3=23); (4) and medium size farm control households (MCTR, n_4=13), which corresponded to livestock farmer households who lived in the villages of the pilot area but did not participate of the FFS activities. The aim was to compare the state of the assets in years 2003 and 2008, for the four groups considered in the study. Farmers were invited to participate in the study without offering incentives for it. This decreased the interest of control farmers for participating in the research and made impossible to get a balance among subgroups.

6.3.3. Procedure

6.3.3.1. Assessment of changes in farmers' assets

The evaluation followed a pretest-postest four groups design without randomization (Rusell 2006). As baseline data were not available the pretest observation corresponded to estimations recalled by farmers. The four human assets were prioritized in the analysis: human, social, cultural and political. The material assets corresponding to the natural, financial and physical/built capitals; and the Institutions, Policies and Processes were not directly addressed because they were already covered by DEPAPRO through other studies (Pomareda 2007, Barrios 2008, Chacón 2008). The changes induced by the FFS in farmers' assets were identified through comparisons of asset indicators between years 2003 (pretest) *versus* 2008 (posttest). Pretested semi-structured interviews and observation guidelines were adapted from those used in Central America for holistic diagnostics (Gutiérrez-Montes *et al.* 2008, Gutiérrez-Montes *et al.* 2009b, Gutiérrez-Montes *et al.* s.f.) based on the impacts observed by DEPAPRO stakeholders in a qualitative study (see Chapter Four). The semi-structured interview included closed, open and scoring questions. Likert-type scales with five categories (1 low – 5 very good) were included in the interview to measure the knowledge on common and induced cattle production practices.

6.3.3.2. Vulnerability context affecting farmers' livelihoods

Five focus group discussions (FGD) were organized in the second semester of 2008 with FFS farmers from the pilot area. The FGD purpose was to identify the salient features from seasonality, shocks and trends that influenced farmers' livelihoods; but also to assess changes in the farmers' social capital. Three Participatory Learning and Action exercises were accomplished during the FGD sessions: (1) time line of important events for the community; (2) seasonal calendars of farming activities; (3) informal social networks using Venn diagrams. The objectives of each activity were explained to participants, and their authorized consent was asked and granted, as well as their permission for audio recording and taking pictures during the FGD sessions. Furthermore, literature review of previous studies in the villages and about the events identified by farmers in the timeline increased the internal validity of the information obtained.

6.3.4. Data analysis

A prioritization of the variables to be used in qualitative and quantitative analysis was done, based on the identification of indicators that DEPAPRO could have affected according to personal observations, results from the documentation and the participatory technology evaluation chapters, informal chats with farmers and previous works on livestock farmers' livelihoods in Central America (La Roche 2006, Alas 2007, Cruz 2007). The resultant dataset was exported to PASW18 (SPSS Inc. 2009) where a quality control stage was performed. It included the verification of outlier data with charts, tables of frequencies and crosschecking of quantitative and qualitative variables. Normality and homogeneity of variance were checked for quantitative variables. However, due to the small size of the subgroups in the sample, imbalances in the subgroups of participants, and the ordinal nature of some variables the latter assumptions were not fulfilled. Therefore, non-parametric statistics such Mann-Whitney (U) and Khruskal Wallis (H) tests were used to compare asset differences between farmers.

Similarly, McNemar's (X^2), Cochran's (Q) and Wilcoxon signed-rank tests (T) were carried out to assess differences in assets before and after attending the FFS (years 2003 *versus* 2008). Charts were prepared for graphical display of results with SigmaPlot11 (Systat Software Incorporated 2008). Regarding qualitative analysis, this included the *in vivo*[30] coding of open-ended answers, the frequencies or relationships of the answers were then exported to Visio 2007 (Microsoft Corporation 2006) or SigmaPlot to elaborate charts and diagrams for visual display. The results are presented in a narrative that describes the vulnerability context of cattle farmers in Central Petén, the associations between assets and the external context that influenced farmers' livelihoods, and the comparison between the assets of FFS participants and FFS non-participants.

6.4. Results and discussion

6.4.1. Vulnerability context affecting cattle production in Central Petén

The elements from the vulnerability context influencing the livelihoods of cattle farmers in Central Petén corresponded to: (a) those mentioned by farmers, which were identified during the FGD sessions, in semi-structured interviews and through field observations; (b) elements identified in the literature which may have not been mentioned by participants. Both were combined in the following narrative for describing in which way they have an effect in the livelihood of cattle farmers.

6.4.1.1. Shocks

The main shocks to the livelihoods of farmers in Central Petén, were classified as human conflicts and natural disasters. The civil war (1960-1996) was the most important shock referred to by farmers, however, their sequels still determine much of the current status of Petén. Civil war effects in Petén affected human and social capitals because cooperatives, unions, political parties and other civil organizations were threatened by the military (Schwartz 1990, Taylor 2007). From the 1960s to the late 1970s much of the conflict occurred in other areas of Guatemala such as the Eastern, the South Coast and Guatemala City (Chamarbagwala and Morán 2011), thus the effects of the war were not directly observed in Petén. In fact, in the late 1960s FYDEP supported land concessions for establishing agricultural cooperatives, this is how La Amistad

[30] Method of coding based where the categories or themes emerge from the answers of participants.

village was established in 1972 (FAO w.d.). Higher repression in other regions of Guatemala caused a larger immigration to Petén (Schwartz 1990, Grandia *et al.* 2001), including some guerrilla members who according to participants arrived to Central Petén in the early 1970s.

During the 1980s the violence in Guatemala increased, and even the farmers were involved in the conflict because the military enforced the formation of civilian patrols. Petén was not the exception as it was ranked fourth among the Departments where more violations of human rights and victims were recorded (Schwartz 1990, Chamarbagwala and Morán 2011). This was a critical period because according to farmers there were too many difficulties for working on the farm. The material assets were largely depressed because the guerrilla or the army "collected" animals or destroyed crops without compensation. Moreover, there was a great uncertainty because just by being suspected as being an army or guerrilla supporter, the opposing party could take violent measures against a household. Many Petén inhabitants were displaced to the North into forested land, or to Mexico and Belize as refugees (Carr 2004). In the early 1980s the army enforced the establishment of villages for maximizing their control over people; those who failed to obey were considered guerrilla supporters. This is how villages such as La Sardina, La Pita and El Zapote Bobal were settled.

On the other hand, the civil war caused internal migration and even the re-settlement of villages in Central Petén, because some were abandoned (Schwartz 1990, Grandia *et al.* 2001). This was the case of Santa Rosita in 1982, 15 households from El Ocote (another community from Petén) organized a group of "*sin tierra*" (without-land) which requested land for work from the army, and received permission to settle in Santa Rosita. When they arrived it was noticed that other people had lived in Santa Rosita before because the football field was already there. However, participants stated that there was nothing else besides the football field, the vegetation regenerated and the land was "*montaña*" (forest). Furthermore, some inhabitants from La Amistad village in Dolores described how they moved from an area near the route to Tikal where they lived before, because of arbitrary military executions that affected some of their relatives.

The civil war had a negative impact on much of the material assets in Central Petén such as private and public infrastructure or crop land. However, it also affected non-tangible assets such as the human and social capitals in the long term because the financial capital from households was invested in covering basic needs, the budget from the government used in the warfare, teachers and students were persecuted and sometimes executed, to such a point that parents associated education with a risk for their siblings (Chamarbagwala and Morán 2011). Among displaced inhabitants, the civil war also impacted negatively upon indigenous technical knowledge of the use of natural capital (Nesheim *et al.* 2006). Considering such effects several studies suggest the necessity for holistic approaches to strengthen non-material assets in any development or conservation programmes (Chapter Four, Nesheim *et al.* 2006). After 1985 the violence started to decrease and in some cases farmers used their relationships and leadership for favouring their villages. For example, the running water project in El Chal and El Quetzal villages was facilitated by labour provided by civilian patrols.

Regarding natural disasters, hurricanes and fires were the main elements identified as shocks by farmers in Central Petén. Farmers described effects of hurricanes such as Fifi (1974), Greta (1978) and Stan (2005), whereas publications also mentioned the impact of Mitch (1998) and Iris (2001) (CMD and SEGEPLAN 2010b). The most severe impacts of hurricanes in the study area were observed mainly from August to October (SEGEPLAN 2003), although hurricanes did not land in the area, there were heavy rains and winds associated to those. The effects were directly related to material assets because: (a) moisture saturation of soils damaged pastures and basic crops; (b) pests and diseases associated with moisture excesses affected human and livestock health; (c) infrastructure such as roads, bridges and education facilities were damaged; and (d) hurricane effects interacting with seasonality elements or other shocks caused further negative effects. For example, Fifi winds brought down trees that in the 1975 dry season caused one of the largest fires observed in Petén.

Fires were considered as a shock in only one village studied. Similar results were reported by a participatory diagnostic that reported fire effects in the area near the Zapote and La Pita villages (CMD and SEGEPLAN 2010b). Origin of fires is related to anthropogenic activities, especially to the cultural management of pastures and crops where burns are traditionally used (Colón *et al.* 2009). During a field visit one participant explained how an agricultural burn from a neighbour went out of control and damaged her live fences and a fodder bank. However, natural events such as El Niño-Southern Oscillation are also associated with fires (Rodríguez Lara 2001). Some of the largest fires documented occurred in 1998 (Griffith 2000, Rodríguez Lara 2001), these were not mentioned by participants because it affected Northern Petén. In fact, a recent study reported just a few fires in land from Santa Ana municipality, being more frequently recorded in Dolores for the period 1998 to 2003 (Herrarte 2005).

The fires' impact in the study area has affected the natural capital because of the loss of forest, biodiversity, pastures and crops (Herrarte 2005, García 2006). However, fires in Petén also have created imbalances in the trophic chain that resulted in insect or rodent pests which affected crops, pastures and even human health (Rodríguez Lara 2001). A financial assessment of the impacts from 1998 to 2003 estimated that 540 fires affected 8,695 km^2, causing damages worth US$508 million dollars[31] (Herrarte 2005). Moreover, fires also have been considered a limitation for further investment in agroforestry, forestry and fruit tree plantations (Gould 2006). Curiously, farmers caring for their investments in such plantations were among the few that have successfully implemented measures for fire control in Petén (Griffith 2000).

6.4.1.2. Trends

The main trends associated with farmer livelihoods in Central Petén corresponded to: (a) population increases; (b) replacement of forests for agricultural land; (c) fluctuations in the price of farm products and production costs; (d) urbanization of villages; and (e) fluctuation of markets for farm products. Estimates based on the National Census of Guatemala 2002, consider that the population in Petén would be increasing at an annual rate of 8.2% per year (1998-2002), more than twice the national Guatemalan rate of 3.4% (INE 2003, 2011). New Petén inhabitants demand for resources and as the natural capital is the best provider of those, it is also the most affected. One study carried out in Northern Petén suggests that for each increase of one household member, about one-half hectare of forest was cleared for agricultural purposes (Carr 2005). Other assets, i.e., built and social, are also impacted by population increase. For example, in one

[31] Considering an exchange rate of 7.95 *quetzales*/USD(2003). Damages to housing and human life were not considered in such estimation.

village participants complained about the arrival of new people, indicating that water facilities were planned to cover the needs for a maximum of 275 inhabitants, but in 2008 the population was 700. Thus, water shortages were common during the dry season and people had to catch rain water and even drink water from the rain water reservoirs, where also animals have access.

The livelihood strategies in Petén have changed drastically. While most of the livelihoods were associated with wood extraction and non-timber forest products from 1890s to 1970s (Schwartz 1990) or providing labour for clearing forest; nowadays swidden agriculture (Sader *et al.* 1994, Shriar 2011) and extensive cattle production are the main strategies in Central Petén. This resulted in high deforestation rates, between 0.33 and 0.4% per year (Sader *et al.* 1994, Manoharan *et al.* 2009). In the municipalities of Dolores and Santa Ana the area of primary forest was reduced by 79% between 1988 and 2003 (García 2006). Farmers consider that deforestation increase ambient temperatures and caused problems with water and forage provision during the dry season (Martínez 2007, Manoharan *et al.* 2009), or affected the health of people and cattle.

Despite increases in the international livestock product prices (Barrios 2008), farm-gate prices in Central Petén for cattle decreased during two consecutive years. Moreover, production costs increased because of rises in herbicides, seeds, concentrates, fuel, labour and food prices. The combination of such fluctuations in prices is one of the most described trends affecting farmers' livelihoods. In consequence, the financial capital of farmers is affected and their investments in improvements for the household or the farm are restricted. Such trends have been associated with improvements in the road network, because more products from other areas of Guatemala and even from Central America can be economically and rapidly transported into Petén (Shriar 2006). For example, live cattle were being imported from Nicaragua where reduced labour and land prices make their price competitive enough to resell in Southern Mexico. This is encouraged by the lack of control at the borders, which also facilitate the importation of cattle from Mexico, El Salvador and Belize. Cattle importation is perceived as a threat for the natural and financial capitals of farmers in Guatemala because most of those animals harbour diseases (Marroquín 2005).

The urbanization of villages in Central Petén was considered positive in most of the cases. The improvement of services such as education, piped running water systems, health services, internal roads, public transportation and electricity were pointed out by participants as factors that improved their livelihoods. For example, the improvement and maintenance of internal roads made transportation of products and inhabitants more efficient and improved access to health services located in larger towns. Moreover, before the establishment of elementary school facilities, some children had to walk up to seven kilometres to attend formal education. Farmers consider that such improvements impacted positively on their livelihoods. However, the establishment of large supermarkets in the Flores area which import many of their products and the improvements of the road network to Guatemala City and the Mexican border is exposing farmers to higher levels of competition for the local market of farm products (Shriar 2006).

The last trend of importance appreciated was the fluctuation of local and regional market opportunities for farm products. Agriculture is the most important livelihood for sustaining a living, thus, Petén has become an important provider of maize, beans and even dried pumpkin seeds (*pepitoria*) for South Guatemala (Shriar 2006). Moreover, in Central Petén where cattle production is among the main livelihoods, farmers have started to sell milk to the pasteurizer industry through an intermediary: Izabalac[32]. This company established milk cooling thanks in El Chal, that in 2007 collected 14,000 L/day, paying US$0.24/L (Barrios 2008). Increases in population, international prices of milk and beef (Barrios 2008), development of urban centres with livelihoods no directly related to farming, and the higher number of tourists attracted by the cultural and natural richness of Petén have increased the local demand for farm products. However, the challenge for Petén farmers is to provide such markets with farm products in quantity and quality, especially when the infrastructure for food processing is minimal and rudimentary. For example, before the establishment of Izabalac the main market for milk was artisan cheese factories that use low technology, poor hygiene and environmental measures that compromised the quality of milk products.

