Australian Government
Australian Centre for International Agricultural Research

Final report

project

Prospects for integrated timber–forage–livestock agroforestry systems for economic diversification in West Timor farming communities

SADI-ACIAR research report

report number FR2009-01

date published January 2009

prepared by

Paul van Nimwegen
Dr David Lloyd
Professor Jerome Vanclay
School of Environmental Science and Management, Southern Cross University

co-authors/ contributors/ collaborators

Miriam Murphy
Nicole Canning
Julia Sare
School of Environmental Science and Management, Southern Cross University

Dr David Ffoulkes
Senior Scientist, Livestock
Northern Territory Department of Primary Industry, Fisheries and Mines

Tigor Butarbutar
Chief of Forest Research & Development, Bali Nusa Tenggara

Dr Esnawan Budisantoso
Assessment Institute for Agricultural Technology, East Java

Australia Indonesia Partnership
Kemitraan Australia Indonesia

approved by	Dr Russell Haines
project number	SMAR/2006/080
ISBN	978 1 921531 68 2
published by	ACIAR GPO Box 1571 Canberra ACT 2601 Australia

Australia Indonesia Partnership
Kemitraan Australia Indonesia

ACIAR's participation in the Australia–Indonesian Partnership

The Australia–Indonesia Partnership (AIP) supports Indonesia's reconstruction and development efforts, both in and beyond tsunami-affected areas. Assistance will involve long-term sustained cooperation focused on economic and social development.

As part of the AIP, the Smallholder Agribusiness Development Initiative (SADI) aims to improve incomes and productivity for farmers and agribusiness, in response to market opportunities, in four eastern provinces—East Nusa Tenggara, West Nusa Tenggara, South East Sulawesi and South Sulawesi.

ACIAR's commitment to SADI focuses on supporting market-driven adaptive research, improving the transfer of knowledge and developing the capacity of key institutional stakeholders. This commitment will overcome constraints and barriers that prevent smallholders and agribusinesses successfully engaging with the market.

Contents

1 Acknowledgments

This work owes much to the many people who have given generously of their time, provided information, and facilitated fieldwork. In particular, it would not have been possible without the support of Tigor Butar Butar, Esnawan Budisantoso, Russell Haines, and all of the informants listed in section 9.1.

2 Executive summary

West Timor is in the poorest and least developed province of Indonesia, where 80% of people live below the poverty line. It suffers both physical and cultural isolation, inadequate infrastructure and limited natural resources. For 40 years many development projects have attempted to improve income and offset the hardships experienced by farmers. Outcomes of these projects have generally fallen short of initial expectations despite the presence of programs demonstrating substantial production gains through new technology.

Agroforestry offers smallholders a significant opportunity to increase their incomes because of its potential to improve dry-season fodder availability and to provide tree-based incomes during drought. This could be further improved by integration of high-value timber species along with more productive forage trees and grasses. This scoping study reviews previous agroforestry, forage and livestock projects in eastern Indonesia. It has also identified strategies for developing more acceptable systems and has proposed methods for their implementation and provided an assessment and analysis of the constraints to adoption of research results. To achieve this, the scoping study includes an extensive literature review including an in-depth look at the most relevant projects and a field investigation and social survey in West Timor conducted in September/October 2007.

In reviewing the previous agroforestry, forage and livestock projects it is obvious that consideration of the socio-cultural aspects are critical to success, yet its complexity has meant that it is often overlooked with bio-physical aspects taking precedence. Other considerations identified during the review of projects are: a) a need for strong partnerships and collaborations; b) a focus toward a needs oriented participatory training; c) project planning should be broad, inclusive and flexible, and; d) review Instruments should be responsive with a minimal turn around time from research and innovators to users, policy makers and other projects.

The social survey aimed to define and understand community stakeholder aspirations and expectations in relations to integrated agroforestry. Feedback from farmers and institutional informants identified that farmer's immediate needs are improvements in cattle production, seedling survival and an understanding of market flows. In many cases, revenues could be increased through better quality control and standards. The informants highlighted the importance of traditional law (*adat)* to rural people. Farmers perceived timber species as a long term investment, but rarely provide adequate care to seedlings. Cattle are seen as a valuable long term investment, but the initial outlay is a barrier to many farmers. The major barriers constraining the adoption of programs can be broadly defined into the interrelated areas of physical, social, institutional and economic. The most significant physical factor is the availability of water. Socially, the lack of understanding of farmer's decision making processes, labour shortages and low household capital are barriers. In addition, farmers are being underpaid for their produce because they lack the understanding of the market chain. Land tenure security and the reluctance of farmers to make long-term investment is a significant issue and difficult to overcome. Other institutional barriers include regulatory frameworks and policies inhibiting beneficial programs. The capacity of NGOs to deliver extension programs was also seen as a barrier by some informants.

This study proposes a Timber, Forage, Livestock Agroforestry (TFLA) approach as a strategy for enhancing the uptake of new technology. This is a flexible integrated rural development approach which allows for the cyclical nature of adoption. The first

step in this approach is determining the available production options within the biophysical limitations of West Timor. The next stage is considering the socio-economic aspects. The success of this approach will be influenced by the extent of integration of the biophysical and socio-cultural aspects and whether stakeholders are willing to work toward the common good.

In formulating a framework to overcome the barriers and allow TFLA approach to function the scoping study recommended the following process: a) conduct a socio-economic survey to establish farmer typologies; b) Conduct an impartial evaluation of major agroforestry systems; c) establish and conduct trials; d) Conduct Rapid Market Appraisals; e) rank potential agroforestry species; f) conduct participatory mapping activities to define boundaries based on acceptable land tenure system; g) conduct a management audit of the farming sphere, and; h) conduct training needs analysis. The study also identifies key research areas which are crucial for overcoming specific barriers. The establishment of micro-loan schemes and an investigation into the role of middlemen may lead to an enhancement of the selling price of commodities. Collecting and storing water using low cost simple infrastructure may increase the availability of water. The expansion of non-cattle livestock and timber species that provide immediate returns should be looked at as income options. Understandings the factors driving urban migration and its impacts, as well as the role of village leaders are areas of social research which may lead to improved uptake in future programs.

3 Introduction of West Timor

3.1 Background

West Timor is part of the Indonesian eastern province of Nusa Tenggara Timur (NTT) and occupies the western half of Timor Island (except for the Oecussi-Ambeno district which is part of East Timor, Figure 1). NTT is the driest of the Indonesian provinces (Roshetko and Mulawarman 2001), with two distinct but unequal seasons, a short unpredictable rainy season for 3 months (December to March) and a dry period lasting 8-9 months. Annual rainfall is highly variable but generally increases with altitude. The average annual rainfall is 1000-1500 millimetres (mm) but some areas can receive up to 3000 mm (Piggin 1997; Roshetko *et al* 2007)**.** Torrential rivers form during the wet season and often trickle to nothing towards the end of the dry season. Streams are short, steep and deep, running north and south from the central range. Ground water is limited and watersheds are small (Piggin 1997).

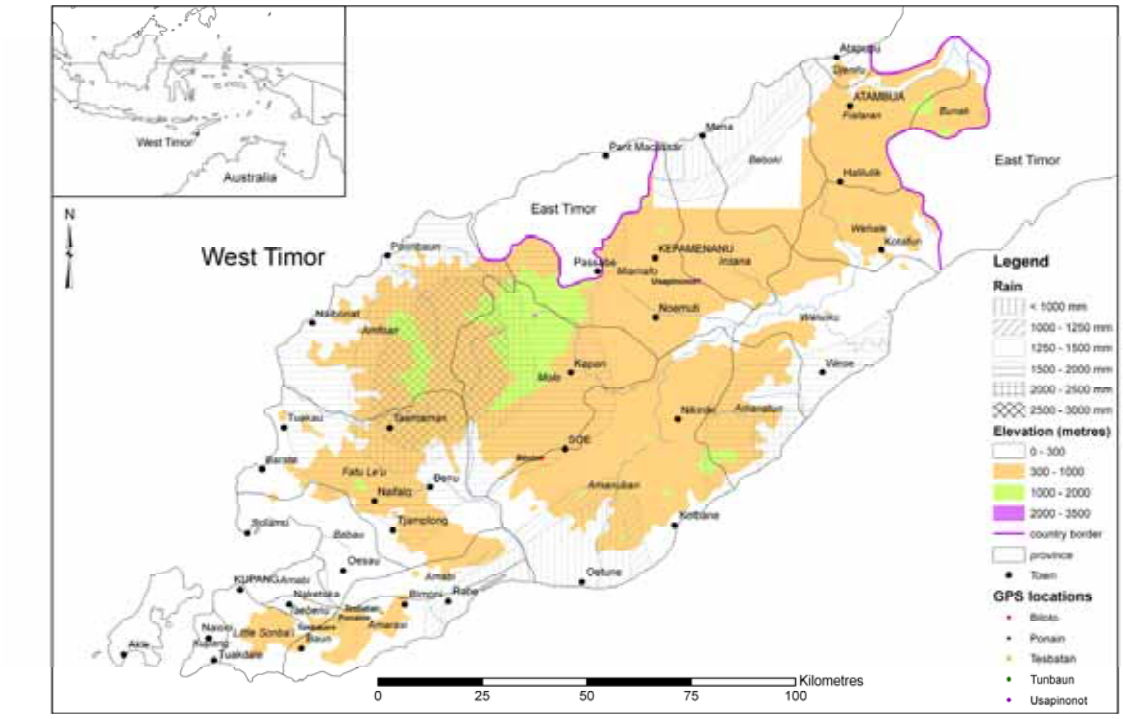

Figure 1. West Timor showing rainfall and altitude (prepared by Greg Luker SCU)

The topography of West Timor's 15,850 km² land area (Nulik 1998) features a steep relief with central ridges running down the centre of the island. The highest point is Gunung Mutis at 2,427m (Figure 2). The soils of Timor are formed from continental uplift derived from marine sediments. The marine derived soils are generally thin, rocky and have weak moisture holding ability compared with the volcanic soils of Flores and Alor (Glover 1986; Piggin 1997; Fisher *et al* 1999). Poor soils combined with the effects of long dry spells and drying winds means the soils on NTT have limited agricultural utility (Johnson *et al* 1986; Roshetko and Mulawarman 2001). The steep ridges and the heavy rains during the wet season contribute to high levels of natural erosion. This situation is exacerbated by the traditional cultivation practice of slash and burn.

Most of the natural forests in NTT have been cut, grazed or burnt. What is referred to as monsoon forests have given way to various savannah associations of palm, open and mixed savannah. Remnants of the monsoon forests are found in various associations in the gullies of uphill areas where *Eucalyptus urophylla*, *Casuarina junghuaniana* and *Acacia leophloea* are found (Butar *et al* 2007). Over the last century land degradation has accelerated due to increasing human and livestock populations, especially cattle together with the consequent introduction and spread of weed species such as *Lantana camara*.

Figure 2. Typical West Timor landscape

Population

According to the 2000 national census, the 1.6 million people of West Timor are mostly concentrated around Kupang, the provincial capital. The population density is 83 persons per square km with a population growth rate of 1.64% from 1990 to 2000 (Badan Pusat Statistik 2007a). West Timor has four regencies – Kabupaten Kupang, Timor Tengah Selatan (TTS), Timor Tengah Ulara (TTU) and Belu (Suharyo *et al* 2007).

Geographically, culturally and ethnically West Timor falls in a transitional zone where Asia, Australia and Micronesia meet (Buckles 1999). Consequently the West Timorese are a mixture of Papuan, Melanesian, Polynesians, Malay and Austronesian with a small population of ethnic Chinese. These differences are reflected in the areas religious affiliations when compared to Indonesia as a whole (

Table 1). Rotinese, Ndaonese and Helong are the three indigenous languages spoken by West Timorese but the official business language is Indonesian.

Table 1. Comparison of religious affiliation between Indonesia and West Timor (percentage of the population)

	Indonesia[1]	West Timor[2]
Muslim	86	8
Protestant	6	35
Roman Catholic	3	56
Hindu	2	<1
Unspecified	3	<1

Infrastructure

Roads connecting villages to the main centres are limited to the coastal areas due to the difficulty posed by the terrain. Compared to other parts of NTT, the roads on West Timor are slightly better than the rest of the province. Provincial infrastructures such as schools, health facilities and other government services are of lesser standard compared with other Indonesian provinces. The government extension service is understaffed, and sometimes staffed by officers from other provinces who are unfamiliar with local conditions.

The province is relatively isolated from the rest of Indonesia both by distance and communication. Many districts are also isolated from the provincial capital Kupang, and therefore lack access to government services. Its location in relation to inter-regional transport and access to international export markets does not allow for major exporting potential. Furthermore without a customs clearance facility in Kupang, international trade is processed through Surabaya in Java (Lee 1990), handicapping trade with Australia and the south west Pacific.

Economic development

The combined effects of physical and cultural isolation, inadequate infrastructure and limited natural resources make NTT the poorest and least developed region in Indonesia. The Gross Regional Domestic Product (GRDP) per capita is only a third of the national average (

[1] *(CIA 2007)*
[2] *(Departemen Agama 2005)*

Table 2). The minimum rural wage in NTT is nearly half of the minimum monthly income (taking this as the urban wage). Generally NTT's economy has steadily improved since the economic crisis and drought in 1997-1998 but growth still lags behind the national growth (Suharyo *et al* 2007).

Table 2. Economic Indicators by selected provinces[3]

Indicators	National	Provincial			
		NTT	Bali	Jawa Timur (East Java)	DKI Jakarta
GRDP (2003-2005) mill rupiahs	2,729,708,200	14,601,790	33,946,468	403,392,351	436,250,721
GRDP/Capita (2003-2005)	12,450,737	3,427,414	10,032,731	11,114,488	49,236,113
Average monthly wage (rupiahs)	729,516	799,932	821,970	607,463	1,078,242
Minimum rural wage/ month (rupiahs)		450,000	447,000	340,000	711,843
Minimum living needs/ month (rupiahs)		402,989	447,500	339,227	759,953

The Human Development Index (HDI) of NTT is 63.6, which is lower than the national HDI of 69.6 (Table 3). NTT is not as densely populated as Bali or East Java but the population growth rate is higher than the national rate of 1.34. The percentage of population below the poverty line is almost twice the national average.

Table 3. Social Indicators of NTT[4]

Indicators	National	Provincial			
		NTT	Bali	Jawa Timur (East Java)	DKI Jakarta
Population (2007)	224.9 million	4.4million	3.4million	36.0million	8.8million
Population density - 2005 (Person/sq.km)	116	87	600	742	13,102
Population growth rate (%) (2000-2005)	1.34	1.54	1.41	0.45	0.80
Human Development Index (HDI)	69.6	63.6	69.8	68.4	76.1
% population below poverty line	16.66	27.86	6.85	20.08	3.18
School Enrolments 7-12 age (%)	97.1	94.3	97.4	98.0	98.7

[3] Adapted from March 2007 edition of selected socio-economic indicators of Indonesia *(Badan Pusat Statistik 2007b)*

[4] Adapted from the March 2007 edition of Selected socio-economic indicators of Indonesia (Badan Pusat Statistik 2007b). Population projections based on 2000 national census of IndonesiaT

School Enrolments 16-18 age (%)	53.9	43.7	61.3	55.6	65.8
Adult Literacy (%) 2005	94.3 (m) 87.5 (f)	87.4 (m) 83.7 (f)	92.5 (m) 79.9 (f)	91.5 (m) 80.5 (f)	99.3 (m) 97.4 (f)

In 2000 the number of West Timorese living below the poverty line rose from 30% to 80% in 1998 (HPCR 2001) and high proportion of population do not have access to clean drinking water (Suharyo *et al* 2007). The education indicator is below the national average. This is further aggravated through the inequality between socio-economical levels, where children from poor families are less likely to continue their studies after junior schooling (SMERU 2006). Enrolments are similar to the national trend with over 90% of children enrolling in junior school but only half of these continuing their studies to senior school (Table 3).

The West Timorese are heavily dependent on subsistence agriculture for their livelihood. While the neighbouring East Timor has oil, coffee and tourism, West Timor lacks the natural resource capital to abate widespread poverty. Overall unemployment rates of 80 and in some places 100% persist, with illiteracy and infant mortality rates the highest in the country (Buckles 1999). High incidences of malaria and tuberculosis persist throughout the province. This is exacerbated by inadequate health facilities and health care workers (SMERU 2006).

Industry

Agriculture is the most important sector in NTT employing 80% of the population. In 1975 this sector contributed 70% to the GRDP but this has decreased to 40% in 2007 (Table 4). Livestock sub-sector constitutes a notable component of the agriculture sector contributing 10-11%, and 2-3% to the national GDP (Diwyanto *et al* 2002; Suharyo *et al* 2007). In the next few decades the growth in the livestock sub-sector is expected to accelerate as consumption patterns in Indonesia change.

Table 4. Industry Sector Contributing to the GRDP[5]

Industry	**Year (%)**		
	1999	2001	2003
Agriculture, Livestock, Forestry & Fisheries	38.3	36.7	34.8
Mining & Quarrying	1.3	1.2	1.1
Manufacturing Industry	2.4	2.4	2.3
Electricity, Gas & Water Supply	1.0	1.0	1.0
Construction	6.7	6.2	5.8
Trade, Hotel & Restaurant	14.2	14.1	14.3
Transport & Communication	10.7	10.7	10.9
Financial & Business Services	4.3	4.2	3.9
Other Services	21.0	23.5	26.0

Growing urbanisation and the economic growth experienced by Indonesia in the last 20 years has influenced these changes. For the rural households, livestock has multiple functions, including a primary source of income, protein and fulfilling socio-

[5] Table adapted from SMERU research report – Improving the Business Climate in NTT: The Case of Agriculture Trade in West Timor (Suharyo *et al* 2007) pg 51,

cultural obligations. Livestock is also complementary to other agricultural activities (Roxas *et al* 1997; Diwyanto *et al* 2002; Copland *et al* 2003). With the apparent growth in the significance of livestock, agricultural policy and organisation has shifted focus from production oriented to income generation and from commodity to agri-business (Djajanegara and Diwyanto 1995). Included in the policy shift is the focus towards efficiency and sustainable production outcomes. NTT is well placed to capitalise on the livestock sector growth especially since central government regards NTT as one of the two major sources of slaughter animals in Indonesia (Christie 2007).

In the latest review of animal health in NTT and NTB, Christie (2007) points out that the prices for livestock are improving except for horses and day old layer chickens (Table 5). There is ample room to expand the existing market for livestock and associated products, especially goats, pigs, cattle and chicken and there is a potential to develop a market for deer. However despite the existence of markets and projection of increasing demand, NTT livestock population has decreased in the last 10 years. While there are localised reasons for the decrease, Christie (2007) identifies a human population growth of 20% (1994-2004) as a significant factor. An increasing population results in a reduction in available land for livestock production, along with increased pressure on livestock populations with slaughter exceeding production. Goat meat is in high demand during religious festivals and there is potential to develop export goat meat trade to Malaysia (Christie 2007).