[32] Lacteos de Izabal S. A. Pasteurizer firm from Izabal, which in 2006 established a milk collection centre in the facilities from the Petenlac cooperative (http://www.youtube.com/watch?v=58a-HRBxcgI).

6.4.1.3. Seasonality

The seasonality elements influencing the livelihoods of farmers in Central Petén were associated with water availability and classified into: (a) fodder availability; (b) cattle management and price; (c) milk production and price; (d) crop production and price. Rainfall fluctuation along the year was a determinant factor because precipitation cannot be controlled by farmers; and their natural sources (i.e. streams, rivers, lakes), infrastructure (i.e. wells, water reservoirs) (Alvarez Godoy 2007) or their management is not adequate for a sustained provision of water in the dry season. Farmers described that water excesses affected their households during the rainy season because of flooding, and cattle or human associated diseases. However, they also mentioned being affected when precipitation was scarce during the dry season or "*canícula*"[33], because rain is the main supply of water for crops, pastures, and cattle and remains important as a source for human consumption.

Fodder availability is highly dependent on rainfall because in the study area there are no irrigation systems for pastures. The lack of moisture in the soil during the dry season, especially from March to May, reduces pasture growth and consequently both small and medium scale farmers struggle to feed cattle. In Central Petén Betancourt (2006) determined that the dry matter availability in pastures dominated by *Brachiaria brizantha* was 3.5 times higher in the rainy season with a production of 5,065 kgDM/ha more than during the dry season in non-degraded pastures, whereas in paddocks with severe degradation dry matter yield was only 1.79 times greater in the rainy season, but the difference with the dry season was of only 335 kgDM/ha. Such contrast affects the livelihoods of farmers, some even have to sell calves before the dry season starts, or invest in alternative sources of fodder such as: renting grazing plots, using crop residues and grazing in "*guamiles*"[34] and even secondary forests. If alternative forage sources are not considered, cattle lose weight and become more susceptible to pests, diseases and in extreme cases could die. Moreover, with fodder scarcity, cattle are forced to change their forage preference and even graze toxic plants such as bracken fern (*Pteridium aquilinum*) (Alonso-Amelot 1999, Aguilar and Nieuwenhuyse 2009).

[33] One or two short dry periods in the rainy season in the study area occurred between July and August.
[34] Secondary natural vegetation sometimes used as synonym of fallow land.

The second aspect of importance regarding seasonality is cattle management and price. For example, the prevalence of cattle pests varied according to water availability, participants were able to identify specific periods when pests or diseases affect their cattle more, and based on it they try to synchronize prophylactic measures. Cattle type also influences the frequency of prophylaxis (parasites management) because fattening steers receive applications every two months, whereas cows are treated twice a year. Internal parasites were not affected by the seasonality and they are a constant concern during the whole year. As most of the farmers use the water captured in the water reservoirs for cattle drinking, these are infestation points due to poor design. Ticks (*Boophilus microplus*, *Amblyomma cajennense*) and the tick-borne disease piro-anaplasmosis, known locally as "*cacho hueco*", affects cattle mostly during the dry season because the lack of rain is associated with higher tick infestations which are the vectors of *Babesia* (Teglas *et al.* 2005, Velásquez 2008).

In June just after the first rains, there is an increase of the "*mosca paletera*" (*Haematobia irritans*) problems, and that fly could be a vector for diseases such as mastitis[35] and anaplasmosis[36] (Puertas 1999). About the same time anthrax (*Bacillus anthracis*) can emerge in certain areas where its presence has been reported earlier, with high rates of mortality among infected animals. However, this problem occurs with non-vaccinated animals (Flores 2002). The infestation by the beef-worm "*colmoyote*", the larvae stage of the warble fly (*Dermatobia bovis*), is more common around September during the middle of the rainy season, and affects cattle by depositing its eggs into the skin of cattle, and larvae grow causing pain and infections. Moreover, *colmoyote* in Petén has been reported to be affecting humans with skin injuries and as a vector of leishmaniasis (Schwartz 1990). The "*pierna negra*" (*Clostridium chauvoei*) disease, was identified by participants as a mortal disease for cattle, occurring mostly around January. Participants pointed out that pests and diseases in general affect their natural and financial capitals because they have to pay money in preventive and curative treatments, and even accept the death of some animals in critical cases.

Regarding herd management, most farmers preferred calvings during the dry season (January to May), which is facilitated by good pasture availability in the beginning of

[35] Mastitis is a disease characterized by the inflammation of the udder caused for bacterial infections.
[36] Anaplasmosis is a tick-borne disease caused by a rykesttsial parasites *Anaplasma* spp.

the dry season. Calves born during the rainy season will face more health problems because of the mud and moisture abundance in the environment. Calves remain with the cows for three to nine months; and the amount of milk that they are allowed to consume depends on the type of production system followed. The ideal fattening period is during the rainy season, starting in June onwards, when fodder availability is not limiting. One informant even stated that he sold fattened calves at the beginning of the dry season because he could not afford financial capital losses due to weight reduction given the lack of feed and water that prevails in such period (SEGEPLAN and UNEPET 1992).

With respect to cattle marketing, participants indicated that calf prices vary little during the year, prices ranging between US$0.82 to 0.88/kg according to small scale farmers. The price depends on the breed, age and type of cattle. The best prices were paid for steers US$1.32 to 1.39/kg, followed by culled cows and bulls US$1.04 to 1.10/kg, and the lowest for calves. When the rainy season starts (April-May), there is a low supply of animals and small scale farmers could receive up to US$0.97 to 1.17/kg.

Some farmers complained about farm-gate prices which have decreased for two consecutive years. Official records of cattle farm-gate prices were not available. Nevertheless, beef carcass prices from *La Terminal* central market[37](Figure 6.3) reflected reduction and instability in prices. The literature also indicates that beef prices are influenced by the importation from other Central American countries and the United States through CAFTA which, since 2006, started the elimination of tariffs (Leister *et al.* 2008). Medium scale farmers expressed their concern saying that the Guatemalan government is directed towards importing beef, instead of supporting national production. Furthermore, the importation of discarded animals from Mexico, Belize and El Salvador is pointed out as another factor encouraging low prices, because these countries were developing animal health certifications and middlemen exported those to Guatemala.

Milk production and prices was the third category analyzed. Unlike cattle prices, this was more influenced by seasonality. Participants stated that regarding milk production two main stages can be identified along the year: (a) from January to July where the

[37] Main market for agricultural products located in Guatemala city.

milk production starts and achieves its maximum yield; and (b) from August to December when milk production is reduced. Calving starts on January and by February most of the cows have delivered calves. This explains why even with water and forage scarcity during the dry season there is milk production because most cows start lactating during that part of the year. In March milk production declines because of forage scarcity, but it then remains stable until May. In June milk production increases in response to improved pasture availability and remains high until the end of July. In August milk production decreases because most animals enter the late lactation phase, and other cows are pregnant to calve in the next dry season.

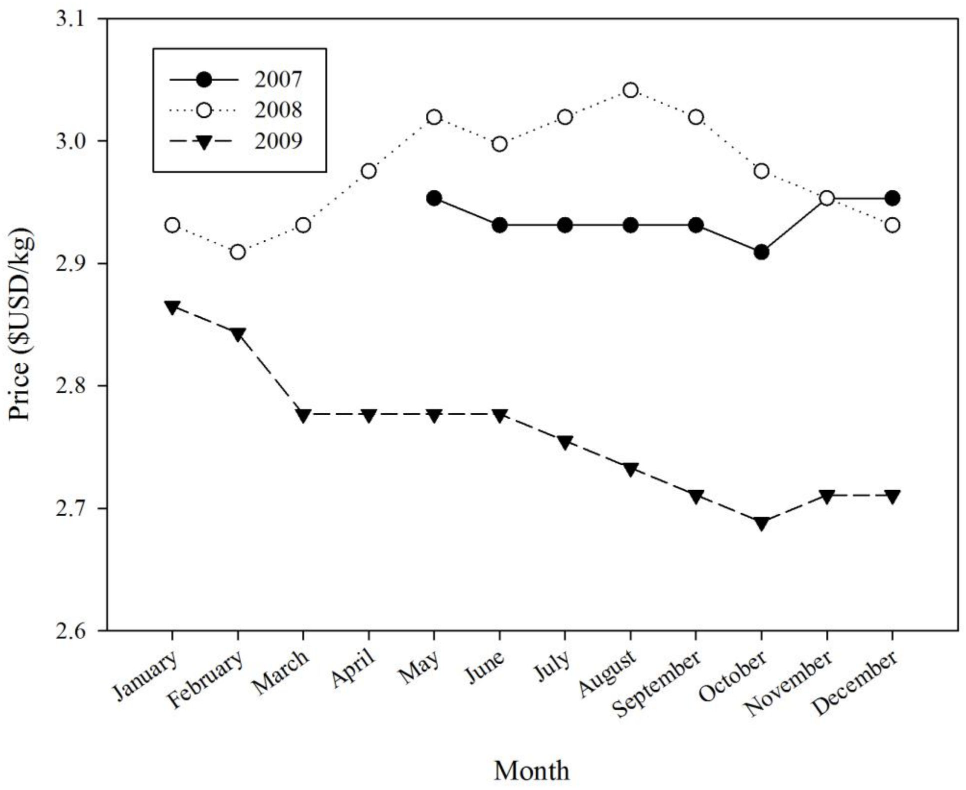


Figure 6.3. Beef carcass average monthly prices in La Terminal Central Market Guatemala (SIM 2011).

Farmers associated milk price with rainfall seasonality, farm location and production from other Departments of Guatemala. Best farm-gate prices for fresh milk are paid when there is low supply, and this occurs from December to May in Santa Rosita (US$0.33/L), October to May in La Sardina (US$0.27/L), and from October to April in El Chal, El Quetzal, San Juan and Colpetén (US$0.32/L). On average, milk prices decline US$0.04/L when there is high milk supply. Farmers could obtain US$0.03/L more by delivering milk directly to the Izabalac Collection Centre. However, most farmers prefer to use the middleman, because milk transportation requires more investment in a vehicle and time, and will compete with the time needed to devote to other farm activities. Middlemen also offered a plus of US$0.05/L, in the price to the medium scale farmers, because their farms have better accessibility, are closer to the milk collection centre, and have the capacity to deliver more milk (Pomareda 2007).

Rainfall also determined the timing for many cultural practices related to crops as well as their prices. Even though cattle production is the main livelihood for most of the participating farmers, most of the small scale farmers allocate or rent some land for planting maize and beans because those are their staples. Therefore, low yields of basic crops mean higher risk because farmers will have to buy maize and beans in cash at market prices, instead of using family labour (not paid in cash) for its cultivation, harvest and postharvest management. This may also affect medium scale farmers because even though most of them do not grow such crops, they have to buy those either for household consumption or cattle supplementation.

Land preparation for planting maize starts in March during dry season by slashing the *guamil* for the establishment of the first cycle of maize ("*primera"* or "*de fuego"*). However, this practice could be performed earlier if forest-land was used for such purpose (SEGEPLAN and UNEPET 1992, Lara 2010). Land is prepared for sowing in late April or May, and this includes burning the slashed trees or shrubs and cleaning the soil of big trunks which can interfere with sowing. The first planting of maize is usually undertaken between mid May to June, depending on when the rains start. In July the weeding of the *milpa*[38] is accomplished. In August two events were identified, the harvest of fresh maize cobs and the "*dobla*" (fold) of the foliage over the maize ears, the latter is performed to establish a second cycle of maize ("*segunda"* or "*de invierno"*) or other crops, usually beans.

In September, land preparation for the second cycle of maize is performed, this includes a clearing (*"chapia"*) of the land or the use of herbicides if the dominant weeds are grasses (SEGEPLAN and UNEPET 1992). Later, in October the sowing of maize

[38] Traditional agricultural system from Mesoamerica, where maize is the main product. Sometimes is intercropped or alternated with other crops such as beans and squashes.

and/or beans is undertaken but this task can also be accomplished in November. At that time the maize cobs from the first cycle are harvested. If farmers got good yields in the first cycle, they sell some of their maize in December so they can afford some expenses during Christmas holidays. In January maize silage is prepared its storage and the harvest of the second cycle might start as well. Farmers in Central and Southern Petén have at least one barrel silo for grains in every home visited. Finally, in February the second cycle of maize finishes and beans are harvested.

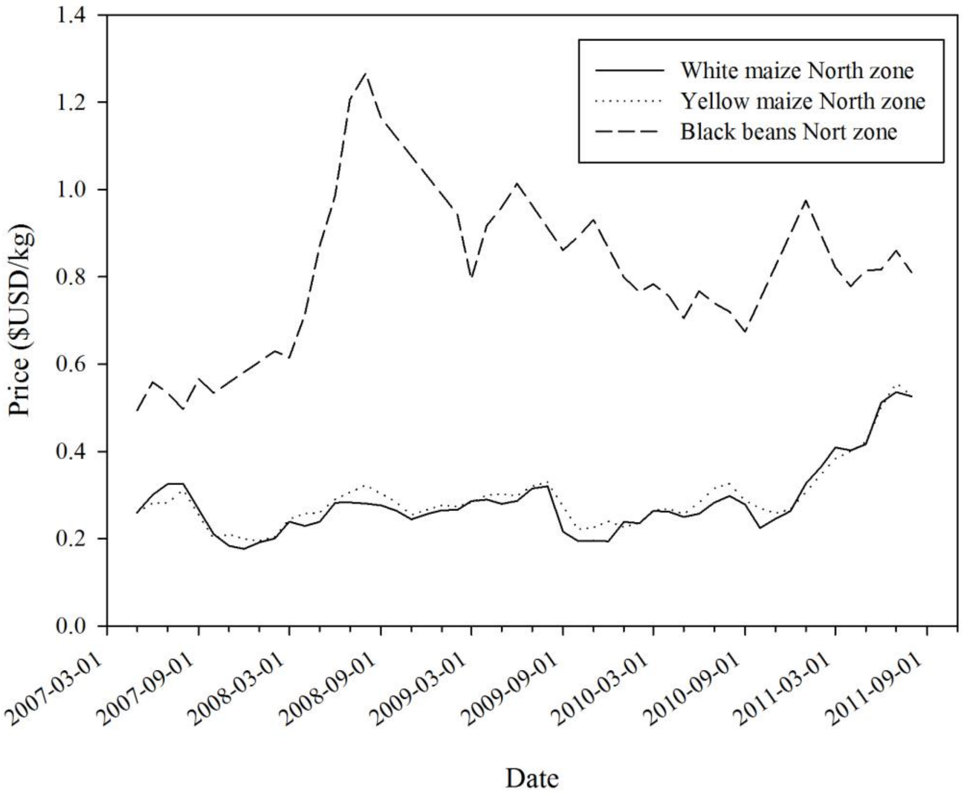


Figure 6.4. Basic crops middleman monthly average prices of the main basic crops from Guatemala North zone (SIM 2011).

Crops prices follow the supply/demand trends, and official records of farm-gate prices were not available for the period analyzed (Figure 6.4). However, participants pointed out that maize price usually is reduced by US$0.14/kg in October to December, when the first cycle of maize is harvested. August and September are the months when maize has the best farm-gate price around US$0.34 to 0.43/kg. According to participants, they get normal prices for the rest of the year, and those were especially good in late 2007 and early 2008, when high prices in the international market resulted in good local prices for maize. However, participants underlined that despite having storage facilities sometimes they cannot obtain profit from price increases because they sell their maize when they need the money and not necessarily when prices are the best. Furthermore, the participants also stated that middlemen sometimes do not pay good prices for maize because they want to maximize their profit.

6.4.2. FFS impacts in human assets of cattle farmers

6.4.2.1. Human capital

The human capital was the asset most impacted by DEPAPRO because the FFS approach included participatory learning and experimentation opportunities for FFS participants. The human capital elements considered in the analysis were emigration, labour and knowledge of cattle practices. Most (63%) of the participants in the study are immigrants from the Eastern and the Pacific Coast regions which settled in Petén on average 31 and 28 years ago, respectively (Figure 6.5). Such background influences their preference for cattle production as a livelihood, because it is an activity that gives status in the culture of "*ladino*[39]" farmers (Macz *et al.* 1999).

On the other hand, emigration towards larger towns in Central Petén, Guatemala City or the United States is an attractive alternative livelihood for rural inhabitants (Grandia *et al.* 2001, Carr 2008). Comparisons between participant categories showed that a higher number of household members emigrated from the control than from FFS households in the period from 2003 to 2008 $H(3)=8.98$, $p<0.05$. However, this effect could not be attributed to FFS, because other factors such as the age of the household members, financial constraints and lack of financially attractive livelihood alternatives are among the main causes for emigration.

No significant changes in the number of households using family or hired labour were found while comparing participant groups. Most of the small scale farmers used family labour and some eventually hired additional labour, whereas medium scale farmers relied more on hired labour and most of them had one permanent worker living in the farm. Similarly, the activities carried out by hired labourers did not differed among groups of participants, and the most frequent were: weeding management, fence

[39] Term used in Guatemala for Spanish speaking population.

construction and maintenance, and pasture establishment, those accounted for 63% of the hired work (Figure 6.6). Small scale farmers more frequently indicated that the labour available was not enough for all farm activities. Thus, labour availability could be a constraint for further intensification of cattle production in the case of the small scale farmers. Some of the comments provided by them on this respect were: “labour is enough only for the most important tasks”, “cannot afford to pay for more labourers” and “the force for working the farm would be enough by hiring labour”.

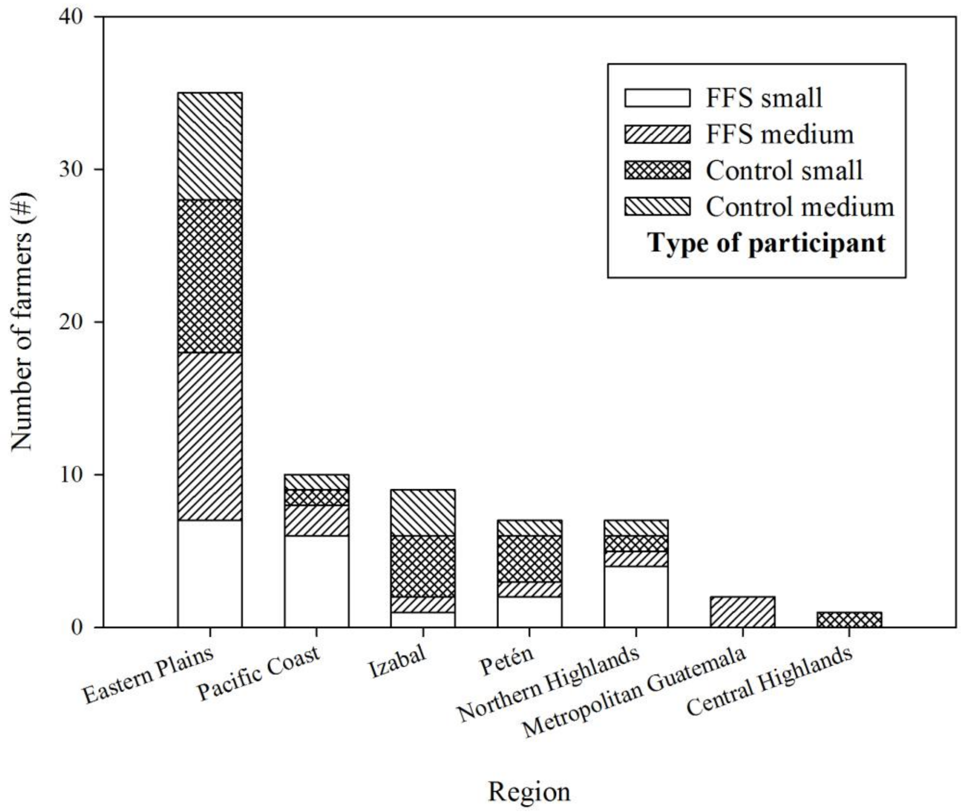


Figure 6.5. Region of origin by type of participant.

When DEPAPRO started (2003) control farmers had more knowledge than FFS farmers about five of the 11 technologies considered for comparison; for two of those (improved pastures and mastitis control) significant differences between groups were detected using the Mann-Whitney test (Table 6.2). Control farmers indicated that they were already familiar with improved pastures management, especially for *Brachiaria brizantha* which is the most common introduced grass in the area (Cruz *et al.* 2007). Such knowledge was generated through conversations with neighbours, personal observation in neighbouring farms, empirical experiences gained in their own farms and previous training offered mainly to those participants who were members in cooperatives. Conversely, the answers given for 2008 by FFS participants showed improvements in their knowledge for eight out of 11 technologies.

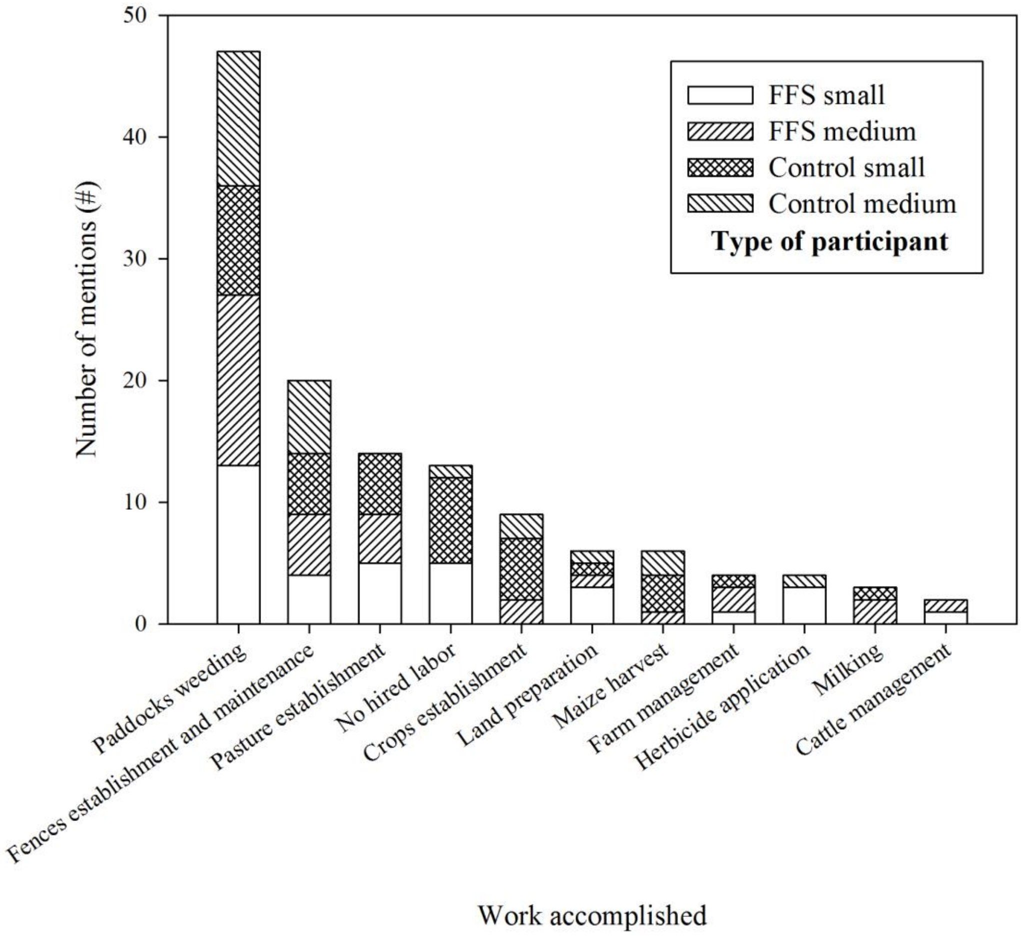


Figure 6.6. Type of work carried out with hired labour by type of participant.

Changes in knowledge can be associated with the FFS because several types of improved pastures were tested in on-farm experiments and evaluated later applying participatory methods (Cruz *et al.* 2007). For example, farmers strengthened their knowledge on improved pastures by planting improved cultivars (Toledo, Marandú and Mulato) to the common *Brachiaria brizantha* already used in the region. Some of the experiments included mixtures with herbaceous legumes such as forage peanut (*Arachis pintoi*) which also helped farmers to acquire experience on the management of herbaceous legumes. In 2003 most farmers identified clinical mastitis only at advanced stages of the disease and applied antibiotics. Whereas, those attending FFS sessions learned about preventive measures, including test for sub-clinical detection and hygienic milking practices that help to reduce mastitis infections and improve milk quality. Both resulted in enhancing natural and financial capitals.

Table 6.2. Differences in knowledge on common and non-conventional cattle technologies between FFS and control farmers before and after DEPAPRO.

Year	**Technology**	***U***	***P***	***r***	**Type of farmer ($\tilde{X}$)**		**$\Delta\tilde{X}$**
					FFS	**Control**	
	Leucaena	1488.5	0.08	-0.20	1	1	0
	Improved pastures	1276.5	0.00*	-0.39	1	3	-2
	Live fences	1474.0	0.18	-0.15	3	4	-1
	Legumes	1521.5	0.25	-0.13	1	1	0
	Paddocks rotation	1427.0	0.10	-0.19	2	3	-1
2003	Cut-and-carry grass	1329.0	0.41	-0.10	2	1	1
	Nutritional blocks	1509.0	0.08	-0.20	1	1	0
	Mastitis management	1371.0	0.02*	-0.26	1	2	-1
	Weeds management	1347.5	1.00	0.00	3	3	0
	Silage	1469.5	0.07	-0.21	1	1	0
	Parasites management	1459.0	0.13	-0.17	3	4	-1
	Leucaena	352.5	0.00*	-0.46	3	2	1
	Improved pastures	687.5	0.56	-0.07	4	4	0
	Live fences	721.5	0.84	-0.02	4	4	0
	Legumes	464.0	0.00*	-0.33	3	1	2
	Paddocks rotation	476.0	0.00*	-0.33	4	3	1
2008	Cut-and-carry grass	413.5	0.00*	-0.39	4	2	2
	Nutritional blocks	295.0	0.00*	-0.54	3	1	2
	Mastitis management	510.5	0.02*	-0.26	4	3	1
	Weeds management	430.5	0.00*	-0.37	4	3	1
	Silage	534.5	0.03*	-0.25	2	1	1
	Parasites management	650.0	0.28	-0.12	4	4	0

Notes: *U*=Mann-Whitney test. *r*=Effect size. *p*= p-value. $\tilde{X}$= median. **$\Delta\tilde{X}$**= median difference. *=$p < 0.05$.

Farmer experimentation has been pointed out as a key element for strengthening the human capital in integrated crop management of sweet potato in FFS from Indonesia (Johnson *et al.* 2003), and had a similar effect with livestock farmers in the present study. Moreover, having previous training in livestock management also supported improvements in technical knowledge, this is the case of cooperative members who have had more access to trainings in livestock production. In Ghana previous training to FFS activities in cocoa management was found positively related to technical knowledge in cocoa production (David and Asamoah 2011).

Changes in human capital impacted the built/physical and natural capitals because FFS farmers improved their grazing systems by dividing the existing large paddocks into smaller ones, and by establishing new small paddocks with improved pastures. A Cochran's Q test comparing the number of FFS small farmers using rotational grazing showed a significant increase from 12 (54%) farmers using rotational grazing in 2003 to 19 (86%) in 2008 $X^2(1, n=22)=5.44$, $p<0.05$. Rotational grazing is considered more beneficial than continuous grazing e.g., in Brazil rotationally grazed *Brachiaria brizantha* cv. Marandú pastures had higher availability of carbon and nitrogen, and increased soil moisture and microbial activity (Garcia *et al.* 2011). On the other hand, a Wilcoxon signed-rank tests suggests that FFS medium farmers reduced the number of grazing days per paddock from a median of 15 to 7.5 days, $T(1, n=18)=5.44$, $p<0.05$, $r=-0.62$. Fewer grazing days can be associated to a better understanding of grazing management promoted by their participation in FFS.

To verify the effect of FFS on human capital Wilcoxon signed-rank tests were carried out to compare the knowledge of each farmers' group in 2003 versus 2008. Results showed a positive effect of FFS in the human capital of farmers because FFS farmers increased their knowledge for all technologies considered (Table 6.3). Control farmers knowledge also increased for some technologies, this is explained by such farmers having enough experience in some of the common livestock practices such as live fences, weeding or parasites management. Moreover, some control farmers explained that they had participated in a few FFS learning sessions, discussed management options with FFS farmers in private conversations, and observed their on-farm experiments (informal dissemination of knowledge). A similar process was reported in Ghana where cocoa FFS farmers communicated their knowledge about some practices to neighbours and relatives (David and Asamoah 2011).

Table 6.3. Changes in participants' knowledge on common and non-conventional cattle practices before and after DEPAPRO.