Table 5. Average Livestock Prices in NTT/ 2004 and 2005[6]

Animal Type	Price 2004	Price 2005
Ongole cattle –male breeder	2,500,000	3,000,000
Ongole cattle –female breeder	2,250,000	2,750,000
Bali cattle – female breeder	2,750,000	3,500,000
Bali cattle - male breeder	2,500,000	3,000,000
Buffalo – male breeder	2,500,000	3,000,000
Buffalo – female breeder	2,250,000	2,750,000
Horse	2,250,000	2,250,000
Goat – male breeder	425,000	475,000
Goat – female breeder	375,000	425,000
Sheep	4000,000	425,000
Pig- male breeder	400,000	425,000
Pig – female breeder	350,000	375,000
Day old chicken –layer	6,500	6,500
Day old chicken – broiler	4,500	4,250
Village chicken	35,000	37,500
Broiler	15,000	19,000

Deer are native to eastern Indonesia but occur in limited numbers. Increasing human population has reduced the potential feeding area available for deer. Attempts to increase deer population through encouraging domestication at both small and large scale have not met with success. Since no formal deer meat market exists, no records of prices and slaughter numbers are kept, nevertheless the meat fetches a

[6] *Source : Statistik Peternakan Tahun 2004 and 2005 cited by B Christie (2007 pg 11)*

good price in Kupang and the Jakarta markets (Christie 2007). While goats are prized by the Islamic population, pigs are considered to be unclean and as result its significance is restricted to the local NTT region. The price of live pigs is comparable to live goats but as meat products goat fetches a higher price than pig (Christie 2007).

The manufacturing sector contributes 2% to the GRDP, mostly from palm sugar and coconut oil industries. There is a growth from the trade, hospitality, transport and communication sectors. The relative contribution from the agriculture sector remains lower than the total economic growth (Table 4) (Suharyo *et al* 2007). For coastal areas additional income sources are fishing and seaweed cultivation. While seaweed cultivation is a growing industry, there are concerns regarding overfishing by both local and foreign businesses (Suharyo *et al* 2007).

Agroforestry Systems in West Timor

In 2001 a workshop was conducted by the International Centre for Agroforestry Research and Winrock International in Denpasar, Bali (Roshetko and Mulawarman 2001). The workshop was on agroforestry in NTT. During the workshop 20 agroforestry systems were identified for NTT. Generally systems differed between islands but some islands utilised more than one system. Many of the systems were quite similar, only differing in name and location. The differentiation of systems on NTT are determined primarily by size, location/ distance from the home and intensity of management (intensive versus extensive). Nonetheless, when viewed as a continuum of land-use the systems overlap between annual/seasonal crop production and natural forests. Agroforestry systems identified in the workshop are:

Slash and Burn or *Oma* and *Rau* which are both dryland agriculture. *Oma* is done on individually owned sites recently converted from forests with some remaining trees and on areas less than 1 hectare (ha). *Rau* is an annual cropping system practiced on land up to 100ha which can be individually or communally owned.

Improved fallow systems include the *Amarasi*, *Turi, Kamutu luri, Budidaya Lorong* and *Sika.* These systems are practiced on patches of individually owned land (0.25 – 3.5ha). All of these systems are indigenous except for the *Budidaya Sika* which is a combination of introduced and indigenous. These systems involve the growing of hedgerow species to improve soil fertility, control erosion and improve site productivity. Annual crops are the primary products of these systems and fodder and fuel wood is of secondary importance.

Kebun/Kebon or the home garden system is commonly found throughout NTT under various names. *Ongen, Uma, Napu* in Flores, *Nggaro* in Sumbawa and *Ngerau* in Lombok. The *Kebun* is a mixture of trees under-planted with food crops, cereal, legumes and vegetables on individually owned 0.25-3ha except for *Ngerau* which is done on larger areas and on community land.

Family forests are an introduced system promoted throughout NTT. The system is primarily for timber and fruit tree production, with annual/ seasonal crop production taking place in the early phase of forest establishment. The family forests are cultivated on individually owned 0.5-1ha blocks further from the home on less fertile soils. The *Omang wike* practised on Sumba is the traditional family forest system.

Forest gardens are found on large community land consisting of trees (fruit, timber, fodder) with some seasonal cropping occurring. The *Mamar* system is a forest

garden that emphasises the production of livestock fodder on 0.1-1.0 ha. This Area can also be bigger.

Silvopastoral is primarily fodder grasses with legume and other fodder trees. Non-fodder trees are usually scattered. On Timor this system is referred to as *Padang Penggembalaan* and on Sumba it is *Pada Mbanda*. The silvopastoral system covers areas up to 20ha of community owned land.

During one of the workshops held in West Timor by the visiting team, Pak Dua from the NGO group Alfa Omega, defined agroforestry systems in West Timor as topographically determined. On the slopes the system combines perennial species such as mangoes and mandarins with pigs, goats and forages. On flat areas food crops are grown in alleys between rows of forage.

3.2 Rationale for the study

For 40 years many approaches have been undertaken to assist the West Timorese farmers improve income and off set some of the hardships experienced during the long seasonal dry weather. In the past, ACIAR (and many other aid agencies) have supported projects on tethered cattle (the 'Amarasi' system) and demonstrated that substantial production gains can be achieved when livestock nutrition is carefully managed. However, concern has been raised that the recommended fodder regimes are rarely followed, and that the potential gains are not being realised. This scoping study offers an analysis of what has and hasn't worked with previous forestry and agroforestry projects in Eastern Indonesia, leading to recommendations and suggestions for future forestry projects in the area.

3.3 Objectives of the scoping study

The objectives of this study were to:

1. Review previous agroforestry, forage and livestock projects in eastern Indonesia, assessing and analysing the extent of and impediments to adoption of research results.
2. Identify and propose strategies for developing more acceptable systems and for their implementation.

Desired outcomes from the study included

- A review of previous initiatives and relevant studies undertaken in the region
- An improved understanding of obstacles to the implementation of approaches used in previous projects, leading to improved design of agroforestry production approaches
- Improved understanding of stakeholder expectations
- Identified income diversification options for further investigation with recommended design and methodology for implementation
- Increased cooperation between Australian, West Timorese education and extension providers.

3.4 Methodology

This study includes a literature review, field research in West Timor, and a social survey conducted during September-October 2007.

Social survey

A key informant approach using semi-structured questions was conducted over a three week period. The approach adopted for the survey ensured informant representation was broad enough to furnish a synopsis of the community in relation to:

- Forestry, livestock, cropping, Non-Timber Forest Products (NTFP)
- Market structures and market flows
- Perceptions of community towards government, non-government organisations and new technology adoption
- Farmer aspirations.

Visit to West Timor

A team of four visited West Timor from the 18th of September to the 4th of October 2007. The purposes of the visit were:

- To conduct a social survey
- To compare an initial list of timber trees obtained through the literature review with the most used species in West Timor
- To meet and conduct workshops with government and non-government organisations and farmer representatives to establish their views on barriers to uptake and potential solutions.

Indonesian government agencies included the Provincial Forestry Service, the Forest Research Institute, the Provincial Livestock Service, the Provincial Crop Service, the Assessment Institute of Agricultural Technology and the Provincial Agency for Planning and Development. Views were also sought from representatives of Nusa Tenggara Assistance for Regional Autonomy (ANTARA), Nusa Cendana University and two non-government organisations. See Appendix 9.1 for full list of people consulted

3.5 Structure of scoping study

In the next chapter the scoping study examines development initiatives and relevant studies undertaken in NTT and specifically West Timor. The chapter provides an overview of both the delivery mechanism and the scientific rationale which guided and formulated rural agricultural projects in the past, and the lessons learnt. In Chapter 5 the results of a social survey provides a synopsis of what West Timor farmers want and aspire to in relation to integrated agroforestry. This chapter also discusses the barriers preventing greater uptake of technological solutions from the environmental, socio-cultural and economic perspectives. Guided by community wants and supported by current literature Chapter 6 is an income diversification options model for West Timor that integrates timber/fodder/livestock with the addition of non-timber forest products. The timber/fodder/livestock agroforestry is a systematic model with sufficient flexibility to allow more than one entry point into the system. Physical limitations may determine the available options but it is the socio-cultural factors that determine the uptake and long term sustainability. The final

Chapter provides a way forward outlining a conceptual framework and research areas to improve or discover new pathways to enhance outcomes for West Timorese farmers

4 Review of past projects

Agroforestry is an integration of biophysical sciences within a socio-cultural framework with the aim of improving rural livelihoods. The biophysical aspects are the most easily understood with clear limitations, however the socio-cultural aspects are more difficult to comprehend and continue to impede technocratic solutions. Nonetheless, if improved livelihoods are to be achieved both the biophysical and socio-cultural aspects need to be considered. This shift in paradigm suggested by Blyth *et al* (2007) is not a move away from technical based solutions which are still just as important, but a shift toward are more balanced approach (Montambault and Alvalapati 2005).

This Chapter is a review of previous initiatives and relevant studies conducted in Nusa Tenggara (NT), and where possible West Timor. It considers both biophysical and socio-cultural aspects in reviewing the delivery mechanisms and the success of aid projects. It outlines the lessons learnt in improved approaches to agroforestry. It also outlines available information on tree species, forage, livestock and non-timber forest products.

4.1 Projects

For more than 40 years there has been a concerted national and international effort through targeted aid assistance to alleviate poverty in NTT (Djoeroemana *et al.* 2007). These projects have targeting the sectors of education, infrastructure, institutional capacity, forestry, agriculture and agro-forestry, and have been implemented with varying degrees of success. Multilateral and bilateral donors such as the World Bank, Deutsche Gesellschaft Für Technische Zusammenarbeit (GTZ), the United Kingdom Department for International Development (DFID), and Australian Agency for International Development (AusAid) have provided aid assistance. This study will examine five of the most relevant agricultural and forestry aid projects (Table 6):

The World Bank funded projects of Nusa Tenggara Agriculture Development Project (NTADP), Agricultural Research Management Project (ARM II), and Decentralised Agricultural and Forestry Extension Project (DAFEP)
The DFID funded multi-stakeholder forestry program (MFP)
GTZ funded Project Nusa Tenggara (PNT)

Table 6. Summary of Recent Agriculture and Forestry AID Projects in Nusa Tengara[7]

PROJECTS/AGENCY/FUNDING/ LENGTH					
	NTADP/WB US$27.0 mill 1996-2003	ARM II/ WB US$22.9 million* 1995-2002	DAFEP/ WB US$18.0 million 1999-2005	Multi-stakeholder Forestry Program (MFP)DFID 2000-2006	Project Nusa Tenggara (PNT) GTZ
Objectives	Raise smallholder incomes to strengthen local-level institutions and to foster broad-based participation at the grass roots level	Strengthen agricultural research and development by establishing a network of regional Assessment Institutes for the Agricultural Research Technology. As well as strengthen commodity specific research	Enhance farmer's capacity to participate in extension activities and to strengthen the capacity of the district level integrated agriculture and forestry extension systems in order to improve farming practices and increase farmer's income (pilot project).	Improve livelihoods of forest communities. Emphasise efforts to foster pro-poor sustainable forestry through grant distribution	Self help promotion for low income communities in critical rural areas in East and West Nusa Tenggara (follow on project from a grant distribution program from 1994-1997)
Reviews and outcomes	1999 project restructured to minimise complexity and confusion. The scope of project reduced	No proper monitoring and evaluation system was in place by government, however the World Bank supervision mission conducted independent reviews	Monitoring and evaluation systems was not effective in measuring outcomes		Review and updates between the different concurrent projects of GTZ ensured optimisation of resources and quick dissemination of results on a regular basis

[7] **Sources:** NTADP/ WB (World Bank 2004), ARM II/ WB & DAFEP/ WB (World Bank 2007), MFP/ DFID (DFID 2004) PNT/GTZ (GTZ 2002; GTZ 2003)

Outcome after term of Project	Overall the outcomes were considered unsatisfactory, and sustainability is unlikely. Institutional development impact was modest	Overall outcome was satisfactory, sustainability likely, institutional development impact substantial	Overall outcome was moderately satisfactory, sustainability likely, institutional development impact substantial	Community impact was minimal because the voice of the poor were not heard, institutional development impact was significant and sustainability not likely without addressing key constraints	Community impact was substantial, sustainability is likely. Institutional development impact substantial

Objectives of projects

The overarching goal of these projects is poverty alleviation through improving the income base of the poor. This is evident in the three World Bank projects and the GTZ project. The MFP by DFID is similar to the predecessor of the GTZ project. In 1997 with the assistance from the German government, the Indonesian government designed a grants making scheme to follow on from the Indonesian program called "*Inpres Desa Tertinggal'* (IDT) (GTZ 2002). The scheme disbursed grants to groups for income generation. In both the IDT extension and the MFP, intended project outcomes were not realised. The impact at the community interface was minimal and sustainability is unlikely. Realising the limitations of the IDT program, GTZ established the PNT project emphasising community empowerment through self help.

Set against increasing decentralisation in Indonesia, working collaboratively with partners empowers people at all levels and induces sustainability. All the projects that this section examines have a collaborative approach, for example the three World Bank projects and the GTZ project PNT are direct collaborations with existing organisations and communities.

Monitoring and evaluation (M&E) are important aspects of any project. It can be a mechanism where managers and donors gain an understanding of their project successes or weaknesses. This information can be used to improve those projects or enhance the design of future projects. The scope of the NTADP project was reduced and restructured as a response to the findings of the mid-term review. This however did not result in substantial outcomes or sustainability and highlights the need for community focused projects to be simple in design (World Bank 2007). Similarly, the problems encountered by the DFID project were identified during the mid-term review. Alternatively, the M&E approach of GTZ is dependent on strong within-group linkages, rather than an actual review during a designated point in the life of a project. The NT group of projects is divided into programs with regional and sectoral focus. PNT is one of two programs with regional focus. The M&E of each program within the group is critically dependent on continuous communication within programs and with the policy formulation processes of the organisation. This ensures that policy and on-ground changes are constantly aligned with minimum turn around time between policy and implementation. GTZ cultivates and promotes their system of M&E by jointly conducting their planning activities during the course of the project life (GTZ 2002).

Lessons learnt

The following are elements identified in the project reviews that can enhance the uptake of development initiatives:

- The need to have effective and strong partnerships and collaboration. In the ACIAR review by McWaters and Templeton (2004) a key finding was that the projects with highest uptake by the next generation of users had a core group of local scientists with credibility and commitment to the project's outcome. In the case of the GTZ project, the creation of the Field Force was identified as a definite contributing factor to the success of their project (GTZ 2002). The Field Force is a collection of young educated local youth familiar with the language, culture and traditions of their people. They are already accepted within their communities but with the educational background to adapt concepts and translate them into the local situation.
- Needs oriented participatory training. This was not limited to appropriate training for farmers but also included training of recipient countries in the procurement guidelines of the donor agency such as the World Bank. Training had to be delivered using the most appropriate medium and not be limited to just the written word (World Bank 1996; GTZ 2002; World Bank 2003; McWaters and Templeton 2004).

- Project planning should be broad, inclusive and flexible. By default, the DAFEP project was a pilot and could have benefited from being identified as that. A pilot project has a higher profile M&E and the expected outcomes are not as great. Without the flexibility, the DAFAP project was treated and evaluated as a project and not as a pilot which resulted in the lack of focus on the M&E aspects of the project (World Bank 2007). As much as possible planning should include the likely impact of in-country policy on research outcomes. The ACIAR research on the peanut stripe virus in Sri Lanka was subverted due to the governments legislation against genetically modified organisms (McWaters and Templeton 2004).
- Review Instruments should be responsive with a minimal turn around time from research and innovators to users, policy makers and other projects. The focus of the DAFEP and ARM II was research but the dissemination systems did not provide this information to users within a minimum timeframe (World Bank 2007). In the case of the GTZ project, another key feature of their approach is strong synergies within the broader Indonesian GTZ projects (GTZ 2002).

4.2 Timber species

Sandalwood (Santalum album)

Sandalwood has a long history in West Timor and continues to maintain significance as the most important export. Studies (McWilliam 2001; Mckinnel 1990; Setiadi and Komar 1995; Rohadi *et al* 2000) have identified the following common trends:

- The sandalwood resources on West Timor are fully depleted.
- Although sandalwood is endemic and has a long history with the Timorese, regeneration, seed quality and nursery techniques continue to be problem.
- Policy and regulations governing classification and ownership of sandalwood trees is a major obstacle to more effective replanting efforts.
- Large scale planting of sandalwood is not working.
- Future research may include: the development of a small scale farmer based system that integrates sandalwood into agroforestry in sync with agro-ecological conditions; identification of quality seed sources and minimise in-breeding; and on-farm research with supportive government regulations to assist the poorer farmers.

Indian Rosewood (Dalbergia latifolia)

The Indian rosewood is premium quality wood naturally found from the sub-Himalaya to the southern tip of India and on Java (Prasad and Sukandi 1994). It is a well researched species however there are no specific studies conducted for NTT or West Timor. Studies in other locations highlight that seed, nursery and tending techniques are well researched and established (Prasad and Sukandi 1994). These studies also indicate that rosewood is grown with teak within an agroforestry system in combination with food crops such as maize, beans or cassava. It can also be grown with fruit trees such as jackfruit, mango, guava and annona (Suhardi 2003). Indian Rosewood is listed as a vulnerable species according to the criteria of the IUCN threatened species (IUCN 2006). The physiological requirements of rosewood may be a limiting factor for West Timor.

Teak (Tectona grandis)

Teak is Indonesia's most important timber species (Suhaendi 1998). Indonesia accounts for an estimated 31% of global teak plantations (Bhat and Ma 2004), and supports an export furniture industry worth over US$1.8 billion annually (Midgley *et al* 2007). Teak is believed to have been introduced some 800 years ago and today the greatest proportion of teak is grown in Java and to lesser extent in South Sulawesi, South East Sulawesi and

NTT (Midgley *et al* 2007). Most of the teak is sold to domestic markets for the purpose of furniture manufacture. Despite the price of teak rising, larger scale plantation production is slowly declining with most teak coming from small landholders. These smallholders generally struggle to make a profit. The reasons for this include a lack of household capital causing farmers to harvest immature trees, a lack of technical knowledge, limited market access and government processes. Despite a considerable body of research on teak, there is limited reference to NT in the literature.

4.3 Livestock

Indonesia has a higher density of cattle, buffalo, sheep and goats compared to other Southeast Asian countries (Roxas *et al* 1997). Livestock contribute 5-41% of farmers income in the wet and dry agro-ecological zones and 60% in semi-arid zones, of which West Timor is a component (Roxas *et al* 1997). There is a tendency of farmers to consider livestock as household banks, easily liquidated when money is required (Wargiono and Sudaryanto 2002; Soedjana 2005). The downside of this perception is that farmers do not optimise their income by selling during times of high demand such as during the Islamic *Idul fitri* and the *Idul Adha* (Soedjana 2005). The reason for the lack of planning can be attributed to farmers' belief that cropping is more important than livestock (Djoharjani 1996; Bamualim and Wirdahayati 2003) and the lack of household wealth. When resources and money become scarce the immediate needs of the family take priority over livestock.

Cattle

In NT, Bali cattle (*Bos sondaicus*) is the predominant breed prescribed by the government (Bamualim and Wirdahayati 2003). It is one of four indigenous cattle breeds in Indonesia and believed to be the result of domestication of the wild banteng cattle (Djajanegara and Diwyanto 1995; Martojo 2003). In 1993 it was estimated that 46% of farming families in NT had livestock. On average 59% of farmers owned 2.4 head of cattle (Bamualim and Wirdahayati 2003). Cattle in NT are managed using four management systems or a combination of these systems. These are all day stabling, tethered under a tree and stabled at night, grazing by day and stabled at night and free grazing (Bamualim and Wirdahayati 2003; Martojo 2003). Studies have indicated a number of major constraints for the production of cattle in West Timor:

- Low reproduction rate expressed as low calving percentage, long inter-calving interval or low weaning percentage (Bamualim and Wirdahayati 2003; Copland *et al* 2003; Entwistle and Lindsay 2003; Ffoulkes 2005).
- Low milk production (Copland *et al* 2003).
- Slow growth rate of young cattle (Bamualim and Wirdahayati 2003; Copland *et al* 2003).
- Poor quality meat products (Copland *et al* 2003).
- Damaged and degraded grazing land and poor quality grasses (Copland *et al* 2003; Martojo 2003; Christie 2007; Maehl 1997).
- Diseases such as brucellosis and *haemorrhagic septicaemia* (Copland *et al* 2003; Ffoulkes 2005).
- Administrative implications of decentralization (Christie 2007).