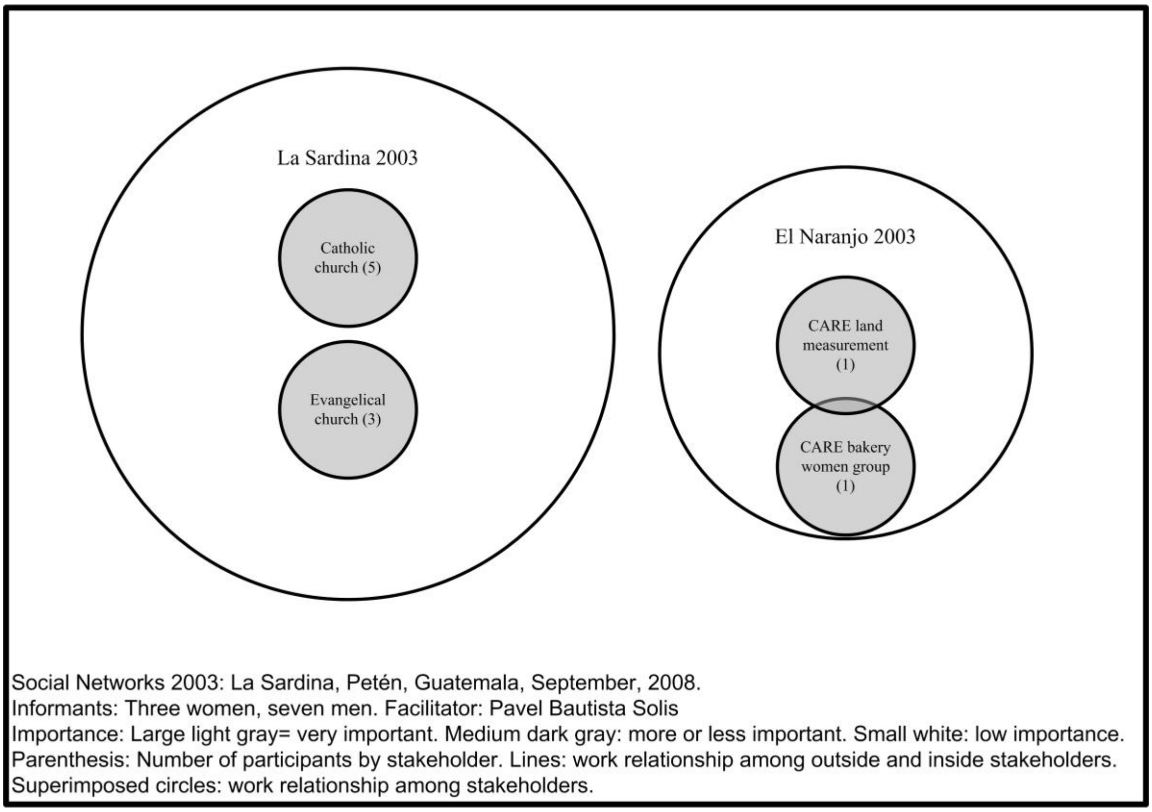
Practice	Participant type											
	FFS						***Control***					
	Small			***Medium***			***Small***			***Medium***		
	T	***p***	***r***	***T***	***p***	***R***	***T***	***p***	***R***	***T***	***P***	***r***
Leucaena	231	0.00*	-0.87	153	0.00*	-0.84	66	0.00*	-0.63	6	0.10	-0.45
Improved pastures	190	0.00*	-0.83	153	0.00*	-0.85	55	0.01*	-0.59	3	0.16	-0.39
Live fences	78	0.00*	-0.66	66	0.00*	-0.68	55	0.00*	-0.59	6	0.10	-0.45
Legumes	120	0.00*	-0.74	120	0.00*	-0.79	36	0.01*	-0.53	3	0.16	-0.39
Paddocks rotation	153	0.00*	-0.78	120	0.00*	-0.80	55	0.00*	-0.61	6	0.10	-0.45
Cut-and-carry grass	120	0.00*	-0.74	55	0.00*	-0.65	10	0.06	-0.39	3	0.18	-0.37
Nutritional blocks	253	0.00*	-0.89	120	0.00*	-0.79	21	0.03*	-0.47	3	0.16	-0.39
Mastitis management	153	0.00*	-0.78	120	0.00*	-0.79	36	0.01*	-0.55	3	0.18	-0.37
Weeds management	120	0.00*	-0.75	91	0.00*	-0.75	28	0.02*	-0.51	3	0.18	-0.37
Silage	91	0.00*	-0.69	105	0.00*	-0.77	10	0.06	-0.39	1	0.32	-0.28
Parasites	91	0.00*	-0.69	55	0.00*	-0.67	19	0.07	-0.38	3	0.18	-0.37

Notes: *T*=Wilcoxon signed-rank test value. *p*=p-value. *=p < 0.05. *r*=Effect size.

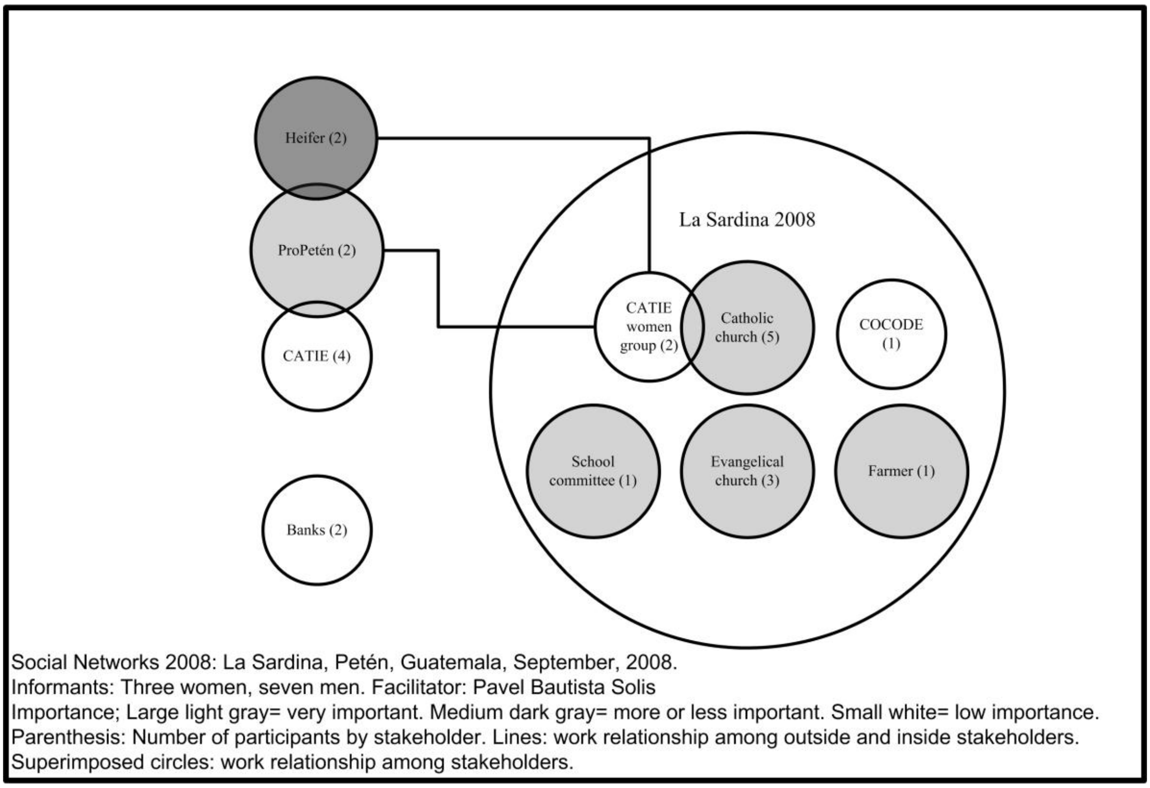
6.4.2.2. Social capital

Most of the impacts of FFS in the social capital can be classified into the reactive-dependence category proposed by Pretty and Ward (2001), because although participation was a voluntary decision of each participant, the most FFS group formation was encouraged by DEPAPRO staff, and the FFS groups finished activities when DEPAPRO ended, showing that groups relied on external facilitation and funding to sustain their FFS learning activities. However, FFS farmers experienced a temporary impact on their bridging social capital because their participation in DEPAPRO facilitated the interaction with students, facilitators and specialists in livestock production (see Chapter Four). Such interactions have been described as positive for the human and political capital because farmers obtain more access to technical information, and learned how to work in groups and how to express their opinion in public (Johnson et al. 2003, Mitei 2011). Farmers indicated that in 2003 they had less contact with organizations and individuals than in 2008, especially with those related to farming because some farmers cited their participation in religious organizations (Figure 6.7).

The increase in the number of organizations and individuals working with farmers was more evident for small farmers who historically had less chance for establishing links with external organizations than medium scale farmers. Small farmers became involved with two types of organizations mainly: (1) NGOs associated with DEPAPRO such as ProPetén; and the Women Association from Petén Ixquik, both working with women groups in most of the study villages. The former is directly related to the FFS, whereas the latter is an independent NGO which had no formal collaboration with DEPAPRO. (2) Local organizations related to the structure promoted by the Guatemalan government such as COCODEs (Committee for Community Development). The latter can be considered as the current traditional organization in Central Petén, because all villages had formally established COCODEs (CMD and SEGEPLAN 2010b, 2010a). These organizations are more active when support for improving the built capital of the villages is needed; and even sub-committees in charge of specific projects are formed. For example, the installation of the electricity services in Santa Rosita and La Amistad required the organization of a local electricity committee in both villages.



a)



b)

Figure 6.7. Informal network analysis for FFS participant households from La Sardina, Petén, Guatemala for the years 2003 (a) and 2008 (b).

Evidence of bonding social capital was scarce among FFS farmers because significant differences in the number of products exchanged were not found; nor the number of community work performed by each type of participant group increased. However, seven FFS farmers exchanged atypical products such as pasture, cut-and-carry grass, leucaena seeds, stem cuttings for live fences and trees. The most notable cases of FFS effects related to bonding social capital was a small scale FFS farmer who described how a middle scale FFS farmer approached to work cattle "*a medias*" (sharecropping). This relationship occurred because the medium scale farmer observed improvements in the paddocks of the small scale farmer produced as a result of his FFS participation. Similarly, another small scale farmer helped a group of women to become organized to obtain a credit for poultry raising. The group was comprised of women who participated in DEPAPRO's FFS on improved poultry management. However, all the participating FFS groups ceased their meetings when the project finished in December 2008.

Several reasons influenced the lack of interest from FFS farmers for continue working as a group, among them: the continuing negative impact of the civil war on the social capital; previous conflicts among FFS participants which limited their potential for working together; and the lack of learning sessions in the FFS curricula on how groups work. Conversely, results from other FFS experiences elsewhere showed evidence of strengthened bonding social capital influenced by their participation in agricultural FFS groups. For example, David and Asamoah (2011) identified informal trainings provided by FFS members to their relatives and neighbours as a positive impact on social capital. Such study also reported that FFS groups remained active after the project finished mainly to share new information.

Moreover, Kisha and Heinemann (2005) described that in Kenya grants managed by farmers was the key factor that motivated farmers to become organized and even created an impact on the political capital because FFS farmers were able to develop skills to obtain additional funding. The same authors reported the formation of FFS networks organized by FFS members as a positive impact of FFS on the social capital. Owenya *et al*. (2011) described the spontaneous creation of conservation agriculture FFS groups, after observing the activities developed by pioneering groups in Tanzania. However, this research also identified a negative effect related to the social capital, farmers got in conflict with pastoralists for the control of crop residues, because before they learned about the use of crop residues for improving soil fertility, those were sold at cheap prices to pastoralists (Owenya *et al.* 2011).

6.4.2.3. Cultural capital

Despite the relevance of cultural capital for understanding the decision making process of farmers regarding the use of the natural capital (Berkes and Folke 1992), it is one of the assets less analyzed in FFS impact studies. This is because methods for measuring material assets are traditionally applied in impact assessment studies; but it also is difficult to define what cultural capital indicators evaluate. In this study cultural capital is defined as suggested by Flora *et al*. (2004) as: "...the filter through which people live their lives, the daily or seasonal rituals they observe, and the way they regard the world around them". As the aim of the study is to assess the impact of the FFS in the human assets of livestock farmers, the analysis was directed to identify the ethnic background of farmers and to explore the potential influence of the FFS in the image of traditional cattle production practices.

The *ladino* farmers did not consider themselves as part of a cultural group, only two farmers identified themselves as *ladinos* and two more as "*de oriente*" (from the East). Eight farmers of indigenous origin belonged to Mayan groups, two were Q'eqchi' and six Kaqchikel. However, it is not easy to differentiate indigenous and *ladino* farmers because the former have been acquiring customs from the *ladino* culture, such as clothing and housing. Indigenous farmers were the only ones citing examples of reciprocity as part of their cultural legacy; for example five farmers shared the management of one farm because their parents encouraged them to work together.

On the other hand, all farmers explained that were using different farming practices in Petén than in their places of origin, because in Petén there are less constraints to work the land; and environmental conditions are different. Most farmers stated that land preparation was more difficult in their place of origin because it required the use of tractor or hoes, compared to the traditional land preparation used in Petén (see seasonality section). Moreover, they also mentioned that in their place of origin the land was less fertile, and the climate was dryer.

The impact of DEPAPRO on the cultural capital is related to changes in the conceptualization of pasture production from exclusively pastoral to silvopastoral. Now farmers have more interest in incorporating more trees in their paddocks (Anfinnsen *et al.* 2009), a production approach encouraged by DEPAPRO FFS; but also influenced by the need of firewood that could be provided by silvopastoral systems. Furthermore, the opportunity for harvesting poles or tree stem cuttings for fence renovation is another important driver for increasing farmers' interest in trees. More FFS farmers (19 small, 18 medium) declared they had planted or allowed the regeneration of trees in their paddocks than control farmers (13 small, 10 medium).

The most frequently mentioned species established in paddocks and live fences were in the Leguminoseae (Fabaceae) family (Figure 6.8); few examples of species frequently used for that purpose are "*madrecacao*" (*Gliricidia sepium*) and "*pito*" (*Erythrina* sp.). Small and medium scale farmers who attended FFS were able to list a higher number of three species (5.3 and 6.3 species/farmer) than those in the control groups (3.3 and 4.5 species/farmer) mentioned by small and medium control farmers, respectively. Trees in paddocks are used for fencing, whether as "*brotones*[40]" or poles; for timber in the case of older trees; shade for the cattle; and firewood. However, FFS farmers mentioned more non-conventional uses than control farmers, i.e. the use of tree products as fodder sources.

[40] Colloquial term used in Petén for any tree species established in living fences.

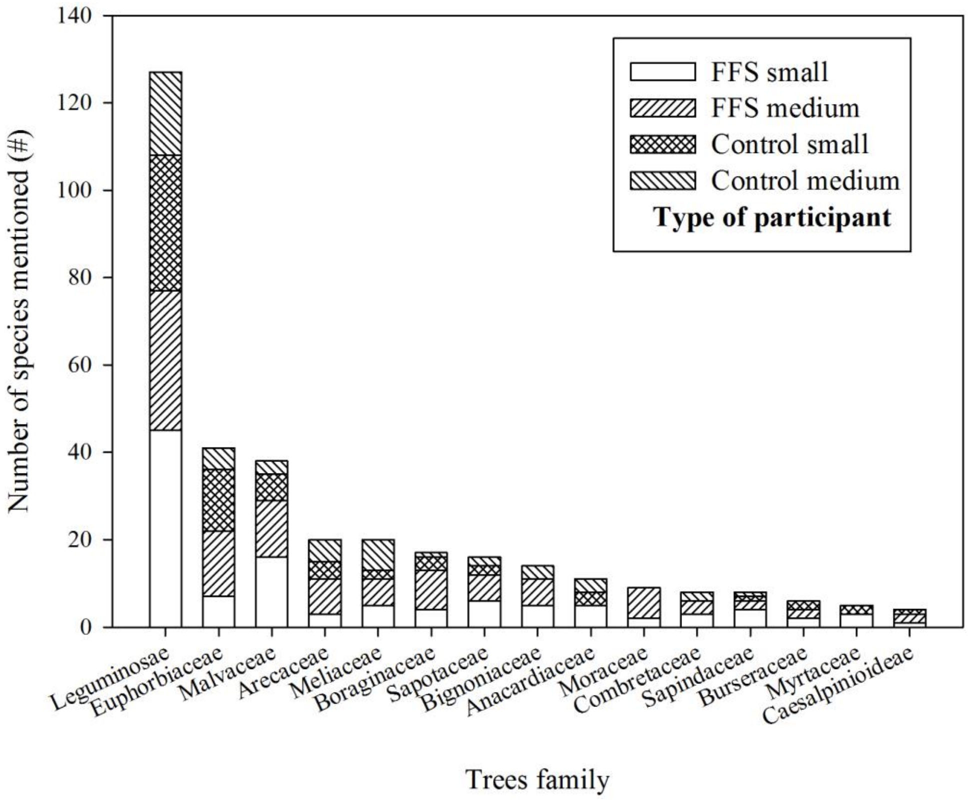


Figure 6.8. Top 15 most mentioned trees in paddocks by participant group.

The second impact from the FFS related to the cultural capital is the change in the conceptualization of forage for cattle. All the farmers used the word "*pasto*" (pasture) to identify the fodder eaten by cattle, which in Central Petén corresponds to either natural and improved pastures (Cruz *et al.* 2007). However, in 2008 most FFS farmers recognized the existence of other fodder alternatives such as tree foliages, herbaceous legumes and cut-and-carry grasses. Farmers also diversified their supplement sources because in 2003 the most commonly used were three: salt, molasses and in some cases commercial concentrates; whereas in 2008 more farmers reported the use of other sources such as mineral salts, maize, urea and silage. Wilcoxon signed-rank tests showed significant increases in the number of feed sources used in 2008 compared to 2003 for FFS small (T(1, n=20)=186.5, $p<0.05$, r=-0.83); FFS medium (T(1, n=19)=120, $p<0.05$, r=-0.79); and control small farmers (T(1, n=21)=36, $p<0.05$, r=-0.55). Only in the medium scale control farmers statistically significant differences were not identified (T(1, n=12)=39, p=0.06, r=-0.57) (Figure 6.9).

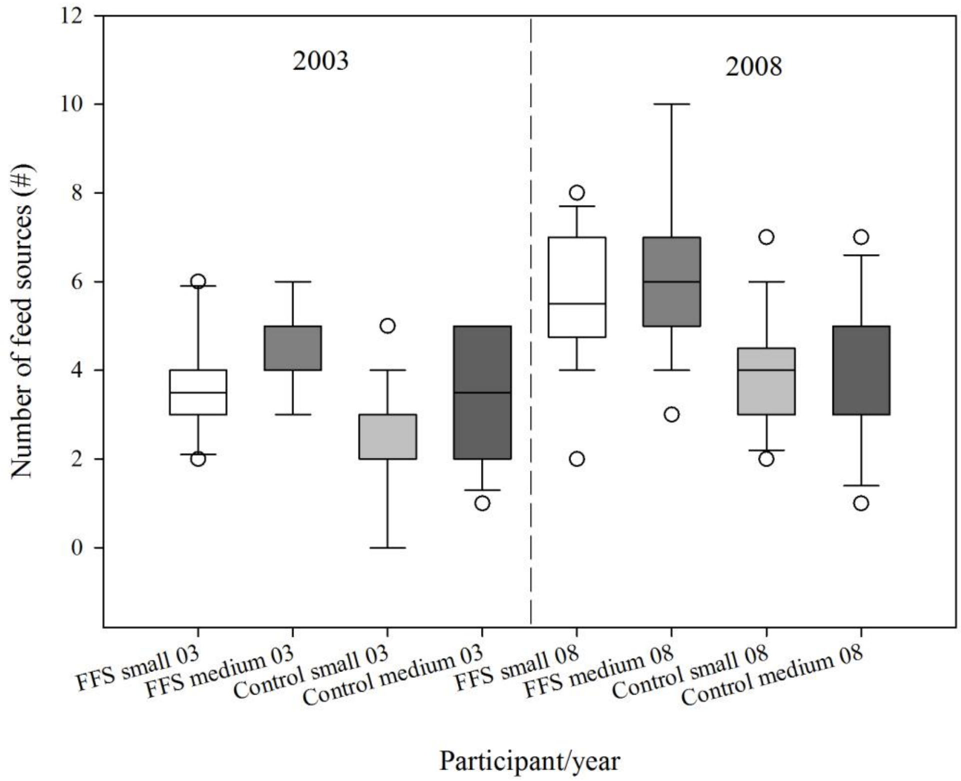


Figure 6.9. Number of feed sources used as function of participating farmer groups and year.

The latter showed that in Central Petén farmers tend to diversify the feed sources used for cattle. A Kruskal-Wallis test found significant differences in the total number of fed sources per participant group in 2003 ($H(3, n=72)=15.1$, $p<0.05$). However, Mann-Whitney tests with Bonferroni corrections used as *post-hoc* comparisons showed that the number of feed sources was significantly higher only between FFS medium and control small farmers. Conversely, a Kruskal-Wallis test for 2008 was significant ($H(3, n=75)=22.4$, $p<0.05$), nonetheless, the *post-hoc* comparisons showed a higher number of feed sources used by FFS farmers while compared with small control farmers (Table 6.4). Using diverse forage resources is considered a suitable strategy for improving cattle production systems in Central America, because different sources can be combined to complement each other, for example forage peanut or leucaena are legumes rich in protein compared to commonly used grasses (Argel 2006, Lentes *et al.* 2010). Moreover, the use of a diversity of species is a strategy to mitigate forage scarcity during some critical periods of the year (Ospina 2010), and eventually could also help to mitigate climate change.

Table 6.4. *Post-hoc* comparison of the number of feed resources 2003 and 2008 by participant type.

Year	Farmer comparison	U	p	r	Feed sources		
	FT_1-FT_2				$FT_1\bar{R}$	$FT_2\bar{R}$	$\Delta\bar{R}$
2003	SCTR-MCTR	11.8	0.640	0.28	23.9	35.8	-11.8
	SCTR-SFFS	-14.8	0.117	-0.36	23.9	38.7	-14.8
	SCTR-MFFS	-24.6	0.001*	-0.61	23.9	48.6	-24.6
	MCTR-SFFS	-3.0	1.000	-0.07	35.8	38.7	-3.0
	MCTR-MFFS	-12.8	0.518	-0.31	35.8	48.6	-12.8
	SFFS-MFFS	9.9	0.773	0.24	38.7	48.6	-9.8
2008	SCTR-MCTR	8.4	1.000	0.19	22.6	31.0	-8.4
	SCTR-SFFS	-22.0	0.005*	-0.51	22.6	44.7	-22.0
	SCTR-MFFS	-29.4	0.000*	-0.68	22.6	52.1	-29.4
	MCTR-SFFS	-13.6	0.419	-0.31	31.0	44.7	-13.6
	MCTR-MFFS	-21.0	0.039	-0.48	31.0	52.1	-21.0
	SFFS-MFFS	7.4	1.000	0.17	44.7	52.1	-7.4

Notes: FT_1: First farmer type. FT_2=Second farmer type. *U*=Mann-Whitney test. *r*=Effect size. *p*=p-value. $\bar{R}$=Average mean rank. $\Delta\bar{R}$=Average mean ranks difference. *=p< 0.008. SCTR=Control small. MCTR=Control medium. SFFS=FFS small. MFFS=FFS medium.

6.4.2.4. Political capital

Political capital has been recently integrated as an asset in the Sustainable Livelihoods Approach. The necessity of such inclusion was evident after observing that political capital was used as a resource for producing other capitals; and also because their lack can be an obstacle for asset access and livelihoods sustainability (Pari and Subir 2001, Haan and Zoomers 2005). During this research political capital was defined as: “the ability of a group (or individual) to influence the distribution of resources within a social unit, including setting the agenda of which resources are available” (Flora *et al.* 2004).

The impacts of FFS on the political capital of farmers were limited to an increase in the reputation of small scale FFS farmers because of their strengthened knowledge in cattle production; and the development of skills for negotiation and participation in rural development projects. The latter was observed mainly in female relatives of FFS farmers who became leaders of women groups organized by them while participating in FFS on vegetable and improved poultry management led by DEPAPRO (Dahlmann-Hansen 2007). Similar results have been reported for cocoa integrated management crop FFS members in Cameroon (David 2007); or by poor women in India who through their enrolment in self-help groups influenced the inclusion of women issues in the agenda and facilitated their access to credits (Bantilan and Padmaja 2008); or by a regional evaluation of FFS on crops and livestock in East Africa (Davis *et al.* 2012).

Even though more FFS members held leadership positions than control farmers, the Kruskal-Wallis tests did not detect significant differences between groups for 2003 ($H(3, n=78)=2.3$, $p=0.52$), 2008 ($H(3, n=78)=3.4$, $p=0.34$), for other years ($H(3, n=78)=5.9$, $p=0.11$), and in total ($H(3, n=78)=5.6$, $p=0.13$). However, the overall number of participants with leadership positions was higher in 2008 than in 2003, in part due to the creation of the local committees for the installation of electrical services in La Amistad and Santa Rosita promoted by FFS members of those communities. Moreover, the creation of boards in the FFS women groups led by DEPAPRO or encouraged by independent NGO's such as Ixquiq facilitated the participation of women in leadership positions. Some small farmers also mentioned that the relationship of the villagers with the local government improved; however, this was a result of the election of new mayors for Santa Ana and Dolores municipalities, rather than due to the FFS.

According to participants, in the past they got involved in leadership positions in small organizations such as the landless groups who established cooperatives or villages in the study area (Figure 6.10). Later, farmers participated in the board of cooperatives; and in charges enforced by the government forces during the civil war such as chiefs of civilian patrols or military commissioners. Nowadays, the power structure in the villages is comprised of local organizations participating in infrastructure projects, board of cooperatives, and COCODEs. Furthermore, some farmers are recognized as natural leaders and their opinions are respected because of their skills in negotiating with authorities and external organizations. In some cases village leaders held the main charges such as auxiliary mayors and COCODE presidents, however, some hold lower directive positions, or some have none. The leadership and participation skills of both control and FFS farmers was developed by their participation in all those organizations, thus, it was difficult to sort out impacts caused exclusively by the FFS.

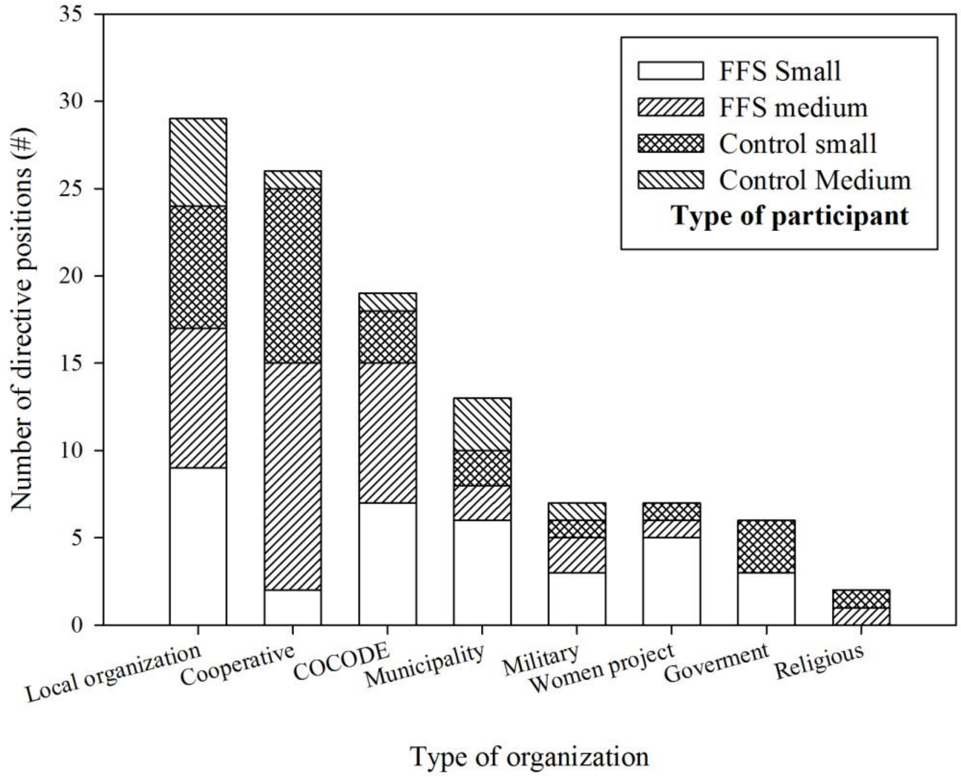


Figure 6.10. Number of leadership positions held by farmers by type of participant and organization.

6.5. Concluding remarks

The integrated use of the SLA and the CCF allowed the identification of human factors influencing the FFS impact on the livelihoods of livestock farmers in Central Petén, Guatemala. First, the vulnerability context elements pointed out the necessity of including integrated and holistic frameworks for planning rural development projects, otherwise such factors will limit the impact of FFS (Meinzen-Dick and Adato 2007). A shock such as the civil war which severely affected farmers' livelihoods requires local strategies and national policies to be combined to encourage strengthening of capitals and facilitating sustainably sound impacts (Pretty and Ward 2001). Moreover, vulnerability to natural disasters such as hurricanes and flooding would be a barrier for the practice of silvopastoral systems and other forage alternatives unless the land for its establishment is carefully selected; and alternative forages have the capacity to tolerate short term flooding conditions in farms located in the Western part of Dolores municipality.