Goats

Small ruminants such as goats are important components of mixed crop livestock systems (Johnson *et al* 1986; Roxas *et al* 1997). Despite this, research on goat production is not as extensive as cattle production research (Johnson and Djajanegara 1989; Djajanegara

and Diwyanto 1995). The role of goats in Indonesia is primarily for meat with attempts to introduce dairying goats to improve nutrition meeting with limited success (Soedjana 2005). Nevertheless, evidence shows that when goat milk is sold, it fetches a higher price than cows milk (Djoharjani 1996). The smaller islands have significant numbers of goats and only Sumatra has more sheep than goats (Soedjana 2005). In NT goat numbers are not as great as other islands due to early Dutch colonial decree discouraging the introduction of goats to minimise competition with cattle which was their preference (Christie 2007). The preference for cattle continued under the Indonesian government until 1994 when a shift in paradigm occurred. Christie (2007) states the shift is the result of increased population pressures, cultural acceptance and increased availability of goats due to goat distribution programs.

Indonesia has four indigenous breeds of goats all adaptable to dry agro-eco-zones. These dry zone breeds are Kacang, Etawah cross, Gembrong and Kosta. Of the four breeds the Kacang and the Etawah are found throughout Indonesia (Djajanegara and Diwyanto 1995). Farmers raise goats for themselves or through a traditional shared arrangement system called the *gaduhan* or *sumba kontrak* (Soedjana 2005). A shared arrangement allows poorer farmers to access breeding stock enabling them to start their own herd, and for farmers with a large herd sharing reduces the risk of theft and diseases. In some instances farmers enter into a shared arrangement to ensure their investment is taken care of while their time is disbursed on other ventures. A study conducted in South Sulawesi showed that the introduction of *Leucaena* based goat production increased income sufficiently to enable farmer's to send their children to school, to meet their socio-cultural obligations and improve soil fertility and yields of permanent crops (Amril and Rangngang 2001).

4.4 Forage

For a comprehensive list of forage species, Shelton (2001), Djogo (1992), Johnson and Djajanegara (1998) as well as the online resources of ICRAF and CIFOR are good starting points. Shelton's report also reiterates the multiple benefits of forage legumes in farm productivity, in the welfare of farmers and in the protection of the environment. Dahlanuddin (2001) highlights 30-40 different forages (including legumes) are fed to goats during the wet and dry seasons on Lombok. The development of dryland agroforestry systems in NTT corresponded with the development of *Leucaena leucocephala (Lamtoro)* as a forage species. Farmers were encouraged to adopt Leucaena-based farming due to its perceived ability to improve farming systems and the health natural ecosystems. However following the adoption by farmers, psyllids attached this species diminishing its benefit. Since the psyllid attacks, researchers have developed psyllid resistant *Leucaena.* Studies have identified the following key issues associated with forage:

Promotion of exotic or native species is a contentious question with no easy answers. Selection should be based on the merits of the species however the way forward may require a combination of both exotics and native species (Djogo 1992; Shelton 2001; Roothaert and Kerridge 2002).

Research shows that without supplements tropical grasses cannot sustain livestock growth (Johnson and Djajanegara 1989). Without scientific knowledge of nutrient content of legume supplements and agri-residues, an appropriate feeding regime for the livestock concerned cannot be instigated. For example, the case of tannins (Shelton 2001) and cyanide in cassava (Johnson and Djajanegara 1989; Wargiono and Sudaryanto 2002).

Scientific evidence may hail the value of one species over another however socio-cultural perceptions are critical to adoption of scientifically sound solutions. For example, the case of farmers perceptions of Leucaena feed for goats on Lombok (Dahlanuddin 2001) and in East Java (Djoharjani 1996).

The global trend for the increased use of forage tree legumes is causing a greater occurrence and severity of pests and diseases. This is not being matched with an increased knowledge of diseases and insects that attack tree legumes (Shelton 2001).

The suitability of a forage species is determined by seasonal and climatic conditions. Local feeding strategies can be developed and taught to farmers when this information is combined with nutritional data (Ffoulkes 2005).

4.5 Non Timber Forest Products (NTFP)

Bees and honey

There have been numerous unsuccessful attempts to domesticate the Giant Honey Bee *Apis dorsata* in Indonesia (Hadisoesilo 2005). Honey harvesters have continued to use traditional methods to exploit wild colonies. Indonesia has two subspecies of *Apis dorsata*, *A dorsata dorsata* and *A dorsata binghami*. The former is endemic to Sulawesi and surrounding islands while the latter is common throughout Indonesia (Hadisoesilo 2005). Hadisoesilo describes a traditional management technique called '*tinku'*, which uses permanent structure. The study team observed a crude method of honey extraction in West Timor where wild hives are cut from tall forest trees and allowed to fall to the ground to obtain honey for extraction, a dangerous practice exposing the collector to bee stings and hazards. The Asian Honey Bee *(A. cerana)* is widespread through tropical and temperate Asia and is present West Timor. There are limited studies on the economic potential of this species in West Timor, nevertheless an initial assessment by the research team of productivity indicated that the value of two operating hives in one year would provide the same financial return as the sale of a three year old Bali bull. Studies have identified a number of issues associated with the production and extraction of honey:

- Honey collectors risk their safety when climbing to the hives and are repeatedly stung (Hadisoesilo 2005).
- Wild bee collectors have expressed a preference for using hives. Since the domestication of the Giant Honey Bee has been unsuccessful, there is potential for other bee species such as the Asian Honey Bee (*A. cerana)* (Figure 3).
- Research needs include the development of a flowering calendar, trials of alternate hive design such as top bar hives, reduction in production costs and controlling the incidence of mites.

Figure 3. Bee (A. *cerana*) hive

Lac beetle

Lac is constituted from the hardened secretions of millions of lac insects and is used as a coating on woodwork, foods, cosmetics, hardware goods, electrical, pharmaceutical and textiles. In Southeast Asia, the lac insect species is *Kerria chinensis*. Globally, India exports 85 percent of raw lac, known as Indian lac *Laccifer lacca*; (syn *Kerria lac)*. The Indian lac insects are particular about their host trees thriving on *Schleichera oleosa, Butea monosperma* and *Zizyphus mauritiana*, while the SE Asian host tree is *Albizzia saman (Indian Lac Research Institute 2001; Rajasthan Heritage undated).* Other host trees are *Acacia catechu*, *A. nilotica*, *Cajanus cajan, Caesalpinia sappan Ficus religiosa* and *F. bengalhensis* (FAO 1995).

Future projection for lac is not encouraging as synthetic substitutes provide cheaper alternatives to lac dye and shellac. The domestic market is also limited (FAO 1995) however it does provide supplementary income and can be an effective mechanism for value adding.

Kayu putih oil

Distilled from the leaves and twigs of *Melaleuca leucadendron* (white tea-tree) *kayu putih* oil is listed with sandalwood oil, shellac, bamboo and rattan as one of the most important NTFP in Indonesia (Budiadi *et al* 2005). A study comparing the productivity of *M. leucadendron* between three sites in East, Central and West Java showed that leaf-twig and branch production was greater with increasing age, with maximum production at 15-35 years after which it declined (Budiadi *et al* 2005). Stand density did not translate to higher oil production. *M. leucadendron* grows best in swampy areas and seashores, which limits its use in the drier areas of West Timor.

Bamboo

Indonesia has 135 species of bamboo (70 endemic) and a long tradition of cultivation for home gardens. It can be found in natural forests, plantations and community forests of many Indonesian villages. The socio-economic value of bamboo is high, as thousands of tons of bamboo shoots and millions of bamboo culms are harvested annually in West Timor (Kartodihardjo undated). NTT is estimated to have 33,898 hectares of bamboo,

which is comparable to many provinces in Indonesia (FAO 2006). The Kartodihardjo report on rattan and bamboo in Indonesia provides a comprehensive overview. It includes a list of marketable bamboo and rattan species, production and management, markets and socio-economics, policy, legislation and research and development needs.

The conventional view of bamboo as a low value product has led to some Asian countries overlooking this traditional resource in their quest to modernise. Local shortages of supply in West Timor were observed by the study team. The value of bamboo as a quick natural raw material for both low-tech and hi-tech products has led to a turnaround in interest for bamboo as an agroforestry product. Better management should ensure the production of a higher quality bamboo product in West Timor. It is likely that additional plantings of both elite local and exotic bamboo species will be required to provide sustainable resource security and import replacement. It is not known the scale of planting which is required.

4.6 Conclusion

It is difficult to evaluate the contribution of 40 years of development projects to livelihoods in NT, nevertheless they have generally fallen short of their intended goals. These projects can provide important lessons and be used to guide future aid programs. In reviewing previous development projects four key considerations were identified. These are a need for strong partnerships and collaborations, needs-oriented participatory training, effective and on-going M&E and broad, inclusive and flexible planning. The studies also showed that where technological/scientific input is required farmers are not adopting these ideas when the socio-cultural aspects are overlooked. There is sufficient research on timber, livestock and forage, however more research is required to determine where to target future efforts, in particular the status of local resources and how best to enhance those resources. The next Chapter will examine community needs and wants in relation to integrated agroforestry through the results of a social survey conducted in West Timor. It also examines the barriers preventing West Timorese adopting development initiatives.

5 Community needs and wants and barriers to the uptake of agroforestry in West Timor

> "Culture really matters when doing business, especially in Indonesia. An understanding of the cultures, outlooks, perceptions of the people with whom we do business, as well as an understanding of our own cultures and values, has enormous real practical application and value."
>
> The response to Gary Dean was:
> "By the way, the problem with cultural views of countries and development is that they don't generally have practical implications. That doesn't of course mean that one should ignore them, but it is hard sometimes to know what to do with them" (Dean 2001)

Defining and understanding stakeholder expectations is delving into complex issues. What community needs and wants is messy and often difficult to ascertain. It is about perceptions, values and attitudes which are products of culture and traditions. The view that culture does not have practical implications captures the essence of why culture was left in the "too-hard basket" for so long. It was hoped that economic incentives would compensate for the oversight. It has taken some time for culture to become an important component in project planning and implementation. Nonetheless it still remains complex and intangible.

Why do some farmers take on new technology, adapt, innovate and pass on their knowledge to others' while other farmers are not interested? Despite the existence of real benefits, why do some farmers choose not to adopt alternative technology and ideas? A farmer evaluation in Yatta Plateau in Kenya of hedgerow intercropping trial of *C samea*, *G sepium* and *L leucocephala* in the 1980's showed an improvement in soil fertility. The improvement translated into increased crop yields, soil protection and provided a handy fuel wood source. Yet farmers were not convinced that these benefits were worth the short term risks. An on-farm evaluation uncovered that soil fertility is not a pressing concern for farmers in Yatta Plateau (David 1995). In the hilly upland of Sierra Madre Mountain range in North East Luzon in the Philippines, demonstrations on the benefits of growing fruit trees were conducted over a 10 year period. Nonetheless, over 50% of the farmers still preferred to grow their annual crops of corn, cassava and rice. Pressed further to grow trees, 90% of farmers would rather grow fruit trees than high value timber species (Snelder *et al* 2007). In the experience of the Forages for Smallholder Project (FSP), farmers were more willing to try new grass species than herbaceous and tree legumes. Though new grass species had greater biomass and were readily received by cattle the greater biomass did not render increases in ruminant productivity (due to the limited rumen nitrogen and shortage of by-pass protein). One factor attributed to the differences in uptake of grass and legumes was the underlying perception that cattle and buffaloes are not able to eat tree fodder (Roothaert and Kerridge 2002).

Closely linked with perceptions are expectations. In FSP's experience with farmers from several different countries, one of their five guiding questions is whether there is a genuine problem. Farmers respond with a yes because they expect free fertilizer, seeds or animals (Roothaert and Kerridge 2002). The value of understanding perceptions is not only applicable to poor farmers in developing countries, but also to farmers in Australia (Emtage *et al* 2000; Fulton and Race 2000), the United Kingdom (Crabtree *et al* 2000) and the United States (Lucht 2007).

In this Chapter the report will outline the methodology used in the social survey, examine findings and discuss the barriers acting to impede the uptake of integrated agroforestry project in West Timor.

5.1 Perceptions and values in West Timor

Perceptions and values of communities are critical to determining where a project should take place, what can or cannot be done, and the approach to take. During the field visit to West Timor, Esnawan from the Balai Penelitian Kehutanan (Forest Research Institute - FRI) emphasised the importance of socio-cultural considerations in any project because the cultures are different. He highlighted some differences which are evident such as the Belu are matriarchal, the Rote people talk more than take action, while the Flores people are humble. The differences are not only evident in the different island groups but also between households. The success rate of seedling establishment between three houses adjacent in Ponain village in the Amarasi district ranged from 20% to 100%. In Tespatan Village, also in the Amarasi district, there was no evidence or knowledge regarding the whereabouts of 298 sandalwood seedlings that were provided by the government. The *Kepala desa* attributed the loss to farmer's busy schedules. Nonetheless the *Kepala desa* was willing to plant more sandalwood as a conservation measure rather than as an investment.

The issue of landownership, tenure and rights is an important driver in the decisions of the farmers. A sandalwood project involving two villages in the Amarasi district achieved seedling establishment success rates of 35 and 50%. The success was attributed to establishing secure ownership as a pre-requisite for the project.

5.2 Social survey in West Timor

Survey procedure

The aim of the survey conducted from 18th of September to the 4th of October 2007 was primarily to establish an understanding of stakeholder expectations and aspirations in relation to an integrated agroforestry system. Time limitations determined the use of key informant approach using semi structured interviews as the best option. The use of semi-structured interviews uncovers a rich diversity of issues which may have some bearing on community aspirations and needs. The use of key informants has the advantage of navigating around the difficulty of conducting multiple questionnaire/interviews in a secondary language (for the researcher) and gaining only a superficial insight from each interview. It allows for flexibility but at the same time purposive where key informants are selected specifically on their relevance to the topic (Sarantakos 1998). In this instance the informants were selected on the basis of their representation within a community (community concerns, issues, aspirations). Selection was determined:

- Through an initial series of meeting with all stakeholders which allowed the selection of key informants for lengthier interviews.
- By ensuring that key informants were chosen to represent the cross section of West Timor community. Informants were selected from central, regional and local government, research institutions, non-government organisations, extension organisations, *Kepala desa* (village heads) and farmers group.
- By ensuring that the sample size was sufficient to represent all stakeholders.

Interviews

A total of fifteen semi-structured interviews were conducted consisting of 9 institutional and 6 village informants (Table 7). Questions were asked in accordance with various themes pre-determined from the literature review and from the initial meetings with

various stakeholders. Face to face interviews were conducted, with the assistance of a translator, allowing for clarification of issues as well as empowering the interviewee through the interviewer's acknowledged interactions. Reponses from the informants were transcribed and summarised into broad themes, some of which form the basis of the following discussions.

Table 7. Study informants

Informants	Category	No. of Informants
ANTARA (Nusa Tenggara Assistance for Regional Autonomy)	Institution	1
Nusa Cendana University	Institution	2
Forestry Department	Institution	2
Forest Research Institute	Institution	1
NGO representatives	Institution	2
Institute for Agriculture (BPTP NTT)	Institution	1
Usapinonot/ TTU	Village	2
Biloto/ TTU	Village	1
Ponain/ Amarasi	Village	1
Tunbaum/ Amarasi	Village	1
Tespatan/ Amarasi	Village	1
TOTAL		15

Background to villages

The study visited five villages in three regencies. Usapinonot is one of 163 villages in the Timor Tengah Utara (TTU) regency, in the sub-district of Insana (Figure 2). The average population density of TTU is 79.27 persons per Km^2 with a population of 211,616 which is 4.97% of NTT population. Based on the 2006 data, the un-employment rate of TTU is 20.04% that includes the actively unemployed and the economically inactive (Badan Pusat Statistik 2006). Of the 50,586 households in TTU, 60.4% of households live in poverty. The illiteracy level of TTU is higher than the provincial average at 18.02%, compared to NTT which is 13.32%. Although Usapinonot is serviced with a primary and junior high school the percentage of children attending school between the ages of 5 to 19 is only 13.25% (Badan Pusat Statistik 2006). A community health centre is located in the village but the nearest hospital and market are in the town of Kefamenanu. The main rivers in TTU are Nain, Powu, Kaubele, Haetko and Mena. Water wells are the main source of drinking water. Usapinonot and Biloto are 180 and 90km respectively from Kupang. Usapinonot is at an altitude of 300m and Biloto at 400m above sea level. Biloto is in the sub district of Mollo in the regency of Timor Tengah Selatan (TTS). Similar schooling and health facilities as those in Usapinonot are found in Biloto. The nearest market and hospital are in Soe. Comparatively Usapinonot has had more government assistance than Biloto, with the trial biogas system as the most recent project.

Ponain, Tunbaun and Tespatan are three of the nine villages in the Amarasi district in the Kupang regency. The villages are at altitudes of 200-300m and 40-50km from Kupang which is the nearest regional centre. The main rivers in the Kupang regency are Oesao and Batu Mera. The population of Kupang regency is 344,008 with 79.07% of the 65,532 households in poverty. This is a much higher proportion than TTU. Illiteracy, on the other hand is lower than TTU at 14.91% reflecting a school attendance of 89.79% (Badan Pusat Statistik 2006). In Tespatan a cemented waterway flows through the village making water accessible all year.

The road connecting all the villages in TTU, TTS and Kupang regencies is a combination of bitumen and dirt.

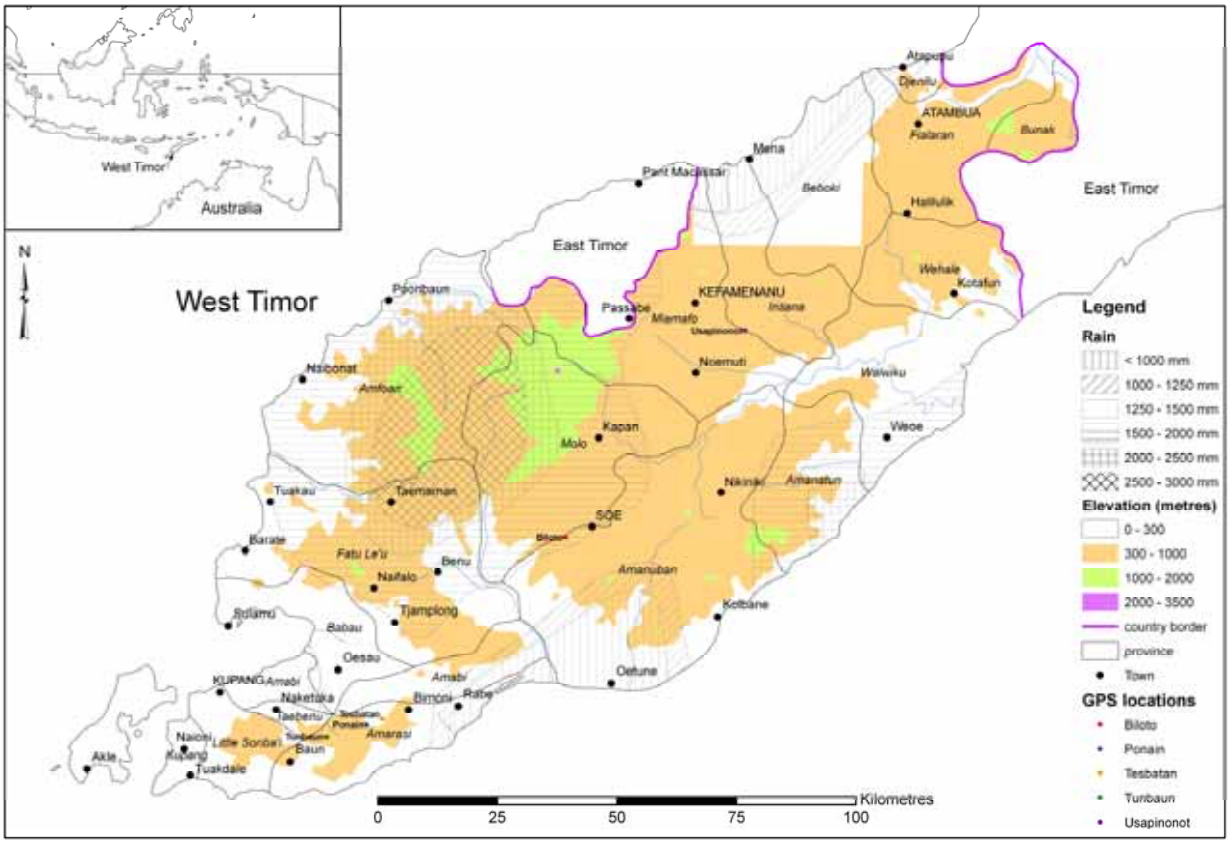

Figure 4: Study villages (prepared by Greg Luker SCU)

Biophysical

Over 60% of informants identified the lack of water as the most constraining of biophysical factors, especially during the dry season. This view was expressed by government experts and village informants. There was a concern over the general lack of water and the lack of water available for irrigation which limits cropping, especially rice cultivation. Extreme weather patterns were mentioned by 25% of institutional informants, but did not feature in the interviews with village informants. Poor soils and pests and diseases are strongly mentioned by institutional informants (Figure 5).

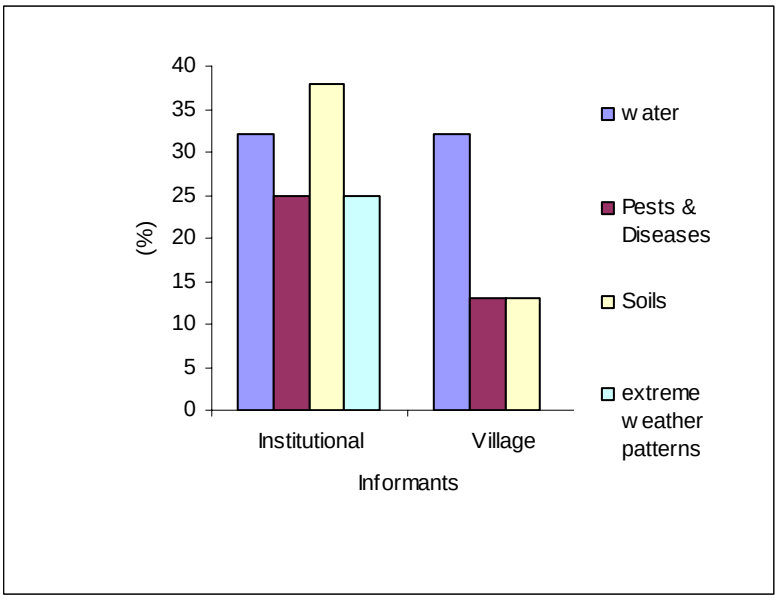

Figure 5. Biophysical factors mentioned by interview informants

Governance

Informants identified a number of issues associated with governance. Institutional informants viewed land tenure, policy, inefficient funding mechanisms, taxes and corruption as issues. In contrast village informants recognised *adat* or traditional governance as the significant issue (Figure 6).

Land ownership in Indonesia is complex. There are many socio-cultural aspects affecting the way in which farmers and government view land ownership. Informants highlighted that traditional law is strong. An Institutional informant stated '*Customary law is still very prevalent in West Timor. Most of the ethnic groups have customary law to manage forests and resources. You must speak to the local leader.'* The national law and the adat may differ in some cases, contradicting on matters of land ownership, ownership of resources from forest land and use rights. This inconstancy was identified as a factor in the breakdown of projects. A government informant stated *'When it comes to managing the forests the people fight. Some people want to implement customary laws, but the government forces them to adopt the state law'* Moreover the agrarian land reforms associated with the *Basic Agrarian Law Act (1960),* which aimed to resolve some of these conflicts, have proved to be ineffective with only 30% of non-forest land in the study area being titled (Thorburn undated). Where titles are granted, many are questioned, revoked and land expropriation occurring without due process. This uncertainty of land tenure has created concern amongst the rural poor. It affects the way in which farmers choose to invest on their property, steering them toward short-term investments. The importance given to this issue by village informants highlights that adat must be treated with the same significance as the national governance systems, especially when working with rural farmers.

An added level of uncertainty for landholders is confusion of land and resource policies. Institutional informants explained that polices change often causing confusion. The study team encountered this situation, interviewing farmers that were unaware of changes to sandalwood ownership policies.

> 'Farmers are worried about the government and theft. Previously farmers have planted Sandalwood in their yards. If somebody steals it farmers won't report it because they don't belief that it is their property.'

This policy changed several years ago to allow private ownership. Institutional informants expressed concern over the lack of transparency surrounding political processes, in particular formal and informal taxation (*retrobusi*) on the sale of small landholder produced commodities. Corruption was mentioned by 25% of the institutional informants, affecting the police, military, civil service and the Kepala *desa*. An informant stated:

> 'When they notice a truck coming through they will set-up along that road. Even though people know you're not supposed to do it, it happens. Cattle can get hit with both illegal and legal taxes each step of the way. It is quite an issue.'

Another informant said:

> 'In NTT and West Timor police corruption is high. Corruption is associated with power. Four and a half tonnes of Sandalwood have gone missing over the past five years. The police take the sandalwood in crimes [confiscating from the sellers] and sell to Bali and Java, out of the port here in Kupang.'

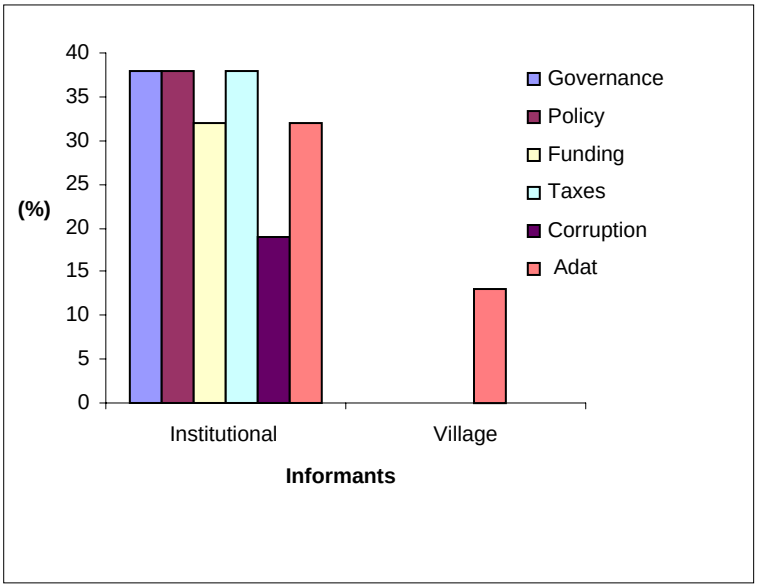

Figure 6. Governance issues identified by interview informants

The lack of concern by the rural poor regarding corruption, taxes, funding and policy issues may be the result of everyday issues taking precedence or that they accept or are blasé about these issues. An informant stated *'People don't ask. Local people accept what we see and think as corruption. They accept the taxes that the Kepala desa request'.* If this is the case, then any rural based project may have to accept the situation and work within this acceptance.

Taxes, both formal and informal, provide a strong disincentive for farmers to pursue the best price option for their products. Predicting such taxes along market chains is difficult when making a product decision. The lack of funds and the inequality of funds distributions between the central, regional and local government is an issue, according to 32% of the informants from various institutions.

Social dimensions

Social concerns included migration, labour requirements, land tenure size and household capital. There is a trend in the rural areas of West Timor for able-bodied men to migrate to larger urban centres in search of better employment opportunities and possibly adventure. An informant stated '*There are a lot of villages around with mainly women. Men are migrating to Kupang or other islands. This is a problem.'* Labour requirement for any

farming is a critical consideration. Fifty one percent of the informants felt that labour is an issue for the intensive activity of cropping (Figure 7). Once men migrate it may take them many years to return, as stated by an institutional informant '*some may return home. Some don't. Some may never return home to work on the land. It can be very expensive to travel and some may send money home to their families.'* The outcome of this movement is a change in the demographic of rural communities. Forty five percent of informants viewed rural areas mostly consisting of the elderly and six percent of informants felt rural areas mostly consisted of women. Another important factor is the seasonal availability of labour caused by employment in Kupang.

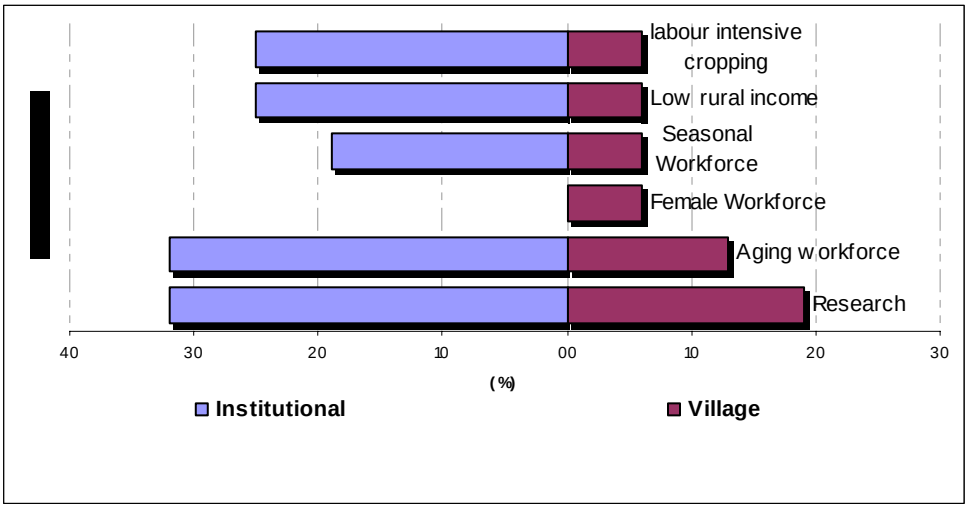

Figure 7. Labour requirements and urban migration

West Timorese farming properties are characterised by being small in size. The Basic Agrarian Law in Indonesia sets limits on the size of land ownership depending on the population density of a region. Several informants, including an expert from the provincial government, felt that this is a barrier for the adoption of agro-forestry activities. Small land ownership limits farming options, including the introduction of alternative income activities. Farmers are forced to maximise gains by focusing on short-term returns. As a result cropping takes precedence over forestry activity.

Farmers encountered by the research team followed a short-term economic cycle, typically an annual cycle for cropping activities and up to two years for livestock. Farmers may not want to invest in longer term and potentially more profitable commodities because of the lack of security of land tenure and past experiences of tumultuous political change. This may have implications for the delivery of development projects. It may be difficult to encourage farmers to adopt longer term commodities such as forestry. Programs may need to consider *steps* rather than encouraging a jump to a long-term cycle.

Information and extension services

The role of local NGOs and extension programs in transferring agricultural knowledge and to facilitate community planning is important. In West Timor, farmers can be characterised as having a lack of formal education and training. Capacity building needs for farmers are focused around tree seedling care and strategies to improve weight gains in cattle (Figure 8). Institutional informants drew attention to technology, and post harvest handling although the later is also important for farmers. The Informants felt that the adoption of technology with minimum or no costly inputs is likely to result in significant and sustainable improvements to farmers. Conceptually though, appropriate technology in this context encapsulates improvements in tree growing, livestock husbandry and product handling.

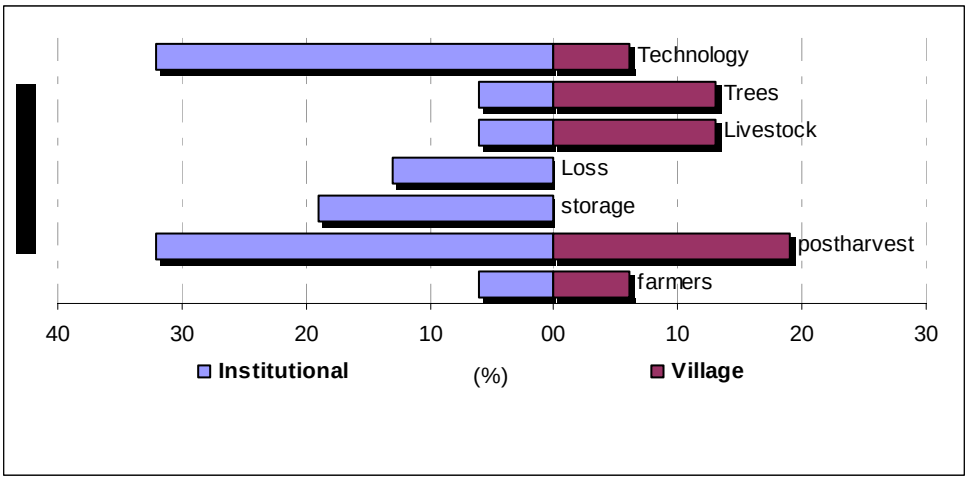

Figure 8. Capacity Building

Several of the informants felt that extension services were inadequate due to the capacity of the NGO and the short time-frames of projects. An institutional informant stated:

> 'They don't have a good enough knowledge on how to manage the local projects. In the past five years the majority of projects have failed in Mutis and Lakaan (Belu). These projects have operation issues and the employees don't have the skills'

Another informant went on to say:

> 'They take the funding and don't support the people with the knowledge or skills. I think people see NGOs as money and are attracted for this reason. Often it is ex-generals, military, people high up, who now run NGOs.'

Financial resources and short project time-frames are seen by several informants as a barrier to successful extension programs Typically, development programs in West Timor have tended to be high investment short term projects. An NGO worker informant believes this is not the most effective approach. This informant says it takes a long-term approach to introduce real changes and that these need to be done in baby steps – lower investment over a longer period.

Economic

Accessibility and availability of appropriate market information for farmers is emphasised strongly by all informants (Figure 9). Market information includes the scantiness of updated price information on the major and minor products, inadequate price differentials between timber species, absence of information on product standards and quality, and information on existing market chains. Market chains includes the distances to markets for the different products, the lack of access to markets, the lack of bargaining power of farmers and the need to strengthen the market chain. The role of middlemen and the limitations of available capital are raised by 6% of village informants as an economic factor. For 32% of institutional informants, general information on domestic and export markets are important economic considerations, however village informants have not considered this aspect (Figure 9). According to some institutional informants the domestic market is hampered by bureaucratic red tape, the existence of a black market and trading in futures. Furthermore, inadequate timber production limits a greater export market which currently consists of lac, honey and teak.

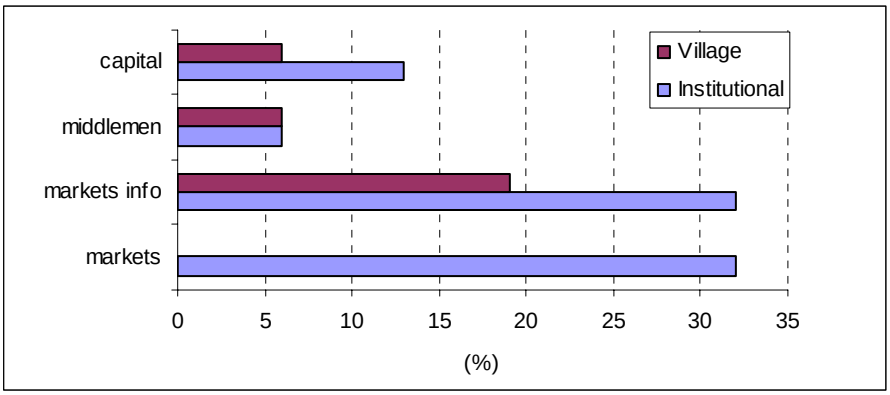

Figure 9. Economic factors

Timber

In the course of the interviews it was evident that sandalwood, teak, mahogany, rosewood, and aka wood are see as long-term investments, especially sandalwood followed by mahogany (Table 8). Nonetheless, this perception did not represent a desire to plant these timber species.

Table 8. Aspirations in Tree growing (%)

Species	Investment (long term)	Income source	Desire to plant	Research Needs
sandalwood	25		8	
teak	8	8	8	8
mahogany	17	8		
rosewood	8			
Aka wood	8			

Figure 10. Timber being imported through inter-island trade at Kupang port

Livestock

For farmers, cattle are an obvious investment and income source but further benefits are hampered by tax. Chicken, pigs, and other small livestock like goats are raised for personal consumption rather than as possible sources of income (Table 9).

Table 9. Livestock (%)

Livestock	Investment (mid-long term)	Income source	Tax Barriers	For Consumption
cattle	17	17	8	
chicken				17
Other small livestock				25

Other livestock discussed during the workshops were deer, as another investment option, and goats for meat rather than for milk. While deer farming has high economic value, conservation issues, lack of technical information and poor knowledge of the deer market may impede it as an investment option.

Fodder

The selection of fodder utilised by farmers are more wide ranging than what is mentioned by institutional informants (Table 10).

Table 10. Fodder Used (%)

Fodder	Informants		Total
	Institutional	Village	
Leucaena	13	19	32
Banana	6	19	25
cassava	6	6	12
kapok		13	13
Other legumes	6	6	12
grass		6	6

Farmers mostly use leucaena and banana leaves but also cassava, kapok, and other legumes as fodder. Leucaena was mentioned specifically as a dry season fodder by the *Kepala desa* from Tunbaun village.

Non Timber Forest Products (NTFP)

NTFPs are an important source of short to medium term income for villagers (

Table 11).
Village informants failed to mention honey as a source of income. This is questionable since the sale of honey and presence of hives were evident during the field visit to West Timor. Nonetheless 13% of institutional informants felt that honey production is an important NTFP and should be further developed by researching the use of domestic bees. Candlenut oil is used for personal consumption as well as a trade. Ownership issues mentioned by 6% of the informants regarding bees and tamarind are related to the laws governing ownership of forests and ownership of NTFP from the forests. For 13% of institutional informants, honey production is an important NTFP and should be further developed by researching the use of domestic bees (

Table 11).

Table 11. Non Timber Forest Products (NTFP) (%)

NTFP	Ownership issues	Established Income source	Research Needs
tamarind	6	25	
candlenut		19	
bees/honey	6	6	13
lac		19	6
coconut		13	
mango		6	

5.3 Barriers to uptake

In the past, many agroforestry projects focused on biophysical (supply side) factors and little emphasis was placed on dealing with demand or socio-economic issues (McWaters & Templeton 2004; Montambault & Alvalapati 2005; Suharyo *et al* 2007). In this section, the report examines biophysical, socio-cultural and economic barriers which have been impeding the success of agro-forestry development projects West Timor. These barriers can be broadly defined within four inter-related themes of physical, social, economic and institutional.