Population increases, deforestation, price fluctuations, urbanization, and market development are related to Policies, Institutions and Processes from SLA. Those have mixed effects on farmers' livelihoods. Some of these trends increased the local demand for cattle products; and some facilitated the importation of products from neighbouring countries or other regions within the country (Shriar 2006). Farmers recognized the importance of those trends; however, they have invested few resources to control the negative impacts of those factors on their livelihoods. As expected from any element considered as part of the vulnerability context small and medium scale farmers have low capacity for influencing such factors individually. However, strengthened social and political capitals helped farmers to manage constraints related to market access and product prices (Rölling 1988, Sanginga *et al.* 2007, Friis-Hansen 2008).

Seasonal lack or excess of rainfall affected farmers' livelihoods, and especially material assets. Those factors influenced crops, fodder and cattle products availability, management and prices. The identification of prices as a limiting factor indicates that farmers have interest in market oriented production. Additionally, small scale farmers were also interested in crops because those are means to facilitate food security for the household. Again, most farmers were interested in alternatives for improving the availability of water, fodder and cattle management practices, however, most of them were not involved in activities to add value to their farm products. The latter is an aspect to be considered for diversifying the curricula of the FFS to encourage that the benefits obtained from improved cattle production are obtained by farmers and not captured by intermediaries. This would require further investment in human resources and the inclusion of organizational and collective marketing FFS learning sessions.

The evidence showed that the FFS had a positive effect on the human capital. The most significant change encouraged by the FFS on the human capital was an improvement in technical knowledge. Such change can be associated with the facilitation of a similar process to the one commonly used by farmers for learning about new farming practices (Pretty *et al.* 1995). This included opportunities for exchanging information with other farmers and stakeholders, personal observations carried out during exchange visits to neighbouring farms and practical experience with potential feed alternatives through on-farm trials (Cramb and Culasero 2003, Franz *et al.* 2010). On the other hand, most of the technologies promoted by DEPAPRO, i.e. silage, nutritional blocks and cut-and-carry grasses require a higher availability of labour. This may limit their use by small scale farmers with less capacity to provide family or hired labour (Murgueitio *et al.* 2006).

The FFS approach showed a limited effect on the social capital of FFS farmers. Conversely to the effects cited in other agricultural FFS experiences, neither small nor medium scale FFS farmers showed interest in working together as a group beyond DEPAPRO, nor formed higher associations of FFS groups. Negative impacts in social capital caused by the civil war, the lack of learning sessions on how to organize groups and lack of more empowering opportunities such as controlling the budget assigned to each FFS group or the formation of FFS boards, were identified as the main factors which limited further impacts in the bonding social capital. The implications of such results are that further efforts should be encouraged for strengthening bonding social capital. Otherwise, community development opportunities will be limited because of the lack of interest in local organization and the dependency on external aid (Flora *et al.* 2004), this is because social capital is considered an asset that enhances positive effects in other capitals (Emery and Flora 2006).

The significant impacts promoted by the FFS relating to the cultural capital were observed as changes in the conceptualization of traditional elements in cattle production systems from pastoral to silvopastoral approaches. Such changes can be the first step for further positive impacts in the natural capital through: (a) the diversification of paddocks layouts with higher tree cover and silvopastoral practices; and (b) the use of alternative feed resources such as fodder trees and herbaceous legumes. This is because cultural capital influences how farmers use the natural capital for establishing a given livelihood strategy (Berkes and Folke 1992). Nonetheless, an appropriation of the sustainable sound concepts in farmers knowledge and their application will require evidences of the benefits produced by their use, i.e. better body condition score in cattle (Burton *et al.* 2008).

Finally, the FFS impacts related to the political capital were focalized in small scale households and especially in women who participated of other DEPAPRO FFS. As a consequence of the low impact observed in the bonding social capital the effects of the FFS in the political capital were restricted to cases of "power within[41]" farmers (Haan and Zoomers 2005), without direct community developmental effects. Furthermore, the power structure observed in the villages did not change, except for the inclusion of more women in directive positions in local organizations. Following the latter, it was observed that even when the villages apparently have democratic local organizations, power is clustered in certain groups or individuals. This caused a negative effect in social capital because many farmers are frustrated by the results obtained in previous initiatives, or by how the outcomes of some programmes are managed (Dahlmann-Hansen 2007).

It is evident that the FFS approach is fulfilling its role as an adequate strategy for facilitating the learning of new technologies for livestock agroecosystems intensification and for their integrated management. The FFS approach as encouraged by DEPAPRO had important immediate effects in the human and cultural capitals that positively affected the livelihoods of participating farmers. More effects related to the FFS would be observed later on because farmers could decide to change their assets based on the experiences obtained during their participation in the FFS. However, the results also pointed out that the use of the FFS for enhancing developmental impacts such as community development were limited by the vulnerability context of the study areas; and by the status of social and political assets. Therefore, rural development initiatives aiming to have further impacts in community development must consider the latter factors and facilitate the integration of activities for strengthening the four human assets.

6.6. Acknowledgements

This study was possible thanks to the financial support from The Government of Norway and The National Council of Science and Technology from Mexico. Furthermore, it is necessary to recognize and thank the support received by the

[41] Individual changes in the confidence and consciousness of farmers for implementing their livelihoods (Haan and Zoomers 2005).

DEPAPRO national coordinator in Guatemala; and the voluntary participation of farmers in Petén, Guatemala.

Chapter 7. General discussion and conclusions

7.1. Key findings

7.1.1. What was learned about facilitating sustainably sound livestock production?

This thesis described the process and impacts of the first adaptation of the Livestock Farmer Field Schools (FFS) approach to the conditions of small and medium size livestock farmers in Central America. Mixed methods (quantitative and qualitative) were used under the integration of the Sustainable Livelihoods Approach (SLA) and the Community Capitals Framework (CCF), which served as the theoretical framework for the analysis. FFS and DEPAPRO had a positive effect for most stakeholders that participated in the study, especially by strengthening their human capital. As the development of sustainable sound livelihoods requires a better understanding of the ecological interactions in the agroecosystem, the knowledge acquired by FFS participants is expected to facilitate the transition towards sustainable livestock production systems in their farms (Pretty 2008). Immediate impacts on the human and material capitals support the findings of previous FFS experiences elsewhere, where the capacities strengthened by the FFS facilitated the comprehension and use of knowledge intensive approaches such as in the case of Integrated Pest Management (IPM) (Pontius *et al.* 2002).

The thesis is comprised of four main chapters: (i) Chapter Two was a literature review of the main concepts related to the theme of this thesis, focused particularly on identifying factors promoting and limiting the practice of silvopastoral systems. (ii) Chapter Four consisted of a critical reflection about DEPAPRO experience, the project that promoted the FFS process in the three Central American countries where the project was conducted. Moreover, a qualitative investigation of DEPAPRO strengths and limitations was done, which was based on the perception of members of the different stakeholder categories that participated in DEPAPRO. (iii) Chapter Five focused on the main activities carried out by the livestock FFS in Petén, Guatemala. The aim was to identify which sustainably sound practices were tested by farmers; and which factors influenced farmers' preference for those practices. (iv) Chapter Six assessed the effects of the FFS approach on the human assets of farmers from the pilot area of El Chal, Petén, Guatemala. Therefore, the chapters are complementary and allowed to understand how the livestock FFS impacted on the main stakeholders of DEPAPRO.

7.1.2. Rural development, innovation sources and silvopastoral systems adoption

The literature review explored the establishment of the relationship between origin of technology innovation and the practice of silvopastoral systems (SPS). A top-down rural development ideology was predominant in Central America, and this facilitated the implementation of non-participatory schemes for agricultural technology innovation. Under such approach farmers' needs and capacities were underestimated and consequently not included in technology generation. Thus, agricultural technology innovation did not consider the real issues of farmers and the assets they had for building their livelihoods (Haan and Zoomers 2005). As a result of it, poor farmers did not have interest in those agricultural technologies that required a higher level of knowledge, external inputs and complex management.

The latter can be appreciated in the current practice of SPS in Central America. Live fences and scattered trees in paddocks are technologies developed by farmers; or are the result of the capacity of particular tree species to withstand adverse factors such as herbivory, trampling and fires. Consequently, their practice is more common in the livestock landscapes of Central America than that of SPS options generated in research centres such as alley pastures and fodder banks (Carter 1995), designed under different conditions than those observed in smallholder farms, thus they are likely to require resources not commonly available or traditionally used by farmers such as intensive rotation of pastures (Argel *et al.* 1998, Gutteridge 1998). Therefore, their practice is limited to some areas where agroforestry development or research projects have worked. A closer interaction between farmers, technical staff, and rural development organizations remains as desirable for facilitating sustainably sound farming (Rölling and Jiggins 1998, Peters and Lascano 2003).

7.1.3. Adaptation of the farmer field schools approach to livestock production systems under the Central American context

The history of DEPAPRO was documented and critically described in Chapter Four. By using a documentation approach (Jara 1994), the different stakeholders involved in

DEPAPRO helped to reconstruct their experience considering the particular context of each pilot area where DEPAPRO organized FFS in Central America. The Policies, Institutions and Processes at the national and regional scales were found to be weak for supporting sustainable livestock production (Aguilar *et al.* 2010). Consequently, DEPAPRO promoted changes such as the formation of alliances, coordinated action between organizations working with cattle production or extension services and strengthening the human capital of professional and technical staff. Such alliances have been suggested as an alternative for encouraging the construction of learning processes based on the integration of local and scientific knowledge (Zanetell and Knuth 2002). Specialists and facilitators established collaboration links which are expected to support the shift towards sustainable livestock production systems. However, further work is needed for creating policies that will support the establishment of sustainable livestock production, which has been a bottleneck for rural development projects emphasized by the SLA (Ellis 2000).

The use of holistic and integrated frameworks such as SLA and CCF helped to identify the influence of hindered and excluded factors in the outcomes of previous rural development programmes. The dole-out approach used by some of the organizations that worked in the pilot or anchoring and expansion areas; and the negligent behaviour of some of their staff created a biased image of "projects" as input providers and creators of false expectations. Such kind of background causes a lack of interest in participatory rural development projects, which was referred by some stakeholders as a "non-participatory culture". This represents a challenge for any rural development initiative working with participatory approaches such as the FFS, because farmers and other stakeholders expect to receive material incentives in exchange for their participation. Furthermore, the negative effects caused by shocks such as the civil wars of Guatemala and Nicaragua on the human and social capitals of rural households, suggest the need of further strategies for strengthening human assets among FFS participants.

The documentation of DEPAPRO work contributed to the identification of which farmers preferred to participate in livestock FFS: (i) small farmers; and (ii) medium scale farmers with significant limiting factors. Even when large farmers were not invited to participate in DEPAPRO, it is clear that they are less attracted by the FFS approach because they tend to have more experience with livestock, no financial restrictions to pay for private technical assistance and some of them do not live in the farms, close to the area where FFS activities were carried out. The last point is important when defining a strategy for facilitating sustainable livestock production in large farms. As large farmers rely on hired workers for farm management, permanent labourers should be invited to participate in FFS instead of the owners.

Smallholder farmers, with limited assets, are the best candidates for the FFS work because of their lack of financial assets to pay for private technical services; and some of them have less experience with cattle management. Thus, they valued more the efforts for strengthening their human capital. Medium scale farmers are less interested in the FFS approach if they already have experience in livestock production, are able to access to private technical assistance, or do not perceive important issues affecting their productivity. For instance, medium scale farmers from the upland Aguan valley in Honduras showed more interest in FFS than medium scale farmers from other areas in Honduras, Guatemala and Nicaragua because the dry season was severe and caused cattle mortality. Similar interest by those farmer categories have been reported in other participatory approaches such as the farmer-to-farmer (Holt-Giménez 2010) and the local agricultural research committees (Ashby *et al.* 2000).

The experience of DEPAPRO also highlighted the opportunity for combining participatory, qualitative and quantitative methods for planning, monitoring and evaluating rural development initiatives. Particularly, the participatory appraisal and annual evaluation and planning meetings scheduled by the FFS were strategies for incorporating farmers' voices in the agenda to be addressed by DEPAPRO. However, such opportunities brought up other issues such as not addressing certain topics suggested by farmers, because they exceeded the "focus" and "capabilities" of DEPAPRO. It is recognized that some improvements pointed out as necessary by farmers such as roads, running water facilities and other community infrastructure were beyond the scope and budget of DEPAPRO. However, addressing topics related to the financial capital such as collective marketing and access to credit opportunities; or strengthening the social and political capital for supporting the creation of policies on sustainable livestock systems are topics that should be considered by future initiatives (Ashby and Sperling 1995, Pretty 1998, Rölling and Jiggins 1998, Ellis 2000).

Individual rather than group experiments were used in the FFS groups from the pilot areas, which was a marked difference between the FFS approach encouraged by DEPAPRO and previous experiences reported elsewhere. The consequences of such a strategy were both positive and negative. In early stages of DEPAPRO the support for establishing individual experiments motivated the interest of cattle farmers in the FFS. Moreover, FFS farmers and facilitators observed the development of the experiments under different bio-physical conditions present in the different participating farms; and the material contribution of DEPAPRO to the experiments helped to overcome the financial barriers for the implementation of some practices. However, individual plots also increased the costs of running the FFS and may limit the development of bonding social capital if additional activities of monitoring are not scheduled, or the evaluation by FFS participants are not properly facilitated. Given the lack of public resources for funding rural development projects in Central America, future livestock FFS experiences will have less chance to use individual experiments without external or self-funding support. Thus, adapting the use of group experiments to the livestock FFS is necessary.

DEPAPRO FFS were based on seven main activities: zig-zag approach for FFS guidelines adaptation, experiments, discovering exercises, group dynamics, exchange visits, demonstration plots and facilitation of special topics. The combined use of all those strategies is expected to contribute to speed up the adoption of sustainably sound livestock practices because the use such set of diversified strategies for learning has been pointed out as a main factor for the adoption of fodder shrubs in East Africa (Wambugu *et al.* 2011). However, agroecosystem analysis (AEA) was not pointed out as the foundation of the FFS approach in DEPAPRO. The use of AEA has been suggested as being essential by previous FFS on livestock management (Minjauw *et al.* 2002, 2003). In DEPAPRO the use of the latter approach was restricted to some exercises included in the learning sessions, which may have limited the possibilities of discovering a broader understanding of the ecological principles of sustainably sound livestock management, and the capacity to adapt the alternative practices to the specific needs of the farmers. Future FFS initiatives in livestock production should include a combination of the learning zig-zag approach if new topics need to be addressed.