Bio-physical

The most critical physical limitation is availability and accessibility of water, especially during the long dry season. Despite this, agriculture still continues to be the primary economic activity for rural dwellers in semi-arid conditions with poor soils. For farmers the lack of water affects food availability for both humans and livestock populations. It prevents farmers from adopting irrigation based agriculture. Appropriate utilisation and management of water resources has some potential to address this barrier. Benu (2003) generated a six scenario policy alternative for farm productivity in West Timor and found that the scenario with a 10% increase in irrigated area gave the greatest positive impact in agriculture productivity.

Another physical aspect which can act as barrier is uncontrolled fires. It can be argued that uncontrolled fires is a socio-cultural matter because fire has long been used as an integral part of farming in West Timor, but it is also linked to the physical consequence of the long dry season. The increased frequency of uncontrolled fires is due to rapid dismantling of traditional structures *(adat*), high population growth rate, limited well watered land, land tenure conflict and the break down of locally coordinated fire management.

Social

Understanding the social factors involved in achieving successful adoption of the multi-faceted agroforestry is far more complex than single sector activities such as cropping or forestry (Black *et al* 2000; Mercer 2004; Ajayi *et al* 2006). Uptake of new technology and concepts requires the alteration of a farmer's 'modus operandi'. It challenges the farmer's mindset and behaviour and requires the farmer to re-order seasonal and daily activities. A lack of understanding of the decision making processes of farmers and their ability and/or willingness to adopt new concepts often affects the rate of uptake and the likelihood of long-term sustainability (Montambault & Alvalapati 2005; Woods & Petheram 2001). As in all social units irrespective of size, there exists a broad and diverse group of farmers with different priorities who react differently to perceived problems. How farmers react is dependent on the workings of their management units, their history, who makes management decisions and how they are made and gendered lines of responsibilities, especially in countries like Indonesia. The decision-making process itself is complex, unpredictable and involves many variables. Because of the nature of the process, the

social analysis to establish the broad socio-economic factors is often bypassed by offering financial incentives without understanding the decision-making drivers (Fulton & Race 2000).

Often the lack of knowledge integration from the beginning of the decision-making process contributes nothing towards creating an enabling environment for technology uptake. Farmers need to be involved in analysing the constraints and subsequent solutions to problems. The enabling environment for agroforestry should be more focused on creating conditions conducive to advantageous innovations drawn from ideas, experiences, and practices generated locally, as well as ideas that have been re-tailored and adapted into the locality (Woods & Petheram 2001; World Bank 2004).

Perceptions and values of communities are critical to determining where a project should take place and what can or cannot be done. Past projects have relied heavily on extension services to transfer skills and promote the activities. However communication needs to be addressed in the project design phase in order to identify beliefs and issues that may become a barrier to adoption. For example, during the field visit to Ponain village the success rate of seedling establishment ranged from 20% to 100% between three adjacent houses. In Tespatan there was no evidence of successful establishment of 298 sandalwood seedlings provided. The *Kepala desa* said '*time was limited and farmers were too busy to water the plants'*. Further discussions among the community members of the second village uncovered a belief that a regulation existed making all sandalwood trees the property of the government, thereby providing no benefit to landowners and therefore there was a reluctance to devote land to a resource owned by another. The law governing the harvest of sandalwood was changed but farmers are still sceptical and often request to see the law changes on paper.

Both farmers and technocrats bring attention to the often overlooked issue of labour availability, especially for farming communities highly dependent on manual labour for basic cropping and farming. In the villages surveyed the implication of labor migrations from the rural areas is that it leaves behind the young, the elderly, and women to maintain labor intensive farming. The low rural income adds more incentive for the young to pursue work in the cities, and while they may return when work ceases in Kupang, their availability is seasonal.

Other barriers identified during the social survey are small property size limiting production options and the lack of household capital preventing the investment in long-term agricultural pursuits and selling produce at times of peak market prices.

Figure 11. Women are often left behind to do farming work while men migrate

Extension and information services

The role of extension personnel in the transfer of agricultural technology has been found to be crucial in the achieving of high adoption levels (Guerin 1994). However, prior to technology dissemination, extension agencies need to explore and understand farmers' needs and the relevance of technology for that particular situation. It is only then that the farmer will adopt the technology. Farmers in NT are not only faced with the lack of formal education but also the lack of informal training. Roshetko and Mulawarman (2001) found that the lack of training and awareness and the use of inappropriate training materials and media to communicate to the target audience, were some of the most significant barriers to the uptake of new ideas (Roshetko & Mulawarman 2001; Suhardi 2003). The outcome of the social survey reinforces this view with several of the informants highlighting that the extensive services were inadequate due to the capacity of the NGO and the short-time frames of projects.

Studies show that education levels of farmers directly correlate with increased adoption of technology and subsequent adaptation into the wider community (Garforth 2004). More and more, agroforestry projects are focusing on on-farm trials (Petheram and Thahar 2001), demonstration plots and pilot schemes as a part of an uptake strategy. It appeared from the study that the difficulties and costs of local travel, coupled with low population densities limited the interaction among farmers and successful neighbours in sharing of information about new technologies. According to Rogers (1995) a 'chain reaction' occurs in communities that are closely linked compared to those that are sparsely distributed. Foster (1995) found successful neighbours to be influential in the extension of new technologies in a social system. In portraying the importance of successful neighbours, Hassan *et al* (1998) demonstrated that an increased number of farmers using new-variety maize significantly influenced others to adopt. The lack of trials constrains the flow of information from research to reality-tested outcomes (McWaters & Templeton 2004). Research needs to build a strong communication and interpretive element into its design to encourage uptake of new or appropriate innovations.

An issue raised during the West Timor visit was the lack of proper 'decommissioning of projects'. Shelton *et al* (2000) in case studies from Timor and Flores among several other countries pointed out the lack of seedlings post-project because projects handed out seeds/seedling during the tenure of the project without any thought of future supplies. Improper exit strategies are counterproductive, irresponsible and leave behind a rural community that is not only worse off but also less likely to embrace future introductions, even if the technology is the most appropriate and highly beneficial. For counterparts, it diminishes the value of collaborative partnerships and does not encourage continuation.

Governance

The Indonesian government is, at present, promoting a decentralisation agenda. The extent of devolution of powers from the central government down to district, sub-district and village is unknown and requires clarification. This has implications for power relationships, the identification of power brokers within regions and the extent of their influence (whether that influence is perceived or mandated) and the associated protocols expected. The process of decentralisation has proceeded with little planning and capacity building to empower the *Kabupatens* (district leaders) to absorb greater responsibilities. Consequently, governance at a district level may be inadequate in terms of accountability and financial management. Governance at the District level blurs the lines of authority when superimposed onto traditional governance structures (Kusumanto & Sirait undated; Subarudi *et al* 2004).

Land tenure

The wealth of rural communities lies in their association and access to land and therefore land ownership and rights is an essential instrument in rural poverty reduction (Contreras-

Hermosilla and Fay 2005; Ajayi *et al* 2006; International Land Coalition 2006). In West Timor the conflict between central and adat law and subsequent confusion over land ownership is seen as the major barrier for the uptake of agroforestry.

Indonesia has a dualistic system of land ownership (International Land Coalition 2006). The creation of the Basic Agrarian Law (BAL) of 1960 was one of the most progressive land laws of its time (Fredrick and Worden 1993; Thorburn undated) nonetheless BAL was not conducive to securing land rights for the majority of the poor because land certification was not compulsory (Fredrick and Worden 1993). By 1980 lands that were not certified were returned to the government. Although BAL is said to be inclusive and supportive of *adat* ownership (Thorburn undated) it wasn't until 1999 that the National Land Board was accepting registration of customary lands as communal and non-transferable (Contreras-Hermosilla and Fay 2005). Looking back, it seems that Indonesian land history provides all the ingredients to justify the deep seated mistrust farmers hold towards the government. From post-colonial Indonesia to the 'guided democracy' of Sukarno (Fredrick and Worden 1993) to land certification with its myriad tales of dispossession (Contreras-Hermosilla and Fay 2005; Thorburn undated), double dealings, nepotism (Thorburn undated) and prescribed limitation of the size of land holdings (Fredrick and Worden 1993), the wealth of the rural farmer has been undermined and eroded away. Consequently the tortuous path towards clearly defined and secure land ownership deters farmers from investing their time and limited resources in long term investments.

With ever increasing population pressure on land resources compounded by tenebrous land policies, conflict is inevitable. Where farmers acquired rights by procession, dislodging them from the *de facto* ownership leads to litigation, social dis-empowerment and violent confrontation (Contreras-Hermosilla and Fay 2005; Junaidi 2005). Without the legal leg to stand on, farmers are further marginalised, their rights to any forest resources are questioned and curtailed.

Institutional

The sectoral divide between forestry and agricultural institutions is pronounced, although the study team saw positive collaboration at middle management and officer levels. The Indonesian constitution places the control of natural resources in the hands of the State with an agenda of resource management for the benefit of the Indonesian people. The authority for the establishment and ongoing management of a permanent forest estate is given to the Ministry of Forests while the Ministry of Agriculture supports small holders and the commercial plantation crop sector. The resulting regulatory framework inhibits large-scale community agroforestry despite the identified enhanced value this would provide to many rural communities (Noordwijk *et al* 2007).

It should also be noted that the costs involved in compliance with laws and regulation may impede the uptake of projects or more effective integrated agroforestry systems. For example the laws and regulations governing livestock in NT, starting from the village level up, especially for cattle, are excessive. Fees include *kecamatan* (sub-district) fees, third-party contributions, *retribusi* for slaughterhouse services, livestock market services, livestock health checks and quarantine and certificates for calves. While the formal charges are distinguishable, informal charges are obscure, randomly applied and for unpredictable amounts and are seen as deterring farmers from accessing more profitable markets. The issue of fees and charges is exacerbated by the lack of understanding by farmers of their rights and obligations regarding licensing and regulations, coupled with a lack of understanding by officials on the impact of informal charges on the economy of the region (Bertomeu 2003; Suharyo *et al* 2007).

Policies governing small-scale farming do not provide incentives to assist farmers in their efforts to improve their livelihoods. The traditional rights of farmers to utilise forests are not recognised by government agencies, as all forests are considered to belong to the

government. As the legal owner of the land, the government can apply patronage and divide and allocate land without consultation with local communities. Policies continue to promote commercial crops and ignore the basic forest services that rural farming communities in NT subsist on (Roshetko & Mulawarman 2001).

Confusing land and resource policies also hamper agroforestry initiatives. For example, sandalwood has been frequently identified as a major focus of agroforestry initiatives in this region. However, the study team, when consulting with communities that had received large numbers of seedlings from forestry nurseries, found they were often reluctant to plant and maintain the trees. Questioning revealed that although the laws governing sandalwood ownership were changed from all sandalwood being government-owned (Lee 1990), to allowing private ownership, farmers were either ignorant of the change in law or timid in case the government changes the laws again. The physiological conditions for growing sandalwood are ideal in NT, yet this concern over ownership hampers efforts at both small- and large-scale expansion (McWilliam 2001). Similar concerns have led to the mismanagement and illegal logging which threatens the sustainability of teak plantations (Purnomo & Guizol 2007) and general timber trade.

BAL in Indonesia sets limits on the size of land ownership depending on the population density of the region. With such a restriction on the size of land ownership, farmers' options are limited and they are forced to maximise gains and focus on short-term returns. Therefore cropping takes precedence over tree crops.

Research applicability and appropriateness

One of the most important research aspects of agroforestry is the compatibility of selected tree species with livestock and fodder within an integrated system (Garforth 2004). Studies have focused on single species (Shelton *et al* 2000) without the benefit of trialling within a system, although this is now changing as 'on farm' trials are the norm rather than the exception. Where countries face increasing population pressures, 'on farm' trials means allocating the scarce resource of land for experimentation, which may compromise livelihood functions for farmers. Other issues related to the lack of *in-situ* research on integrated systems are the lack of quality planting materials, limiting the choice to a single species and inadequate pest and disease research. The lack of quality planting material has caused farmers to use the most available and accessible planting materials which are usually of low quality (Ochsner *et al* 2001; Ajayi *et al* 2006). Introduction of better quality planting materials is met with indifference (Shelton 2001), thus the genetic quality of plants or animals is compromised through inbreeding, establishment rates and subsequent survival are affected. Because of the narrow genetic base of the low quality planting materials, pests and disease problems tend to persist and can be extensive.

For research to be appropriate it must be applicable to the farming community concerned. In the case of West Timor farmers, their primary concern is food security and if that concern is not evident in the systems being promoted, any uptake is likely to be temporary, lasting as long as the going is good. This is evident in livestock literature when farmers had to choose between cropping or animal husbandry most chose cropping. Where farmers had planted sandalwood seedlings and young crops of maize at the beginning of the planting season, farmers spent time tending their crops and neglected the young sandalwood seedlings. The issue of appropriate research is also highlighted from an economic perspective by the 2006 SMERU study (Suharyo *et al* 2007) which identified the over-emphasis on supply side assistance (technology, credit access, new products) and the limited focus on assessing the demand side as a barrier to improving the business climate in West Timor.

Economic

The SMERU report (Suharyo *et al* 2007) points out several important considerations which indicate a formidable economic climate in West Timor. Compared to other regions, the perceptions of business operators, economic potential and the quality of human and infrastructure resources are poor. Generally farmers in West Timor are uncertain about the price of products, price differentials and the quality or quantities needed to maximise profits. They are not aware of appropriate marketing channels and are mostly at the mercy of the traders who come to them. Farmers have a limited understanding of market linkages and lack the resources to create their own market opportunities without the presence of traders at their farm gate. Furthermore, farmers have limited cash and labor to invest in technology to enhance production or to develop farmer cooperatives to strengthen markets.

The scoping study found a poor understanding of the value chain from field to market results in farmers being grossly underpaid for products and failing to see the potential for value-adding through improved post-harvest handling or processing. For example in the Amarasi district farmers reported selling 20cm diameter teak trees to middlemen from Kupang for 100,000IR or 15AUD. This problem is not limited to small teak growers (Purnomo & Guizol 2007) but occurs with other products such as fruits and cattle (Copland *et al* 2003). The 2006 study by the SMERU Research Institute of Indonesia highlights that too much emphasis has been placed on supply side assistance with too little focus on assessing the business climate itself (Suharyo *et al* 2007).

The scoping study found many positive elements to the role of middle men. In the case of tamarind, where it is uneconomical for farmers to transport their produce individually, middlemen bid for the product and transport it in bulk for export (Figure 12). Improving livelihoods through income generation requires an understanding of the local, regional and national market flows. When traders do not come to the village, tamarind products go through three intermediate traders before the inter-island trader. In the flow from the cattle farmer to market, there are not as many intermediate traders as in the tamarind flow. The flow diagrams in Figure 13 and Figure 14 demonstrate that the market infrastructure in NTT is dominated by traders. With no access to ‘micro-credit’, the poorest communities are in a vulnerable position with little bargaining power. The transaction practice such as the *Ijon*, is when a produce is sold before the harvest period. Although farmers may obtain what they perceive to be a better price than what is offered by inter-island traders, more often traders adjust their scales to accommodate their generosity (Suharyo *et al* 2007).

Figure 12. Middleman weighing tamarind purchased from a farmer

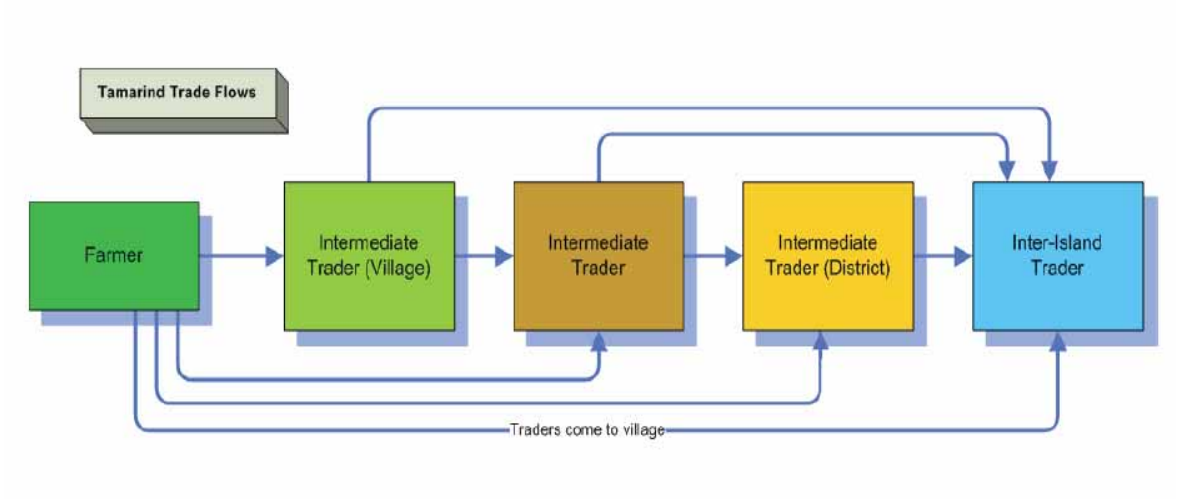

Figure 13. Tamarind flow from grower to market[8]

[8] **Adapted from Suharyo et al (2007)**

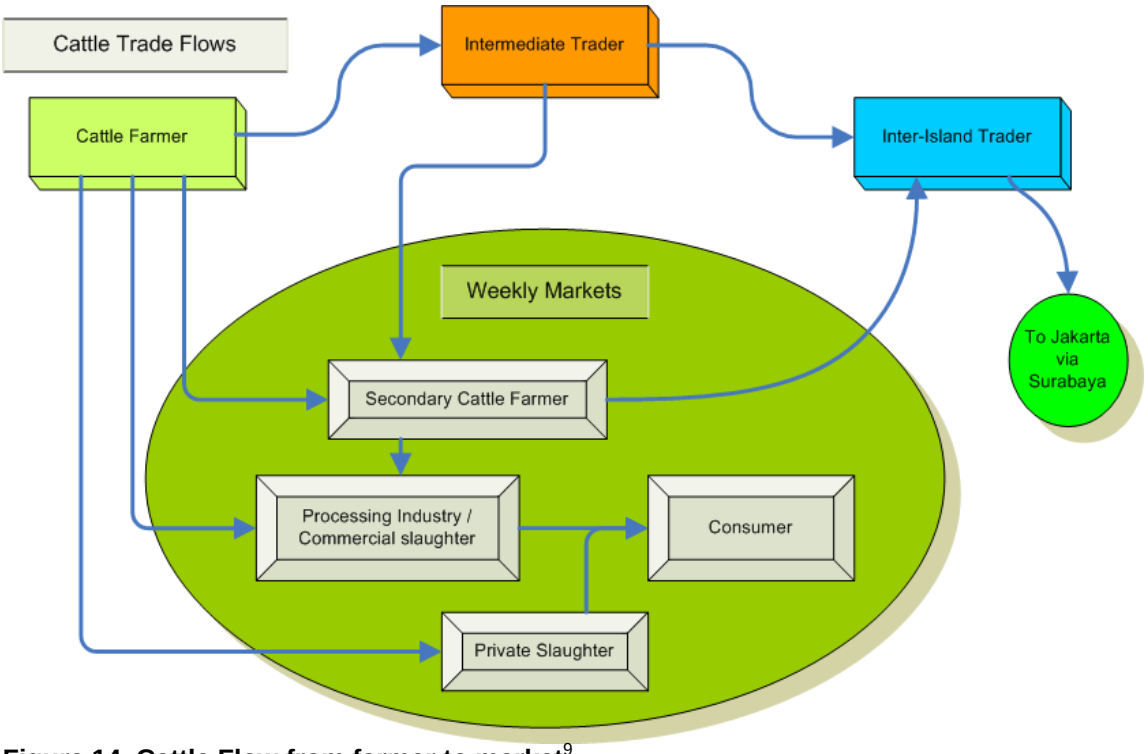

Figure 14. Cattle Flow from farmer to market[9]

In addition, taxes can negatively affect produce markets. *Pendapatan asli daerah* (PAD) is the source of income for the regions in Indonesia. PAD includes taxes, fees for services and proceeds from local government ventures (Toyamah and Poesoro 2006). Because income through PAD is flexible and control is vested in the regional rather than the central government, regional governments strive to increase contribution to PAD. While PAD offers regional governments an avenue for increased income, the brunt of the tax squeeze is felt by the farmer, especially cattle farmers. Quoting from SMERU's Toyamah and Poesoro's article, *"the imposition of any kind of charges will, directly or indirectly affect the efforts of poor people to improve their economic circumstances. In other words, every additional local charge imposed to increase PAD revenues will create a greater burden on the poor"* (pg 15). The implication of increased taxes reverberates down the market chain from farmer to the trader and to the final price of the product. Such formal tax pressures cultivates and maintains the introduction of informal taxes which in turn distorts the final price of the product (Toyamah and Poesoro 2006). While the formal charges are distinguishable, informal charges are obscure, randomly applied and of unpredictable amounts and is seen as deterring farmers from accessing more profitable markets.

5.4 Conclusion

Defining and understanding community wants and needs is complex and often difficult to ascertain, nonetheless it is critical to determining the potential success of a project. With the aim of understanding stakeholder aspirations and expectations in relations to an integrated agroforestry system in West Timor a social survey was conducted.

Overall, farmers aspire to long term investment in timber and cattle, but immediate and medium term incomes are sourced from the sale of NTFPs and other products. Both farmers and technocrats felt water is the most important biophysical constraint. They highlighted the importance of *adat* to rural people and that migration is leaving the old, young and women in villages creating labour storages. Institutional informants felt issues associated with land tenure are a major barrier to long-term investments and expressed

[9] **Adapted from Suharyo et al (2007)**

concern over governance and the capacity of NGO's. The interviews revealed that capacity building needs for farmers are centred on tree seedling care, strategies to improve weight gains in cattle, and an understanding of market flows through appropriate information access on product prices and price differentials, especially for timber. For NTFPs quality control and standards are needed. Farmers felt that the lack of household capital is a problem. The underlying perception of timber species is as a long term investment, this however is not reflected in farmer's desire to plant and grow these species. Farmers tend to feed their livestock a wide variety of fodder ranging from Leucaena, banana leaves and stems, kapok, cassava leaves, and other available legumes. Smaller animals such as chickens, goats and pigs are produced for local consumption while cattle featured prominently as an investment. Tamarind, candlenut, coconut, lac and mango constitute an important income source for farmers. Honey was not mentioned by village informants as source of income, which is surprising considering the presence of honey sellers in the villages visited.

The third section of this chapter draws together interview results, observations from the study team and literature to discuss major barriers impeding the uptake of integrated agroforestry. These barriers are broadly defined within four inter-related themes – physical, social, economic and institutional. The semi-arid climate of West Timor has produced a community of rural farmers attuned to the natural rhythms of their environment but who are also at its mercy when extreme weather patterns play out. Combining the biophysical limitations with the socio-economic state, West Timorese farmers are some of the poorest in the country. The most critical physical constraint is the availability and accessibility of water, with uncontrolled fires being of secondary importance. An understanding of the decision-making processes of farmers and their ability and/or willingness to adopt new technology is essential in affecting likely uptake and the long-term sustainability of any project. The issue of labour is often overlooked. In this study labour shortages caused by urban migration can constrain the community's ability to adopt new technology. Low household capital and small property sizes are other social barriers. The wealth of rural communities is associated with access and ownership of land. In West Timor, confusion and conflict over ownership and subsequent security of resources deter farmers from investing their time and limited resources in long term investments. Institutional barriers come in the form of regulatory framework and policies which inhibit large-scale community forestry and agroforestry initiatives. West Timor is characterised as having a depressed economic climate with poor business confidence, infrastructure and human capital. Farmers have poor understanding of the market chain, resulting in them being grossly underpaid for products and failing to see the potential for value-adding through improved post-harvest handling. The role of middlemen is crucial in determining the price for commodities. The capacity of NGO's to deliver extension programs is acting as a barrier and there is a need for research which is applicable and appropriate.

The next chapter will outline an income diversification options model for West Timor that integrates timber/fodder/livestock with the addition of non-timber forest products.

6 Income diversification options for West Timor

6.1 Proposed income diversification approach

The proposed Timber, Forage, Livestock Agroforestry approach (TFLA) is based on an extensive review of literature as well as drawing on the lessons from the past and taking into consideration the identified barriers to uptake (Figure 15). The findings of the social survey conducted in West Timor were also utilised to inform the development of the proposed TFLA approach.

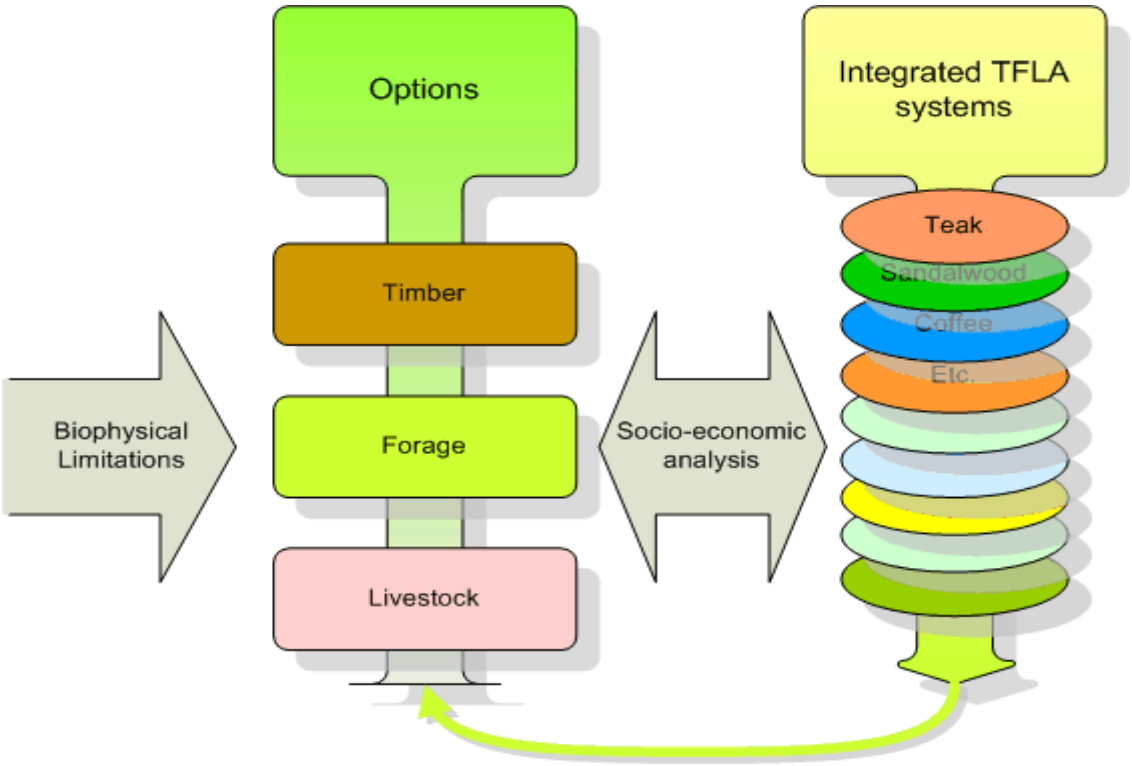

Figure 15. TFLA – A Suggested Income Diversification Approach in IRD

The Djoeroemana *et al* (2007) integrated rural development (IRD) approach suggested for NTT was agreed to by participants of the workshop held in Kupang in 2006 which takes into account the four components of socio-cultural, economic, environmental and political (Figure 16). The suggested TFLA approach takes the Djoeroemana *et al* (2007) livelihood approach to the next stage to show the cyclical nature of adoption. In fact the TFLA approach addresses a fundamental need revealed during the Kupang conference which is the need to have a framework or strategy for the design and implementation of IRD. Technology transfer cannot be generalised or continued to be viewed as a traditional production system of inputs and outputs.

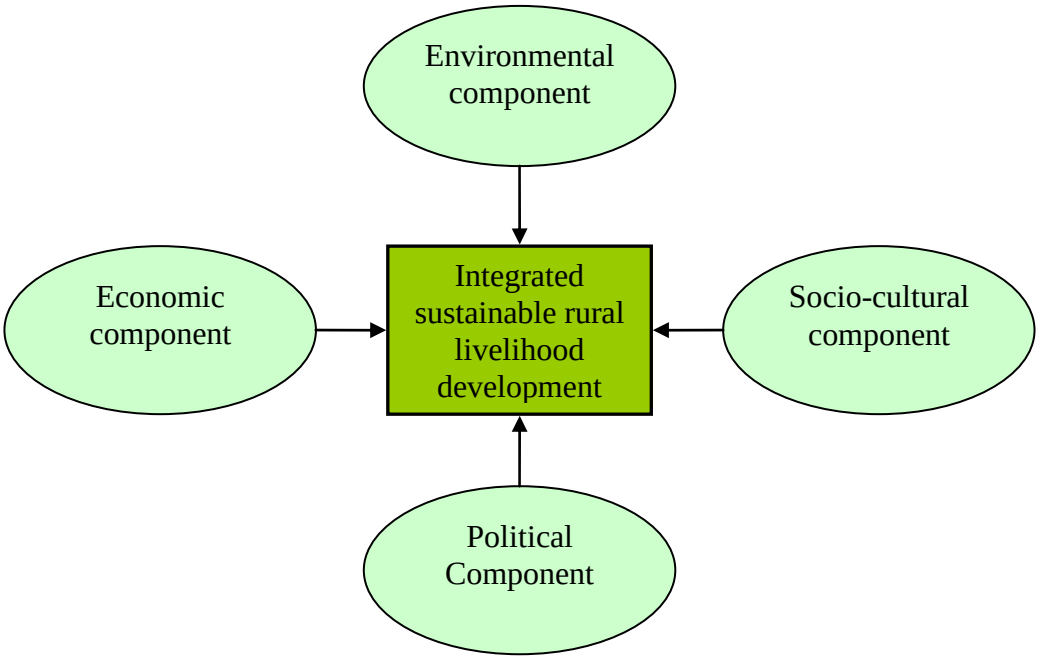

Figure 16. The integrated sustainable rural community livelihood approach to IRD (Djoeroemana *et al* 2007)

Without doubt the biophysical limitations are the key determinants of what can be grown or raised within a particular geographical and climatic zone. Therefore it would be safe to assume that at the beginning of the TFLA process there should be a list of timber, forage, livestock, and NTFP (TFL & NTFP) possibilities for West Timor. Furthermore because integrated land use in West Timor is not a new concept the list of TFL & NTFP possibilities may include some workable tried and tested combinations by farmers, NGOs and other IRD organisations. Keeping in mind that, although the impetus for TFLA is to develop an integrated agroforestry with timber as the long term crop, potential timber species are not considered in isolation to the other components of TFLA diversification options.

The next stage of the TFLA approach is the socio-economic processes. The biophysical aspect of the TFLA process may 'kick start' the process but the socio-economic aspect determines adoption and subsequent adaptations. It is during this stage of the process where the most appropriate systems evolves through farmers innovations, appropriate and sensitive technocratic guidance supported by marketing and political structures conducive to improving farmers' wellbeing. It would be short-sighted to define wellbeing strictly in terms of increased income and not include the wealth created by workable options. Just as much as a farmer is guided by physical seasons, social seasons guide what is available to the farmer, where labour, land and resources are scarce or abundant. When, how and where can the farmer invest time and resources in preparation to fulfilling cultural obligations.

The technocrat/scientist must redefine their role, often interchanging between a guide and facilitator. The definition of a guide is to show the way while to facilitate is to make easier or less difficult. There is a danger in IRD to swing too far into the facilitative role and risk building a dependency rather than instigate long term sustainability. The technocrat/scientist has developed the technical ability as well as having access to information to create possibilities while the farmer is informed and limited by what is operating within their local sphere. Nevertheless together, both parties can facilitate progress towards a common goal, often for the technocrat the role of guide is interspersed with facilitative function throughout the process.

The TFLA approach is a systematic income diversification approach that is:

- Not an input-output system but a cyclical system with sufficient flexibility that recognises the need to be sustainable. The cyclical nature of the approach induces a multitude of options as influenced by socio-cultural and economic factors.
- Dynamic, holistic and adaptable as knowledge is shared and learning increases between technocrats/scientists, farmers and extension service providers. At the same time the system recognises the importance of socio-cultural determinants and drivers in the adoption/adaptation processes. As socio-cultural and economic factors are highly localised, the options which are generated should be socially and culturally possible.
- Guided by physiological and ecological and limitations notwithstanding the possibilities of creating micro-ecological niches.
- Able to provide a framework to assist all parties involved to establish where strengths/weaknesses are and where roles are defined and redefined.

The TFLA approach can only function if all parties involved are transparent in their expectations, are willing to compromise for the greater good and willing to respect the definitions of their involvement. Whilst the current move in IRDs is for greater participation by the community, this move must be kept in balance with the needs/ direction of scientific and technical organisations as well.

6.2 List of timber species and compatibility within a TFLA framework

To begin the TFLA process, two sets of tables were generated by this study. Table 12 is derived from the workshops, meetings and the social survey during the visit to West Timor. The second table is list of potential species for consideration within the TFLA economic diversification option derived from the literature (Appendix 9.3)

Table 12. List potential alternatives for the TFLA economic diversification option gained from consultation

Timber	Forage	Livestock	NTFP
Teak	Leucaena	Cattle	Sandalwood
Mahogany	Gliricidia	Deer	Honey
Rosewood	Kapok	Goat	Lac
		Pigs	Tamarind
		Chickens	Candlenut
			Borasis palm
			Rattan
			Aku

6.3 Conclusion

The proposed TFLA approach is a systematic IRD model with sufficient flexibility to allow more than one entry point into the system. Physical limitations may determine the available options but it is the socio-cultural factors that determine the uptake and long term sustainability. The first step of the TFLA process should be the development of a timber, forage, livestock, and NTFP possibilities for West Timor. The next stage is considering the socio-economic aspects. This approach will only function if all parties are transparent in their expectations and are willing to compromise for the greater good and respect the definitions of their involvement. The final Chapter identifies a way forward outlining a conceptual framework and research areas to improve or discover new pathways to enhance outcomes for West Timorese farmers.

7 Conclusion and recommendations

West Timor is part of the poorest and least developed province in Indonesia, suffering both physical and cultural isolation, inadequate infrastructure and limited natural resources. In a BBC report titled *"El Nino means hunger"* the impact of weather fluctuation was evident in the village of Tes in TTU (Painter 2007). The rainy season arrived at the expected time in November but it did not last the full 3-4 months, instead by December it was dry and farmers lost half of their maize crop. Young children were facing malnutrition and under nutrition as meals were either reduced from three meals to only two meals a day or meal portions were reduced (Painter 2007). With 80 percent of West Timorese living below the poverty line (HPCR 2001), food security must remain the focus of an integrated agroforestry system and should also be capable of creating conditions conducive for innovations to improve the income of farmers. With increasing regularity of extreme weather patterns, the capacity of the farmers and their fragile environment are stretched. Bring in the complexities of government policies, land ownership, socio-economic factors, traditional *adat* versus state law and the outlook is not encouraging.

For 40 years many approaches have been undertaken to assist the West Timorese farmers improve income and offset some of the hardships experienced during the long seasonal dry weather. Nonetheless these projects have generally failed to meet their goal of poverty alleviation. Integrated agriculture is not a new phenomenon in West Timor. Farmers have adapted and changed their farming techniques in accordance with available technology and changes in environmental and social conditions. Why then, despite technocrats in development programs demonstrating substantial production gains through new technology, have farmers rarely adopted these concepts? In addressing this question this study examined the literature including an in-depth look at the most relevant forestry and agricultural projects and a field investigation with a social survey.

It is apparent that a consideration of the socio-cultural aspects is essential to the success any development project, however it is often overlooked because it involves delving into complex issues which can not be easily defined or solved. It was hoped that economic incentives would compensate for this oversight. In reviewing the past development projects the report identified number of key considerations. These are: a need for strong partnerships and collaborations; a focus toward a needs oriented participatory training; project planning should be broad, inclusive and flexible, and; review Instruments should be responsive with a minimal turn around time from research and innovators to users, policy makers and other projects.

The social survey aimed to define and understand community stakeholder aspirations and expectations in relations to integrated agroforestry in West Timor. Farmers' immediate needs are improvement in cattle production, seedling survival and an understanding of market flows. For NTFPs what is needed is quality control and standards. Farmers perceived timber species as a long term investment, but this is not reflected in their actions. Cattle are seen as a beneficial long term investment. Institutional and village informants highlighted the importance of *adat* to rural people. In chapter 5 interview results, field observations and the literature were drawn together to discuss the major barriers impeding the uptake of integrated agroforestry. These barriers can be broadly defined in to the interrelated areas of physical, social, institutional and economic. The most critical physical constraint is the availability of water. The lack of understanding of farmers' decision making process, labour shortages and the lack of household capital are social barriers. Land tenure security and the reluctance of farmers to make long-term investment is a significant issue and difficult to overcome. The other major institutional barriers are regulatory frameworks and policies inhibiting beneficial programs. Farmers are being underpaid for their produce because they lack the understanding of the market chain. The role of middlemen is crucial is determining the price for commodities. Several

informants highlighted that the capacity of NGOs to deliver extension programs is also an important consideration.

Chapter 6 proposes a TFLA approach based on an extensive review of literature and the findings of the social survey. It is a systematic IRD model with sufficient flexibility to allow entry at more that one point. The first step of this approach is determining available production options for West Timor and the second being a consideration of socio-economic aspects. The success of this model will be influenced by the degree to which physical and socio-cultural can be integrated and whether stakeholders are willing to work toward the common good and compromise. This Chapter outlines a conceptual framework and research areas to improve or discover new pathways to enhance outcomes for West Timorese farmers.

7.1 Conceptual framework

The Kupang conference (Djoeroemana *et al* 2007) defined a conceptual model to determine which development approaches are likely to produce low, moderate or high change (Figure 17).