The anchoring and scaling up phase helped to validate the FFS approach. In this phase partner organizations were encouraged to organize and facilitate new FFS groups. This increased the number of farmers participating in FFS groups; but as well brought new challenges such as funding their implementation, facilitating the appropriation of the FFS approach, and facilitating learning about technical aspects of sustainable livestock production and monitoring the FFS group's activities. Despite budget limitations, most of the partner organizations agreed to support this phase with their own human and logistic resources. Moreover, some partner organizations officialised the FFS; and even changed their conventional approach of lecturing for the facilitation of learning. This allowed undergraduate students to discover the FFS approach during their professional education. Therefore, the impact of DEPAPRO in some partner organizations has gone beyond its lifespan and continued facilitating the learning on livestock production systems in Central America (Pezo *et al.* 2010).

The documentation also showed that each stakeholder had a different view about DEPAPRO and the effects encouraged by the FFS. More human capital changes were observed in decision makers and facilitators. Instead, partner farmers and promoters referred more to the changes in the material assets of the FFS participants, especially the natural capital; whereas supervisors, specialists and students suggested more changes in their cultural capital. Human and cultural capital changes are regarded as the main contribution of DEPAPRO towards the practice of sustainably sound livestock production systems, because FFS facilitated learning, frequent encounters between professional staff and farmers, and a more human interaction among stakeholders.

7.1.4. Factors favouring and limiting the use of sustainable livestock practices

The factors that favoured or limited the testing of intensive livestock practices, especially of *Leucaena leucocephala* fodder banks (hereafter referred as leucaena) in Petén, Guatemala were investigated in Chapter Five. The literature review and fieldwork showed that farmers in Petén have started to use more intensive practices, favouring the decision of FFS farmers to test and learn about the technologies encouraged by DEPAPRO. The participatory technology evaluation showed that FFS farmers preferred intensive technologies such as rotational grazing; whereas control farmers valued more conventional practices used in Petén such as planting *Brachiaria* *brizantha* pastures. Moreover, the reasons behind the interest in more intensive livestock technologies were mainly associated with factors related to the natural and cultural capitals. This suggests that the financial capital is not the only factor that farmers consider for selecting which practices they use, instead farmers showed interest in practices providing benefits for cattle, the pastures, or the soil; or those more compatible with their stock of assets.

The main barriers to implement some technologies not tested in the farms were factors related to the financial capital (Lapar and Ehui 2003, Murgueitio *et al.* 2006, Murgueitio *et al.* 2011). However, such issues were less frequently voiced by pilot area FFS participants. These participants had a longer involvement in FFS, and their opinions about intensive practices changed as a result of the learning process encouraged by DEPAPRO. Such process requires time because learning is based on experimentation, observations and reflection, a process farmers in Petén had to go through when deciding which technologies were implemented. Similar results were not observed in the participants of the FFS established subsequently in the anchoring and expansion areas, who had less time engaged in such learning process.

Beyond financial issues, the second most cited limitations for testing technologies identified by FFS males from the pilot were those related to the natural capital. In contrast, farmers from the anchoring and expansion area pointed out factors related to the cultural capital; and control male farmers pointed out factors associated to the built capital. The latter suggest a trend where farmers not exposed to the FFS learning process cited more material limitations. Farmers with less FFS experience cited more financial and cultural aspects because of their perception about the benefits from a given technology is influenced by the conventional cognition about farm elements (cultural capital). Finally, FFS graduates with more experience testing intensive practices, pointed out financial and natural capital limitations. This is because experimenting with the technologies for longer time allowed farmers to identify adaptation issues associated to land and management limitations. The lack of medium and long term evaluations of SPS has been pointed out as a barrier for further practical experience and adoption in Mexico (Nahed-Toral *et al.* 2010).

On the other hand, aspects related to the social and political capital were rarely identified by farmers as factors favouring or limiting the establishment of intensive practices. Political capital was considered a limitation just by one of the participants in the participatory technology evaluation; whereas the importance of social capital was not suggested individually, but discussed by one group of participants while analysing the leucaena learning process. The livestock FFS had limited effects on the social and political capitals because elements of the vulnerability context such as the civil war have historically limited their strengthening. Moreover, the use of certain strategies used by DEPAPRO in the pilot area of Petén such as the use of individual experimental plots limited the creation of bonding linkages among FFS farmers.

From the range of practices that FFS farmers tested in Petén leucaena plots were one of the most preferred and tested practices. This is interesting because even projects offering financial incentives have struggled to overcome fodder banks associated constraints such as the high demand for labour. Rather than an immediate and spontaneous preference for testing leucaena, DEPAPRO had to find out strategies for motivating the interest of farmers in such practices. Those included video presentations, discussions, the funding of a demonstration plot, and to conduct exchange visits to such plot. The latter was essential for farmers to get decided for testing leucaena after they participated in group sessions visiting the demonstration plot, especially after they observed cows eating leucaena leaves.

The factors influencing leucaena testing varied according to the method employed for their identification. The limiting factors in previous studies were related to the financial, natural, human and cultural capitals, especially high establishment and management costs. The participatory technology evaluation confirmed issues related to the financial capital issues as a main factor limiting leucaena, because farmers considered that establishment costs were expensive. Moreover, farmers also identified limiting factors related to the natural capital because they explained that leucaena growth was slow and affected by pests. This was linked also to issues related to the human capital because farmers and even some experts and facilitators had little practical experience with leucaena management. Finally, the logistic regression model identified a negative effect of farmers practicing the dual-purpose production systems (FaDual) which was related to larger investments done by those farmers in other technologies that limited the availability of money and time for leucaena management.

The most mentioned factors favouring leucaena testing suggested by farmers in the participatory technology evaluation were associated with the natural capital such as providing forage for cattle and proteins; or even less directly observable attributes such as fixing nitrogen and improving soil fertility. Moreover, farmers identified financial capital factors such as increasing milk production; and aspects related to the cultural capital such as practical management. On the other hand, a logistic regression model also identified three variables as positive related to leucaena testing: one of them was related to human capital (1) the percentage of attendance to the FFS (Attend). Another was considered an interaction between human and financial capital: (2) the number of practical FFS sessions attended (NumPra). The third one was linked to an interaction between the human and natural capital: (3) having forest in the farm (FaForest). As the first two variables were associated to the FFS, the approach used by a given project determines the interest of farmers in testing sustainable sound practices. However, in the case of innovations that require space for its trial such as leucaena and pastures, the abundance of suitable land for their establishment is also important. Most farmers will be reluctant to risk already established pastures for testing a less known fodder option (Dagang and Nair 2003).

7.1.5. FFS impacts in the human assets of livestock farmers in the DEPAPRO pilot area of Petén, Guatemala

The FFS impacts in the human assets of livestock farmers from the pilot area of Petén, Guatemala were investigated in Chapter Six, following a combination of the SLA and the CCF as the basis for the evaluation. This stage also included an in-depth review of the elements of the vulnerability context that were voiced by FFS farmers during Focus Groups Discussions (FGD). As suggested by the SLA the elements from the vulnerability context were classified in: (a) shocks; (b) trends; and (c) seasonality factors (Table 7.1). The main shock suggested by farmers was the civil war (1960 to 1996), which resulted in short and medium term impacts in material assets; and long term impacts on human assets which affected the outcomes of rural development projects.

Most of the trends observed were related to demographic, land use change and market factors, in most of the cases those were considered as limitations for the livelihoods of farmers. The exception was the urbanization of the villages from the study area which was considered as a positive trend because according to the farmers more access to electricity, running water, education and health improved their quality of life. On the other hand, farmers also noticed increases in the price of inputs and weak market opportunities especially for beef (fattened steers and culled cows). These factors were explained in part by the integration of Petén to the regional economy, because more farming products are easily transported and distributed within the region (Shriar 2006). However, farmers have made few efforts for improving the commercialization of their products, by forming organizations for negotiating better prices for either the purchase of farming inputs or selling their products. This lack of social capital reduces the possibility of influencing local and national policies affecting the livestock sector such as taxes or international trade agreements. For example, the Guatemalan government has favoured the importation of cattle and by-products from Central America; and more recently with the tariff reductions of CAFTA from the USA.

Table 7.1. Elements from the vulnerability context influencing the livelihoods of livestock farmers in Central Petén, Guatemala.

	Vulnerability context	
Shocks	***Trends***	***Seasonality***
Civil war	Immigration	Fodder production
Flooding	Land use change	Cattle management and price
Fires	Prices fluctuation	Milk production and price
	Urbanization	Crop production and price
	Market changes	

The seasonality factors identified by farmers were related to rainfall seasonality which influences fodder availability, management of cattle and prices of the main farming products. Productivity and cattle management factors are issues addressed by rural development projects, including DEPAPRO. However, few efforts have been devoted by farmers and rural development organizations for addressing marketing issues. Farmers pointed out that the price of milk and crops was more affected by seasonality; whereas the price of cattle was less affected by the latter. In most cases farmers pointed out that seasonality impacted their financial capital. However, effects upon the human capital occurred as well, for example people had more health issues during the rainy season resulting from increasing population of vectors of diseases such as dengue. Regarding natural capital, the dry season favoured issues with pastures management that produced more degraded pastures.

Most of the effects encouraged by the FFSs in farmers from the pilot area were classified as immediate and associated to the human and cultural capitals; whereas the evidence of developmental impacts related to the social and political capitals was limited. In the case of human capital, FFS farmers exhibited a strengthened technical knowledge about intensive livestock practices which was facilitated by strategies used during the FFS such as on-farm experiments and exchange visits. Regarding cultural capital, farmers started to change their cognition about traditional elements about livestock production i.e., paddocks, and monoculture pastures, for a vision that includes elements considered atypical for livestock farmers such as trees, shrubs and mixes of pastures with herbaceous legumes.

Few FFS impacts in the social capital of FFS farmers were identified, which corresponded to the establishment of bridging social capital links between farmers and professionals and organizations working in livestock production. The interactions of the latter actors is considered beneficial because facilitate the access to technical information, or further training. Despite of the limited actions of DEPAPRO in the pilot area during 2008 (see Chapter Four), farmers reported that some of specialists and facilitators continued visiting them, however, is uncertain if such links would remain in the longer term. Moreover, bonding social capital among FFS farmers was rarely observed. As explained by Flora (2004) limited bonding social capital tends for reinforce individualism, or clientelism when dependency on external aid is observed. Consequently, political capital effects were also limited to changes in the confidence in expressing opinions and managing the farm observed in small farmers; and to a higher number of women with leadership positions in the villages.

7.2. Analysis of limitations

7.2.1. Did the methods used in this research limit their results?

The most salient limitation to the knowledge of the author is not being able to extrapolate results to FFS groups or participants who did not participate in the study, because a non-parametric purposive sampling strategy was used. Such a sampling strategy was chosen because of the lack of sampling frames, restrictions of time and funding during fieldwork. For example, the results obtained in Chapter Four reflect the perception of the 106 informants that participated in it. Such opinions cannot be considered valid for other stakeholders who were not interviewed in this respect. Nonetheless, the results yield information with high internal validity due to the triangulation with the material assets observed in the farms, probing of participant answers and crosschecking of information in publications (Laws *et al.* 2003, Rusell 2006).

In Chapter Five the study was structured in three phases, thus, the implications of using a purposive sampling strategy must be analysed separately. The aim of the study in Phase One was to determine the activities encouraged by DEPAPRO in Petén, Guatemala. In this case the rate of response was near to 100% in each of the six FFS groups that participated (four from the pilot area; two from the expansion area). Thus, the results are robust for describing facts from the pilot area; however, they just reflect the perception of two from the eight FFS groups from the anchoring and expansion areas. In Phase Two the aim was to accomplish a participatory evaluation of nine technologies tested by FFS farmers in Petén. In this case non FFS members (*ad hoc* groups) participated in the study and were selected with the help of FFS farmers who identified households with similar characteristics to their own. However, just two groups from the pilot area participated in this phase and their opinion may not represent the rest of the livestock farmers from Petén.

In Phase Three the aim was to identify factors influencing the decision of FFS farmers to test leucaena fodder banks. Non FFS participants were rarely included in this phase because the decision to test leucaena was clustered just among FFS participants and some of their relatives. Again, the high rate of response among FFS farmers and relatives do not impose credibility issues about the FFS farmers' opinions, however, they do not reflect those of the rest of the livestock farmers of Petén. On the other hand, in Chapter Six the use of a non-parametric purposive sampling strategy affected similarly than in the phase two of Chapter Five, because the farmers selected for the comparison (control farmers) could not be representative from the rest of the farmers of Petén. Moreover, due to the non-participatory culture and the lack of incentives the participation of control farmers in the study was limited, causing a reduced rate of response and an imbalance between the subgroups compared. In response to this most of the statistical tests for comparing answers between subgroups were non-parametric.

Additional to the limitations just described, each research chapter presented challenges that were addressed according to their nature. For example, farmers were asked to recall facts occurred during their entire participation with DEPAPRO (2003-2008). This was because baseline information compatible with the SLA used in the analysis was not available. However, impact analysis scholars have shown that such method yields approximations with high variability, biased by the recall of information in demographic data of small animal species (Lesnoff 2009). Consequently, several strategies were taken to reduce such potential bias: (i) all interviews were conducted following probing techniques; (ii) the quantitative information asked was not detailed, in the case of the cattle herd only the total number of animals was recorded, with no questions about its composition; (iii) when baseline data were available these were printed in the interview guidelines for comparison with farmers' answers; (iv) most of the variables of interest were about general conditions of the household or the farm which are less biased by recalling (Bamberger *et al.* 2004).

The evaluation strategy used in Chapter Six was a snapshot from the years 2003 and 2008, thus the approach used for comparing the assets of livestock farmers before and after the FFS was static. This may have limited the identification of immediate effects occurring in middle stages of DEPAPRO. For instance, during the participatory analysis of social networks participants qualified their relation with DEPAPRO as being of little importance, because the project has finished their direct work with women and was about to finish activities with men. Different results would have been obtained by asking farmers to estimate the average importance of individuals and organizations during the last six years as was done during the documentation. Then even when Chapters Four and Six were intended to complement each other for reducing the potential bias of the timing of the evaluation, the approach used could have underestimated effects observed in earlier stages of the FFS.

7.3. Overall implications

7.3.1. Can the farmer field schools approach facilitate the adoption of sustainable livestock production systems?

The results of this thesis indicate that the farmer field schools are an option for facilitating the practice of sustainably sound livestock production systems in Central America. DEPAPRO encouraged the strengthening of the human capital of farmers, and livestock production professionals for facilitating the implementation of FFS. However, as the documentation suggested the FFS approach as implemented by DEPAPRO requires adaptations to make it financially affordable for rural development organizations. Moreover, the inclusion of empowering strategies for strengthening the social and political capitals of farmers such as the formation of FFS boards is also necessary to facilitate long term developmental effects. Such efforts should be supported nationally and regionally by the creation of policies encouraging the use of sustainably sound production systems.