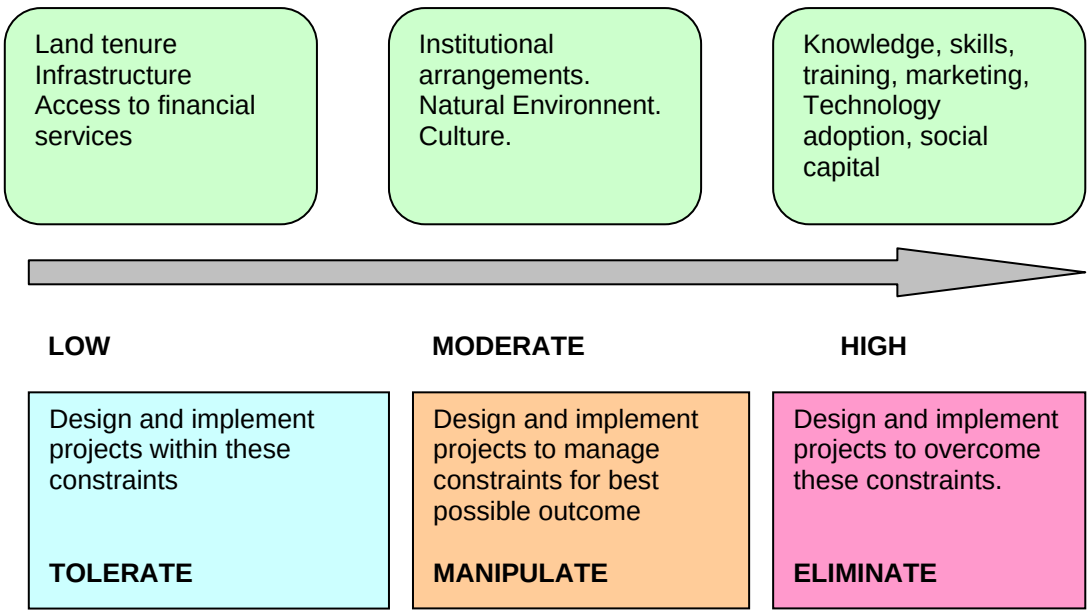

Figure 17. Conceptual Framework of Potential for Change (Djoeroemana *et al* 2007).

This model provides a good guide to decisions on where to address the barriers identified in this study. In formulating a conceptual framework to overcome these barriers and allow TFLA options to function, this model along with findings from the literature and social survey were used. As suggested by Djoeroemana, some barriers such as land tenure, infrastructure and access to credit are better tolerated during the design of projects while other issues can be manipulated or eliminated by proper planning and appropriate implementation.

Below are the steps in the recommended conceptual framework:

1. Conduct a socio-economic survey to establish farmer typologies (Vanclay 2005). Using partnerships and collaborations this could include identifying community decisions-making processes and farmer's social capital. This step should provide a targeted

approach as well as improving efficiency (Johnson *et al* 1986; Kwesiga *et al* 2003; Patrick *et al* 2006).

2. To conduct an impartial evaluation of major agroforestry systems, verify the systems identified in the Roshetko and Mulawrman summary from the 2000 Denpasar conference (Roshetko and Mulawarman 2001) and from the 2006 Kupang conference (Roshetko *et al* 2007). One aspect of the evaluation should include morphological information of the species within the major systems (Johnson *et al* 1986; Roshetko and Mulawarman 2001; Roothaert and Kerridge 2002).
3. Establish and conduct trials on the likely agroforestry species appropriate to the farmers needs (David 1995; Roshetko and Mulawarman 2001; Diwyanto *et al* 2002).
4. Conduct Rapid Market Appraisals (RMA) to provide an overview of market strengths and weaknesses and identify potential opportunities (GTZ 2002; Kwesiga *et al* 2003; Subarudi *et al* 2004; Albu and Griffith 2005). The RMA should assist in increasing the market literacy of farmers as well as technocrats and scientists.
5. Based on the socio-economic findings, farmer typologies and biophysical properties of potential agroforestry species, a ranking system should be developed as a preliminary guide and as an interactive learning tool.
6. Conduct participatory mapping activities to define boundaries based on acceptable land tenure system. This suggested activity should not be an attempt to solve the land tenure issue but to establish an acceptable framework for all parties to agree and work within. This activity should include all the stakeholders, government, non-government and farmer communities (Roshetko and Mulawarman 2001).
7. Conduct a management audit of the farming sphere to determine the lines of authority and the strengths and weaknesses of the relationships. The audit will establish who and where the power brokers are. It will also identify where the decentralisation process is at, especially with government departments. The audit should also establish intra-organisational strengths and weakness which will inform a TFLA process (Gatau 1999; World Bank 2007).
8. Training needs analysis should be formulated from the findings of the RMA, socio-economic analysis and evaluation of the major systems. This analysis will allow the needs of farmers and government to be identified and as a result in the development of the most appropriate training and awareness programs. This approach will ensure optimum use of resources as well as strengthen the capacity of individuals and organisations (Djoeroemana *et al* 2007).

7.2 Research areas

Within the conceptual framework the following is a list of key research areas which are crucial for overcoming specific barriers which could affect the uptake of the TFLA approach:

- Collecting and storing water using low cost simple infrastructure has the potential to increase the availability of water. This may include the installation of low pressure solar pumping equipment and tanks. This could be particularly effectively at the start of the dry season when labour requirements are high and as result primary needs such as cropping take precedence over perceived secondary activities such as watering forestry trees. The capacity of West Timor aquifers are unknown and thus research into this technology should be accompanied with an investigation of resource potential.
- The role of middlemen is crucial in determining the price of farm produce. The study team observed how two middle men competing to buy tamarind from the same farmers resulted in an increased price. Alternatively, the study team also observed when a single middleman was present the price of the produce was substantially deflated. An investigation into influences which lead to middlemen operating and mechanisms to encourage competition could create a more robust market reflecting the real cost of produce.
- The lack of household capital is preventing farmers from undertaking effective economic planning. Farmers are selling produce when they need money, usually at the end of the dry season, rather than at the time of optimal price. Establishment of micro-loan schemes where farmers borrow against the commodity could give farmers the opportunity to retain their produce until the best price is available and thus maximising returns. It could also provide some bargaining power against middlemen.
- The expansion of livestock has significant potential to enhance income of rural communities. So far the focus has been on the expansion of cattle production, with the potential of goats, pigs and chickens being overlooked. The non-cattle livestock potential should be investigated as an additional income stream. These animals are generally sold for local consumption. This means farmers do not need to have an understanding of the market chain. In addition these species are less influenced by formal and informal taxes and may be better adapted to the harsh West Timorese environment.
- The study team observed that urban migration of men is having a significant social impact on rural communities, with women and the elderly and young undertaking the majority of farming duties. There has been little research in this area. Development projects should investigate this phenomenon (i.e. factors driving migrations, numbers of migrates, destinations) and examine what are the influences which could encourage men to return to their villages and participate in farming duties.
- The role of village leaders can be critical for the uptake of new technology. During the field visit the study team observed the influence of village heads in two adjacent villages. In the first village the *Kepala desa* had a clear vision taking an active interest in the community's development. This resulted in the adoption of new technology such as forestry species and subsequently the village being more prosperous. In the second village this vision was lacking and as result the living standards of the community were much less including the existence of sanitation issues. The study team believes that future projects should encourage village enterprise through working with the village leaders. This could be achieved through workshops where village heads travel to successful villages.

- Farmers perceive timber production to be a good long-term investment, but this view has not been reflected in the planting and caring of trees. In the past tree species with a high long-term return such as teak and sandalwood were promoted to farmers for planting. The study team observed in some instances when these species are planted they often fail to reach maturity because the need for household capital is too great. Timber species which provide a secondary intermediate returns such as rosewood with fodder may encourage farmers to retain trees until they are mature.

7.3 Strengthening Indonesian Australian Partnerships

Knowledge and skill sharing between Indonesian and Australian researchers will lead to improved capacity to develop and implement targeted research and extension programs. Researchers will develop better understanding of integrated rural development systems, and how best to facilitate the needed changes to improve smallholder's agribusinesses. Focus group discussions, workshops, and publications of research findings will enhance public recognition and professional standing of researchers and the institutions involved. These activities will assist the Indonesian collaborating organisations and their staff in developing project design, management, and facilitation skills. Furthermore strengthening institutional capacities to be responsive and receptive, to change rather than remain rigid and prescriptive.

8 References

Ajayi, O.C., F.K. Akinnifesi , J. Mullila-Mitti, J.J. DeWolf and P.W. Matakala (2006) *Adoption of agroforestry technologies in Zambia: sythesis of key findings and implications for policy.* World Agroforestry Centre (ICRAF), Lilongwe, Malawi 31pp.

Albu, M. and A. Griffith (2005) *Mapping the Market: A Framework for Rural Enterprise Development Policy and Practice.* Practical Action Technology Challenging Poverty, Warwickshire, UK 35pp.

Amril, M. A. and M. B. Rangngang (2001) Goat Production on Leucaena in Small Farming System at Majene Regency, Sulawesi Selatan Province. *7th Meeting of the Regional Working Group on Grazing and Feed Resources: Forage Development in Southeast Asia: Strategies and Impacts*. Madano, Indonesia, FAO**:** 4pp.

Arifin, B., H. Ismono and T. Endaryanto. (undated) *Farmers' Decision Under Risk Conditions in Agroforestry System in Lampung Province.* College of Agriculture, Banda Lampung 4pp.

Badan Pusat Statistik (2006) *Propinisi Nusa Tenggara Timur dalam angka 2006* (NTT in figures). Bidang Integrasi Pengolahan dan Diseminasi Statistik (Integration processing and Statistical Division, Badan Pusat Statistik, Kupang.

Badan Pusat Statistik (2007a) *Badan Pusat Statistik Propinsi Nusa Tenggara Timur*. BPS Statistics of Nusa Tenggara Timur http://www.bps.go.id/index.shtml. accessed 21/08/07.

Badan Pusat Statistik (2007b) *Beberapa Indikator Utama Sosial - Ekenomi Indonesia - Selected Socio-Economic Indicators of Indonesia*. March Edition 2007. Sub Directorate of Statistics Services -Badan Pusat Statistik, Jakarta 65pp.

Bamualim, A. and R. B. Wirdahayati (2003) Nutrition and Management Strategies to Improve Bali Cattle Productivity in Nusa Tenggara - ACIAR Proceedings No. 110. *Strategies to Improve Bali Cattle in Eastern Indonesia*. *Ed*. K. Entwistle and D. R. Lindsay. Canberra, ACTT, Australian Centre for International Agricultural Research (ACIAR)**:** 17-22.

Benu, F. (2003) Farm Productivity and Farmer's Welfare in West Timor, Indonesia. PhD Thesis. Muresk Institute of Agriculture, Curtin University of Technology, Western Australia.

Bhat, K. and H. Ma (2004) Teak growers unite! *ITTO Tropical Forest Update* **14**(1): 3–5.

Black, A., K. Forge and F. Frost (2000) *Extension and advisory strategies for Agroforestry.* RIRDC Publication No. 00/184. Rural Industries Research and Development Corporation (RIRDC), Kingston, ACT 112pp.

Blyth, M., S. Djoeroemana, J. Russell-Smith and B. Myers. (2007) Integrated Rural Development in East Nusa Tenggara, Indonesia: Overview of opportunities, constraints and options for improving livelihoods. *Integrated Rural Development in East Nusa Tenggara, Indonesia. Ed*. S. Djoeroemana, B. Myers, J. Russell-Smith, M. Blyth, E.I.T. Salean. Canberra, ACT, Australian Centre for International Agricultural Research. **126:** 9-19.

Buckles, E.D. (1999) *Cultivating Peace Conflict and Collaboration in Natural Resource Management*. Ottawa, Canada, International Development Research Centre (IDRC), World Bank.

Budiadi, Y. Kanazawa, H.T. Ishii, M.S. Sabarnurdin and P. Suryanto (2005) Productivity of Kayu putin (*Melaleuca leucadendron*) tree plantation managed in non-timber Forest Production System in Java, Indonesia. *Agroforestry Systems* **64** (2):153-155.

Butar, T. B., G. N. Njurumana and I.M. Widnyana (2007) Some Notes of Agroforestry Model as Pioneer to Develop Small Scale Forests for People Nearby Forests in East Nusa Tenggara. Improved Triple Bottom Line from Small Scale Forest, Leyte, Philippines.

Chrisitie, B. M. (2007) A Review of Animal Health Research Opportunties in Nusa Tenggara Timur and Nusa Tenggara Barat Provinces, Eastern Indonesia. ACIAR Technical Report Series. Australian Centre for International Agricultural Research Canberra, ACT 76pp.

CIA (2007) The World Fact Book - Indonesia https://www.cia.gov/library/publications/the-world-factbook/print/id.html. accessed 07/11/07.

Contreras-Hermosilla, A. and C. Fay (2005) Strengthening Forest Management in Indonesia Through Land Tenure Reforms: Issues and Framework For Action. World Agroforestry Centre, Bogor, Indonesia 55pp.

Copland, R.S., A.B.M. Afonso, L.B. Fontes and E.A. Serrao (2003) The Role of Livestock in the Development of East Timor-Constraints and Potential. Agriculture: New Directions for a New Nation East Timor (Timor-Leste) proceedings of a Workshop 1-3 October 2002, Dili, East Timor - ACIAR Proceedings 113. *Ed*. H. d. Costa, C. Piggin *et al*. Canberra, ACT, Australian Centre for International Agricultural Research (ACIAR).

Crabtree, B., N. Chambers and D. Eiser (2000) Voluntary Incentive Scheme for Farm Forestry: Modelling Uptake, Policy Effectiveness and Employment Impacts. *Developing Policies to Encourage Small Scale Forestry. Ed*. J. L. Herbohn, S. R. Harrison *et al*. Kuranda, Australia 9-13 January IUFRO Research Group 3.08**:** 49-56.

Dahlanuddin (2001) Forages commonly available to goats under farm conditions on Lombok Island, Indonesia. *Livestock Research for Rural Development* **13** (1).

David, S. (1995) What do farmers think? Farmer evaluations of hedgerow intercropping under semi-arid conditions. *Agroforestry Systems* **32** (1).

Dean, G. (2001) Culture Matters http://www.okusi.net/garydean/works/culturematters.html accessed 08/09/07.

Departemen Agama (2005) *Jumlah Penduduk Menurut Agama Tahun* 2005 - Number of Population by Religion Year 2005. Departemen Agama, Republik Indonesia Indonesia http://www.depag.go.id/index.php?menu=page&pageid=17. accessed 22/11/07.

DFID (2004) Mid-Term Evaluation Multistakeholders Forestry Program - DFID Nusatenggara - case study of district of Sumbawa, province of West Nusatenggara. Department For International Development (DFID), London, UK 31pp.

Diwyanto, K., A. Priyanti *et al* (2002) Indonesian Approaches to Technology Adoption for Livestock Development. Research and Development Strategies for the Livestock Sector in South East Asia through National and International Partnerships - proceedings of a workshop held in Bangkok, Thailand 11-15th March 2002. *Ed*. A. S. Frio and G. D. Gray.

Rome, Italy, FAO, Japan Livestock Technology Association (JLTA), International Livestock Research Institute, Nairobi.

Djajanegara, A. and K. Diwyanto (1995) Research Priorities for Improving Animal Agriculture by Agro-ecological Zone in Indonesia *Global Agenda for Livestock Research. Ed*. C. Devendra and P. Gardiner. Los Banos, Philippines, International Livestock Institute**:** 193-205.

Djoeroemana, S., E. Salean and W. Nope (2007) An Overview of Environmental, Sociocultural, Economic and Political Aspects of Rural Development in East Nusa Tenggara. *Integrated Rural Development in East Nusa Tenggara, Indonesia. . Ed*. S. Djoeroemana, B. Myers *et al*. Canberra, ACT, Australian Centre for International Agricultural Research (ACIAR). ACIAR Proceedings No. 126.

Djogo, A.P.Y. (1992) The Possibilites of Using Local Drought Resistant Multipurpose Tree Species As Alternatives to Lamtoro *(Leucaena Leucocephala)* for Agroforestry and Social Forestry in West Timor. Working Paper No.32. Environment and Policy Institute, East West Centre, Honolulu, Hawai 41pp.

Djoharjani, T. (1996) Survey on Production System of Dual Purpose Etawah goat and its Potential for Development in East Java. *Livestock Research for Rural Development* **8** (2).

Emtage, N., J.L. Herbohn and S.R. Harrison (2000) Landholder Subcultures in Far North Queensland and Implications for Policy Development to encourage Farm Forestry. *Developing Policies to Encourage Small Scale Forestry*. *Ed*. J.L. Herbohn, S.R. Harrison *et al*. Kuranda, Australia 9-13 January IUFRO Research Group 3.08**:** 64-73.

Entwistle, K. and D. R. Lindsay, Eds. (2003) Strategies to Improve Bali Cattle in Eastern Indonesia: Proceedings of a Workshop 4-7 Februrary 2002, Bali, Indonesia. Canberra, ACT, Australian Centre for International Agricultural Research (ACIAR).

FAO (1995) Natural Colourants and dyestuff. Non Wood Forest Products 4. Food and Agriculture Organisation of the United Nations, Rome.

FAO (2006) Global Forest Resources Assessment 2005 - Indonesia Country Report on Bamboo Resources Global Forest Resources Assessment 2005, Working Paper 119. Forestry Department Food and Agriculture Oganisation (FAO) & International Network for Bamboo and Rattan (INBAR), Rome 33pp.

Ffoulkes, D. (2005) Strategies for Improving the Nutrition of Ruminant Livestock Kept by Smallholders in SE Asia. Technical Publications- AGNOTE No. J51. Northern Territory Government, Darwin.

Fisher, L., I. Moeliono, S. Wodicka (1999) The Nusa Tenggara Uplands, Indonesia: Multiple-site Lesson in Conflict management. *Cultivating Peace: Conflict and Collaboration in Natural Resource Management*. *Ed*. E. D. Buckles. Ottawa, Canada, International Development Research Centre, The World Bank.

Fredrick, W. H. and R. L. Worden, Eds. (1993) Country Studies - Indonesia. Washington, DC, Library of Congress.

Fulton, A. and D. Race (2000) Farm Forestry in Australia: Why do land holders get involved? *Developing Policies to Encourage Small Scale Forestry*. *Ed*. J.L. Herbohn, S.R. Harrison *et al*. Kuranda, Australia 9-13 January IUFRO Research Group 3.08**:** 101-108.

Garforth, C. (2004) Introduction. Demand Driven Approaches to Agriculture Extension: Case Studies of International Initiatives. *Ed*. W. Rivera and G. Alex. Washington, DC, Agriculture & Rural Development, World Bank. Vol.**3**.

Gatau, M. E. (1999) Environmental Auditing in Forestry: A case study from Wandumi Village - Morobe Province, Papua New Guinea. School of Environment and Management: Southern Cross University Lismore, . MSc. XX 204pp

Glover, I. (1986) Archeology in Eastern Timor. Canberra, ACT, The Australian National University (ANU).

GTZ (2002) Raising Capacities of the Poor - Experience of Nusa Tenggara Projects. Ministry of Home Affairs, Deutsche Gesellschaft Flur Technische Zusammenarbeit (GTZ), 24pp.

GTZ (2003) Summary of the Evaluation "Poverty Alleviation and Support for Local Governance in the Nusa Tenggara Province - Indonesia. Gesellschaft Flur Technische Zusammenarbeit (GTZ), Germany 5pp.

Hadisoesilo, S. (2005) Tingku - a traditional management technique for Apis dorsata in Indonesia. Forest and Nature Conservation Research and Development Indonesia. http://www.beesfordevelopment.org/info/info/exploiting/tlngku-a-traditional-mana.shtml accessed 01/10/07.

HPCR (2001) Building Human Security in Indonesia - West Timor. Humanitarian Policy and Conflict Research. http://www.preventconflict.org/portal/main/ maps_wtimor_overview.php. accessed 12/11/07.

Indian Lac Research Institute (2001) What is Lac? ICAR India http://www.icar.org.in/ilri/basicinfo.htm. accessed 28/09/07.