The study also highlighted the necessity of reviewing the approach used by rural development projects on focusing efforts for strengthening mainly the material assets or elements of the vulnerability context related to these. Most rural development projects in Central America allocate efforts in strengthening the natural capital or the main livelihood of farmers such as cattle production. However as the SLA and CCF indicate, community development requires a balance among the different assets that farmers use for establishing their livelihoods (Flora *et al.* 2004). Given the low budgets generally available for rural development programmes, it is necessary to include in such initiatives activities for strengthening farmers' human assets. This also implies the necessity of establishing alliances with organizations with more capacity for enabling such process, hiring staff with backgrounds in social, policy making and collective marketing expertise; or invests in the creation of such capacities.

If the balance among the seven capitals is not considered, local inequalities will be reinforced. For example, the profit obtained by intermediaries would increase, because farmers lack the social and political capital necessary for obtaining more financial benefits from their investments in the improvement of livestock management (Rölling 1988). Collective marketing and community micro credits are alternatives based on strengthened social and political capitals that was used as an option for improving the access to markets in the context of a developing country and using the FFS approach (Sanginga *et al.* 2007). On the other hand, a topic that was rarely addressed during this research is the combination of compatible approaches used by rural development organizations in Central America with the FFS. For example, in the pilot area of Petén a partner organization worked with the farmer-to-farmer approach. More studies addressing the process of integration between the latter approaches are needed.

7.3.2. Are silvopastoral systems the only option for a sustainable cattle production?

The learning experience implemented by DEPAPRO in Central America suggests that silvopastoral systems are one set of technological options that can have a role in the facilitation of sustainable livestock production. However, the opinions of the FFS farmers coincided to point out that an integrated approach is required (Groeneweg *et al.* 2007). Livestock farmers prioritized household, farm and landscape issues related to pasture degradation which require an integrated approach to be addressed. After all, pasture degradation is a complex and dynamic challenge that requires the integration of multidisciplinary strategies (Dias-Filho 2005). This has also been observed in agricultural FFS where the initial IPM approach evolved into Integrated Crops Management (ICM) and farmers' interest in the learning process was thus improved.

The integrated use of the SLA and the CCF highlighted the importance of human related factors for the adoption of sustainably sound livestock practices and community development. Factors such as social and human capital have been amply discussed in agroforestry, conservation and agricultural practices adoption studies, however, factors associated with the cultural and political capitals need further research. The results of this thesis suggests that cultural capital has an important role for facilitating and adopting sustainable practices in farmers, technical and professional staff working with livestock production in Central America. Further efforts for strengthening social and political capitals are needed because the processes for adapting sustainably sound agroecosystems interventions will imply the modification of some of the established power relationships among livestock stakeholders (Merrill-Sands and Collion 1994, McAreavey 2006). Therefore, a balance between human and material assets is needed for achieving long term developmental impacts.

In the end the results of this thesis indicate that we are learning to facilitate more resilient processes for rural development in Central America. Following the arguments of Rölling and Jiggins (Rölling and Jiggins 1998) the practice of sustainable livestock production should be facilitated rather than lectured (Deugd *et al.* 1998); co-managed rather than imposed by authoritative top-down programmes; and supported by adequate processes, rules, policies and platforms for knowledge (Pretty 1998, Rölling 2009). The learning experience encouraged by DEPAPRO and partners strengthened the human capital of the stakeholders that participated in the FFS. However, more efforts are needed to consolidate an ecological innovation system and sustainable livelihood outcomes.

7.4. References

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Appendices

Appendix 1: Guideline for technology census semi-structured interview (English).

Greetings and personal presentation

Explaining the visit

I am completing a study for my graduation in a university. This pretends to identify the impact of CATIE's Degraded Pastures Project (DEPAPRO) in the livelihoods of livestock farmers households in the El Chal, Petén area. Thus, my work consists in establishing conversations with farmers participating in DEPAPRO for identifying the farming activities that you have made in the last five years. I would like to have your permission for interviewing you and I need to clarify that your participation is voluntary. If you do not wish to participate or answer some questions, you simply tell me and there is no problem. Moreover, your answers are important, and will be considered in the study but your name and address will not be divulgated. This is for respecting the trust that you are giving me while sharing this information with me. The information will be used for writing my graduation work (thesis), make a presentation in the university and to write some reports.

Informed consent

Can you give me your permission for interviewing you voluntarily?

ID

Name______________________ Date_____________________ Time_____________

Household head general data

Age: Group: *Aldea*: Municipality:

Group since: Farm name:

No. of farms: Farm area (03/08): Area units: Lives in farm:

Distance to farm: Time to farm: Schooling years: Tenancy:

Farming years: Cropping years: Cattle years: Petén years:

Origin: Farm years: Herd size (03/08): Production system:

Household data

How many persons are parts of your household in 2003 and 2008?

Name	Age	Years in school	Attends school	Helps in farm	Illness?

Activities inventory

What works have you made in your farm during the last five years?

Activity	Mentions	Tests	Important	Why?	Not important	Why?	More training	Why?

Appendix 2: Guideline for impact evaluation semi-structured interview (English).

Changes in livelihoods semi-structured interview guideline

Greetings and personal presentation
Explaining the visit
I am completing a study for my graduation in a university. This pretends to identify the impact of CATIE's Degraded Pastures Project in the livelihoods of livestock farmers households in the El Chal, Petén area. Thus, my work consists in establishing a dialogue with farmers for identifying some changes that you perceive in your household or farm. I would like to have your permission for an interview and I need to clarify that your participation is voluntary. If you do not wish to participate or answer some questions, you simply tell me and there is no problem. Moreover, your answers are important, and will be used in the study but your name and address will not be divulgated. This is for respecting the trust that you are giving me while sharing this information with me. The information will be used for writing my graduation work (thesis), make a presentation in the university and to write some reports.

Informed consent
Can you give me your permission for interviewing you voluntarily?

ID
No______________________ Date_____________________ Time______________

***Aldea*: Municipality: Lives in farm:**

Livestock type 2003: Livestock type 2008:

Years farming:____ Years agriculture:____ Years in Petén:____ Years farm:_____

HUMAN CAPITAL: Lets speak of you and your family, the health, education and the population in your community.
Household composition/population

1. Has any member of your household left the *aldea* from 2003 to 2008? Where are they, and why?

Name	Place	Year	Why?

2. Is there any migration of persons along the year in the *aldea*? (¿People left or come? ¿Why?)

3. What are the main activities of the household members in 2003 and 2008?

Name	Occupation 1	Occupation 2	Occupation 3	Occupation 4	2003	2008

4. What is the level of wellbeing that you consider for your household has in 2003 and 2008?

Year	**Wellbeing (*Calidad*[42])**				
	Very poor	Poor	Regular	Good	Very good
2003	1	2	3	4	5
2008	1	2	3	4	5

Knowledge/ Education

5. What type of training or technical assistance have you received in 2003 and now in 2008 regarding to the farm or cattle?¿How do you use this knowledge?

Who gave it?	**Topics?**	**Year?**	**Applied (S/N)?**

6. How much do you know how to work with the following activities (2003 y 2008)?

Activity	**Very little**	**Little**	**Regular**	**Well**	**Very well**	**Has/Make 2003**	**Has/Make 2008**
Leucaena plots	1	2	3	4	5		
Improved pastures	1	2	3	4	5		
Live fences	1	2	3	4	5		
Legumes	1	2	3	4	5		
Paddocks rotation	1	2	3	4	5		
Cut and carry grass	1	2	3	4	5		
Nutritional blocks	1	2	3	4	5		
Mastitis management	1	2	3	4	5		
Weed management	1	2	3	4	5		
Silage	1	2	3	4	5		
Parasites management	1	2	3	4	5		

7. Who else gives you advice about farm and cattle management?

Health

8. Where do you go if a member of your household is ill? ¿Do you use traditional medicine? ¿Which?

9. What are the most common diseases in the *aldea*?

Diseases	**Adults**	**Children**	**2003**	**2008**

10. Are there health campaigns in the *aldea*? For what? How are the campaigns?

11. How many times did you need medical health in 2003 and 2008?
2003:____________________ 2008:______________________

12. In general terms how do you rank the health of your household during 2003 and 2008? Why?

Year	**Health**				
	Very poor	Poor	Regular	Good	Very good
2003	1	2	3	4	5
2008	1	2	3	4	5

[42] *Calidad* is a colloquial term employed in Guatemala for expressing wellbeing.

CULTURAL CAPITAL: Let's speak a little bit about customs and traditions.

13. Do you belong to a cultural group? Do you speak another language besides Spanish?

14. Your membership to that cultural group influences you way of living or working your farm?

15. ¿What trees do you use as posts, *brotones*[43] or for leaving in the paddocks and why?

Name	Use	Why?

SOCIAL CAPITAL: Now let's speak about the relationships among the people, the organizations and the *aldea*

16. What is your religion?

17. Which were your main information media in 2003 and 2008?

Media	2003	2008
TV		
Radio		
Newspaper		
Organizations		
NGO's		
Neighbours		
Others		

18. Does your household practice any kind of products exchange with neighbours in 2003 y en 2008?

Product	2003	2008

19. Does your household practice any kind of communitarian activity with your neighbours or in the *aldea*? (Labour, inputs, etc.)

Activity	2003	2008

20. Does your household participate in an organization? What role have they had? What activities they usually do? Did you participate in 2003?

Organization	Role	Activities	2003 (Y/N)	2008 (Y/N)

[43] This is the common term in Petén for a tree species used in a living fence.

21. Have you hold a directive position in the *aldea*? What position? When?

22. In your opinion which organization had the biggest contribution to the *aldea*?

POLITICAL CAPITAL: Now let's speak about how decision making is made and about the organizations or persons that have the role of leading the *aldea*

23. Which organization is the strongest in the *aldea*? Who in the *aldea* participates in such organization? (And women?)

24. Do you believe that organizations from the *aldea* have capacity for negotiation?

25. Who is the top authority in the *aldea*? When and how is elected? What is their role? How are organized the authorities for caring the *aldea*? What do you expect from them?

26. Are your interests represented in the local government? Why? How do the inhabitants voice their concerns, interest and needs to the authorities?

27. Who decides how to use the natural resources in the *aldea*?

28. What governmental organizations have had influence in the *aldea*? List of institutions working in the *aldea* in the last five years.

Institutions/ organizations	From	To	Aims	Activities	Household participation

29. Are there good relationships between government organizations and the *aldea*? What is happening?

30. Are there good relationships among private companies and the *aldea*? What is happening?

31. Is there any law, norm or local agreement influencing your work in the farm?

NATURAL CAPITAL: Now let's speak about the natural resources that you use and that have importance for your household

32. Is there any natural resource that belongs to the *aldea* or used by the whole *aldea*? Who regulates or controls the use of such resources?

Resource	Regulated by	2003	2008

33. What kind of animals and wild plants are there in the *aldea*? In what amount? Have you noticed any changes in time**?**

Animal	Amount	2003	2008

34. What is the most important natural resource for you and your household? Why?

35. What were the main crops or land uses in your farm in 2003 y 2008?

Use	2003	2008	Consumption	Sell	Price	Sold/ year	Consumed/ year	Why?

36. Do you have livestock in your farm (2003 and 2008)? What kind?

Animal	Quantity 2003	Quantity2008	Use	Money from?	Price

37. What were the main water sources in your farms and household?

Name	Use	Available along the year (y/n)	Quality	2003	2008

38. What does your livestock eats?

Type	Name	Frequency	2003	2008
1)				
2)				

39. What amounts of degraded pastures are there in your farm?

Year	Degraded pastures				
	Very little	little	Regular	Much	Very much
2003	1	2	3	4	5
2008	1	2	3	4	5

BUILT/PHYSICAL CAPITAL Now let's speak about the built infrastructure in the *aldea* or your farm

40. What is the tenancy status of your farm (owned, leased or communitarian)? What is the size of your farm? When did you get it? How? Has been any change along time in the property?

Name	Size	Units	Year	Distance (time)	Distance (km)	Tenancy

41. How many rooms does your house have in 2003 and 2008? How many do you use as bedrooms?

Id	Use	2003 (#)	2008 (#)
1	Bathroom		
2	Kitchen		
3	Bedroom		
4	Others		

42. How many paddocks do you have in your farm in 2003 and 2008?

Paddocks	Size	Units	Pasture type	Water (Y/N)	2003 (Y/N)	2008 (Y/N)

43. What tools do you have?

Tools	Year 2003	Year 2008	Uses	How did you get it?
Tractor				
Yoke				
Trimmer				
Vehicle				
Cart				
Chaff cutter				
Plough				
Backpack sprayer				
Chainsaw				
Shovel				
Machete				

44. Do you have any transport means?

Mean	Year 2003	Year 2008	Uses	How did you get it?
Car				
Pick up				
Motorcycle				
Bicycle				
Beast of burden				

45. What sources of energy do you use? What for do you use each energy and in what year (butane, firewood, electricity)?

Energy	2003	2008	Uses
Electricity			
Butane			
Firewood			
Sun			
Biodigestor			

46. What distance and time do you need to reach the education centers and health services? ¿Is their access easy? If limited, why?

47. Are the roads in the *aldea* in good condition or accessible all the year? Does the *aldea* have public transportation service?

FINANCIAL CAPITAL. Now let's speak about the financial resources for the farm and your household

48. Where do you obtain the income for your household? ¿What income sources do you have? From which type?

Income source	**Price (Q)**	**Units**	**Quantity**	**Subtotal/year**
Labour				
NR Use				
Remittances				
Milk				
Cheese				
Cream				
Maize				
Beans				
Calves				
Cows				
Beef				
Pigs				
Poultry				
Eggs				

49. Are the available financial resources enough for the household? Is the income enough for saving? Where the money for buying food does comes from?

50. What infrastructure do you have in the farm? How did you pay for it?

Infrastructure	**Quantity**	**Units**	**Condition**	**Date of purchase**
Corrals				
Milking parlours				
Electric fencing				
Water through				
Feeding through				
Warehouses				
Cooling tanks				
Houses				
Water reservoirs				
Dead fences				
Live fences				
Salt through				
Chutes				

51. How do you decide the work that you do in the farm?

52. What do you consider for deciding what to produce in the farm and when to stop doing it?

53. How do you pay for you farm production? Who can provide loans for production an under which conditions?

54. What is your bestseller product?

55. How do you pay for the inputs of the farm?

Credit

56. Do you have access to credit? Do you have or have used credits? What for?

57. Are there credit organizations in the *aldea*? What are the requirements for obtaining credit?

58. Is there any money lender in the *aldea*?

59. In what way the people from the *aldea* or your household save money?

60. In what season does the people in the *aldea* has more money?

61. Does the government grant money for a given activity?

62. How much is usually paid for one day of labour in 2003 and 2008?

CLOSING

63. Who else can collaborate with information for my study?

FAREWELL:

- Is there any answer or question that we must review?
- Thanks for all you time, patience and for participating.