International Land Coalition (2006) Agrarian Reform and Rural Development - Country Report. International Land Coalition Italy http://www.landcoalition.org/pdf/ICARRD_nr_Indonesia.pdf. accessed 05/09/07.

IUCN (2006) IUCN Red List of Threatened Species. www.iucnredlist.org. accessed 28/08/07.

Johnson, W. L. and A. Djajanegara (1989) A Pragmatic Approach to Improving Small Ruminant diets in the Indonesian Humid Tropics. *Journal of Animal Science* **67** (11): 3068-3079.

Johnson, W. L., J. E. v. Eys, H.A. Fitzhugh (1986) Sheep and Goats in Tropical and Subtropical Agricultural Systems. *Journal of Animal Science* **63** (5): 1587.

Junaidi, A. (2005) Land Dispute Sparks Violence in West Nusa Tengarra. Friends of the Earth International Jakarta, Indonesia www.eng.walhi.or.id/kampanye/ psda/050928_landviolence_cu/. accessed 29/11/07.

Kartodihardjo, S. (undated) The State of Bamboo and Rattan Development in Indonesia. Land Rehabilitation and Social Forestry, The Ministry of Forestry and Estate Crops, Indonesia.

Kusumanto, Y. and M.T. Sirait (undated) Community Participation in Forest Resource Management in Indonesia: Policies, Practices, Constraints and Opportunities. Policy Research Working Paper No.28. ICRAF Southeast Asia, Bogor, Indonesia 28pp.

Kwesiga, F., F. Akinnifesi, P.L. Mafongoya, M.H. McDermott and A. Agumya (2003) Agroforestry research and Development in Southern Africa during the 1990s: Review and Challenges ahead. *Agroforestry Systems* **59**: 173-186.

Lee, J.L. (1990) The Role of Forestry in the Development of West Timor. University of Adelaide. Honours thesis 83pp.

Lucht, J. (2007) Paths to Agroforestry: Landowner Types, Land Use and Perceptions. Faculty of Graduate School: University of Missouri, Columbia. MSc. 100pp.

Maehl, J.H. (1997) The National Perspective: A Synthesis of Country Reports Presented at the Workshop. Crop Residues in Sustainable Mixed Crop/Livestock Farming Systems. *Ed*. C. Renard. Wallingford UK, Andhra Pradesh India & Nairobi Kenya, CAB International, International Crop Research Institute for Semi-Arid Tropics (ICRISAT) & International Livestock Research Institue**:** Chapter 13.

Martojo, H. (2003) Indigenous Bali Cattle: The Best Suited Cattle Breed for Sustainable Small Farms in Indonesia. The Relationship between Indigenous Animals and Humans in APEC Region. *Ed*. H.-L. Chang and Y.-C. Huang. Tainan, Taiwan, The Chinese Society of Animal Sciences**:** 21-35.

Mckinnel, F.H. (1990) Status of Management and Silviculture Research on Sandalwood in Western Australia and Indonesia. Gen. Tech. Rep. PSW-122. USDA For. Serv.

McWaters, V. and D. Templeton, Eds. (2004) Adoption of ACIAR projects outputs: Studies of Projects completed in 1999-2000. Canberra, ACT, Australian Centre for International Agricultural Research (ACIAR).

McWilliam, A. (2001) Haumeni, not many: renewed plunder and mismanagement in the Timorese Sandalwood Industry. Working Paper No.29. Resource Mangement in Asia-Pacific Program, Division of Pacific and Asian History, Research School for Pacific and Asian Studies, Australian National University Canberra, ACT.

Mercer, D. E. (2004) Adoption of Agroforestry Innovations in the Tropics: A review. *Agroforestry Systems* **61** (1): 311-328.

Midgley, S., A. Rimbawanto, Mahfudz, A. Fuazi, A. Brown (2007) Options for teak industry development in south-east Sulawesi, Indonesia. Australian Centre for International Agricultural Research (ACIAR), Canberra, ACT.

Montambault, J. R. and J. R. Alvalapati (2005) Socioeconomic research in agroforestry: a decade in review. *Agroforestry Systems* **65**: 151-161.

Niog, L. T. (1998) Socio-Economic Dimensions of Crop-Livestock Integration in Slopeland Areas. Southern Mindanao Agricultural Programme (SMAP), Davao City, Philippines 14pp.

Noordwijk, M., S. Suyanto, S. Budidarsono, N. Sakuntaladewi, J.M. Roshetko, H.L. Tata, G. Galudra and C. Fay (2007) Is Hutan Tanaman Rakyat a new paradigm in community based tree planting in Indonesia? ICRAF Working Paper # 45. ICRAF Southeast Asia, Bogor, Indonesia 38pp.

Nulik, J. (1998) The use of *Leucaena leucocephala* in farming systems in Nusa Tenggara, Eastern Indonesia. Regional Meeting of the Forages for Small Holders Projects, Samarinda, East Kalimantan, Indonesia.

Ochsner, P., I. Nathan and A. Pedersen (2001) How to Reach Rural People in Developing Countries with Quality Tree Planting Materials. Danida Forest Seed Centre, Denmark 10pp.

Painter, J. (2007) El Nino Means Hunger. *BBC News* 30th July 2007.

Patrick, I., G. Marshall, M. Abdurrahman and I.G.A.A. Ambarawati (2006) Determining the Role of Social Capital in Linking Smallholders with Agribusiness. 50th Annual Conference of the Australian Agricultural & Resource Economic Society, February 8-10, 2006., Manly Pacific Hotel, Sydney, Australia, Rural Futures, UNE.

Petheram, J. and A. Thahar (2001) Trials on Farms - and particularly "adaptation trials". International Union of Forest Research Organisations (IUFRO), Bogor, Indonesia 6pp.

Piggin, C. (1997) The Role of Leucaena in Swidden Crop and Livestock Production in Nusa Tenggara Timur Province, Indonesia. ACIAR Proceedings No.113 Agriculture: New Directions for a New Nation - East Timor (Timor Leste). Australian Centre fo International Agricultural Research (ACIAR), Canberra, ACT.

Prasad, A. D. G. and T. Sukandi (1994) *Dalbergia latifolia* - the high-valued Indian rosewood NFT Highlights:A quick guide to useful nitrogen fixing trees from around the world. Winrock International- FACT Net & Indonesian Forest Research and Development Centre Bogor, Indonesia & Arkansas, USA, http://food-security.info/ food-security.info/Winrock%20Archive/d_latifolia.html. accessed 16/09/07.

Rajasthan Heritage (undated) Lac Jaipur, India http://www.rajasthanheritage.com/lac.asp. accessed 28/09/07.

Rohadi, D., R. Maryani, B. Belcher, M. Ruiz Perez, M. Widnyana (2000) Can sandalwood in East Nusa Tenggara survive? Lessons from the policy impact on resource sustainability. *Sandalwood Research Newsletter* **10**: 3-6.

Roothaert, R. and P. Kerridge (2002) Adoption Strategies for forage-experiences of the Forages for Smallholders Project Research and Development Strategies for the Livestock Sector in South East Asia through National and International Partnerships - Proceedings of Workshop held in Thailand 11-15 March 2002. *Ed*. A. S. Frio and G. D. Gray. Bangkok, , FAO, Japan Livestock Technology Association (JLTA) & Intenational Livestock Research Institute**:** 140-152.

Roshetko, J. M. and Mulawarman (2001) Agroforestry for Nusa Tenggara: A Summary of Workshop Outputs. Wanatani di Nusa Tenggara. Prosiding Lokakarya Wanatani Se- Nusa Tenggara, Denpasar, Indonesia, International Centre for Research in Agroforestry (ICRAF) & Winrock International.

Roshetko, J. M., E. Nugraha, J.C.M. Tukan, G. Manurung, C. Fay and M. van Noordwijk (2007) Agroforestry for livelihood enhancement and enterprise development. Integrated Rural Development in East Nusa Tenggara, Indonesia. *Ed*. S. Djoeroemana, B. Myers *et al*. Canberra, ACT, Australian Centre for International Agricultural Research (ACIAR). ACIAR Proceedings No.126: 137-148.

Roxas, D., M. Wanapat and M. Winugroho3 (1997) Dynamics of Feed Resources in Mixed Farming Systems in Southeast Asia. Crop Residues in Sustainable Mixed Crop/ Livestock

Farming Systems. *Ed*. C. Renard. Wallingford UK, Andhra Pradesh India, Nairobi Kenya, CAB International, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) & International Livestock Research Institute**:** Chapt 3.

Sarantakos, S. (1998) Social Research. Australia, MacMillan Publishers.

Schnepf, C. (2001) Participatory Needs Assessment: Improving Extension Programs by Making Learners Partners. International Union of Forest Rsearch Organisation (IUFRO) Idaho www.regional.org.au/au/iufro/2001/schnepf. accessed 27/11/07.

Setiadi, D. and T.E. Komar (1995) Current Sandalwood Seed Source in Timor Island. *Sandalwood Research Newsletter* (May 2000).

Shelley, C. (2004) Development of leading centres for mud crab culture in Indonesia and Vietnam. Adoption of ACIAR project outputs: Studies of projects completed in 1999-2000. *Ed*. V. McWaters and D. Templeton. Canberra, ACT, Australian Centre for International Agricultural Research 63-68.

Shelton, H. M. (2001) Advances in Forage Legumes: Shrub Legumes. International Grassland Congress, Sao Pedro, Brazil, FAO.

Shelton, H. M., C. M. Piggin, R. Acasio, A. Castillo, B.F. Mullen, I.K. Rika, J. Nulik and R.C. Gutteridge (2000) Case Studies of Locally-Successful Forage Tree Systems. Working with Farmers: The Key to Adoption of Forage Technologies. *Ed*. W. W. Stur, P. M. Horne *et al*. Canberra, ACT, Australian Centre for International Agricultural Research (ACIAR)**:** 120-131.

SMERU (2006) Development Challenges in East Nusa Tenggara. *SMERU Newsletter* **20** Oct/Nov 2006,40pp.

Snelder, D., M. Klein and S.H.G. Schuren (2007) Farmers preferences, uncertainties and opportunities in fruit-tree cultivation in Northeast Luzon. *Agroforestry Systems* **71**: 1-17.

Sodiq, A., S. Adjisoedarmo and E.S. Tawfik (2003) Reproduction Rate of Kacang and Peranakan Etawah Goats under Village Production Systems in Indonesia. International Research on Food Security, Natural Resource Management and Rural Development Technological and Institutional Innovations for Sustainable Rural Development, Deutscher Tropentag - Göttingen 7pp.

Soedjana, T. D. (2005) Accessibility to Small Ruminants Input and Output Markets in Indonesia. *Jurnal Litbang Pertanian* **24** (4): 137-142.

Subarudi, M. Mansyur, Idris, B. Achmad and M.N. Iman (2004) Community forestry for poverty reduction-lessons learned in Indonesia. Proceedings of the Workshop Forests For Poverty Reduction: Can Community Forestry Make Money? *Ed*. S. A. a. W. M. L. H.C. Sim. Bangkok, FAO, Regional Office for Asia and Pacific**:** 11pp.

Suhaendi, H (1998) Teak improvement in Indonesia. Teak for the Future -Proceedings of the Second Regional Seminar on Teak. *Ed.* M. Kashio and K. White FAO Regional Office for Asia and the Pacific Publication, Yangon, Myanmar.

Suhardi (2003) Biodiversity for poverty alleviation in Indonesia. Forests for Poverty Reduction: Opportunities with Clean Development Mechanism, Environmental Services and Biodiversity, Seoul, Korea.

Suharyo, W. I., N. Toyamah, A. Poesoro, B. Sulaksono, S. Usman and V. Febriany (2007) Improving Business Climate in NTT: The Case of Agriculture Trade in West Timor. Research Report, March 2007. SMERU Research Institute, Jakarta, Indonesia xiii, 80pp.

Thorburn, C.C. (undated) The Plot Thickens - Decentralisation and Land Administration in Indonesia. Program in International Development and Environmental Analysis (IDEA) Monash University, Clayton, Victoria, Australia.

Toyamah, N. and A. Poesoro (2006) Development Challenges in East Nusa Tenggara. *SMERU Newsletter* **20** Oct/Nov 2006,40pp.

Vanclay, J. (2005) Using Typology of Tree Growers to Guide Forestry Extension. *Annals of Tropical Research* **27** (1): 97-103.

Wargiono, J. and B. Sudaryanto (2002) Cassava Leaves and Forage Crops for Ruminant Feed in the Establishment of Sustainable Cassava Farming Systems in Indonesia. 7th Regional Cassava Workshop, Bangkok, Thailand, International Centre for Tropical Agriculture (CIAT).

World Bank (1996) Nusa Tenggara Agricultural Area Development Project. Staff Appraisal Report No.15043-IND Agriculture Operations Division, Country Dept III, East Asia and Pacific Region, World Bank, Washington DC, 130pp.

World Bank (2003) Implementation Completion Report Indonesia - Second Agricultural Research Management Project. Rural Development and Natural Resource Sector Unit, Indonesian Country Unit, East Asia and Pacific Regional Office of the World Bank, 42pp.

World Bank (2004) Nusa Tenggara Agricultural Area Development Project. Implementation Completion Report No. 28036. World Bank, Washington, DC 37pp.

World Bank (2007) Indonesia - Second Agricultural Research Management Project & Decentralised Agricultural and Forestry Extension Project. Project Performance Assessment Report No. 39843. Thematic and Global Division - Independant Evaluation Group, 41pp.

9 Appendixes

9.1 People consulted

Name	Organisation	Date Interviewed
Amalo.SE.MM Dicky CH.S.	Kepaia Bagian Tata Usaha) Provincial Crop Services (Dinas Tanaman Pangan Prop.)	19/09/07.
Benggu Y.	Lecturer in Biological Sciences & Environmental Soils; NUSA Cendana University; Graduate in Biological Sciences from Murdoch University	21/09/07
Budisantoso E.	NTT Assessment Institute for Agriucltural Technology (BPTP NTT)	19/09/07; 03/11/07; 04/11/07; 06/11/07
Butar Butar T.	Forest Research Institute (Balai Penelitian Kehutanan)	18/09/07; 08/11/07.
Dethan, Drs Soleman	Alfa Omega – Wakil Direktur (deputy director)	20/09/07.
Geong M.	Provincial Livestock Services (Dinas Peternakan Prop.)	19/09/07.
Ibu Edo	Alfa Omega - Training and development division, divisi pengebangan diklat	20/09/07.
Levi, R.	Nusa Cendana University, lecturer, (involvement in the Amarasi Sandalwood project)	21/09/07; 28/09/07.
Lukas, E.	Provincial Forestry Services (Dinas Kehutanan Prop.)	19/09/07
Manning R.	Program Director; Australia – Nusa Tenggara Assistance for Regional Autonomy (ANTARA); Australian Government AusAid	20/09/07.
Mbipi,S.IP. Cyrilus T.	Chief of Program Planning Data and Information; Provincial Crop Services (Dinas Tanaman Pangan Prop.)	19/09/07
Nolik J.	NTT Assessment Institute for Agricultural Technology (BPTP NTT)	19/09/07.
Pabisangan, M.R.	Chief of forest land zoning; Provincial Forestry Services (Dinas Kehutanan Prop.)	19/09/07.
Pankratius Bernard. S. Balun	Agriculture and Forestry Sub Division, Regional Development and Planning Board of East Nusatenggara Province	19/10/07; 02/11/07.
Prayudi S.	Program Officer; Australia – Nusa Tenggara Assistance for Regional Autonomy (ANTARA); Australian Government Ausaid	20/09/07.

Schottler J.	Contractor Representative; Australia – Nusa Tenggara Assistance for Regional Autonomy (ANTARA); Australian Government Ausaid	20/09/07; 01/11/07.
Slamat	Forest Research Institute (Balai Penelitian Kehutanan)	18/09/07.
Zasa Umbu M.	Alfa Omega – Yayasan Peleyanan Aan Pengembangan Masyarakat	20/09/07.

9.2 Informal Interviews

Name	Organisation	Date Interviewed
Betti Anton.	Tunbaun Village; date interviewed	21/09/07.
Naiklas, Andraus.	Forest Research Institute (Balai Penelitian Kehutanan) - Sandalwood Nursery/ Captive Bird Breeding and Deer Research Centre; Oilsonbai Village;	19/09/07.
Mableni A.	Deer carer; NUSA Cendana University; Kupang;	21/09/07.
Modena, John	Forest Research Institute (Balai Penelitian Kehutanan) - Sandalwood Nursery/ Captive Bird Breeding and Deer Research Centre; Oilsonbai Village;	19/09/07
Sawmill Owner.	Tunbaun Village: (Boy Nitti);	21/09/07

9.3 Potential species for consideration within the TFLA economic diversification approach

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Acacia mangium	• Alt: 0-800m, rainfall: 1500-3000 mm. • Deeply weathered or alluvial soils. • Prefers slightly higher and drier sites than other Acacias. Can establish on degraded alang-alang areas. Intolerant of waterlogging and soils derived from ultra-basic rocks.	• Fast early growth, but does not exceed 35 cm dbh • Provenances from PNG show better growth and superior form • Mycorrhizal association for best performance	• Young shoots and leaves are browsed by buffalo and cattle.	• Nitrogen fixer with potential for intercropping	• Seeds edible • Good charcoal
Albizia saman	• Previously *Samanea saman.* • Alt: 0-1300 m, rainfall: 600-3000 mm. • Neutral to moderately acid soils with pH as low as 4.6. Tolerates infertile or waterlogged conditions.	• Grows fast, coppices well. • Moderately durable, stable, used for wood carving.		• Nitrogen fixer	• Fruits edible • Good firewood
Aleurites moluccana (Candlenut)	• Alt: 0-1200m, rainfall: 650-4300 mm, prefers pH 5-8. • Thrives in moist tropical regions, ranging from subtropical dry to wet through tropical dry to wet forest life zones.	• Wood whitish and soft and suitable as a timber species.		• Shade or shelter • Seed press cake used as fertiliser	• Medicine: Numerous uses. • Seeds are moderately poisonous but may be processed and eaten.
Azadirachta excelsa	• Alt range: 0-350 m, rainfall: 1600 – 3000 mm. • Prefers alluvial, medium textured, free draining, acidic soils. Also found on clay, granitic and lateritic soils and on limestone.	• Light- to medium-weight hardwood, moderately durable, easy to work, used for construction and furniture. Potential as veneer.			• Edible shoots, leaves and flowers. • Seed oil used in soaps. • Insecticide.
Azadirachta indica (Neem)	• Alt: 0-1500 m, rainfall: 400-1200 mm • Tolerant of a wide variety of neutral to alkaline soils. Grows best on soils with a pH of 6.2-7	• Insect resistant, used for furniture and cases	• Bitter leaves used as dry season fodder	• Pesticide applied directly to crops • Used for dune-stabilisation and windbreaks • Seed cake used as fertiliser	• Fruits eaten fresh or cooked. Young twigs and flowers are occasionally consumed as vegetables. • Tannin or dyestuff: Tree bark contains 12-14% tannins.

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Bamboo	• Many species exist, including about 60 Phyllostachys spp. • Mast flowering every 15 years.	• General construction	• Bamboo leaves have high protein content.	• Domestic farm use (e.g., stakes, poles)	• Food (edible shoots)
Boswellia serrata (salai, frankinsence)	• Alt: to 1150 m, rainfall: 500-2000mm. • Thrives on neutral soils over gneiss, schist, quartzite, limestone and sandstone. Tolerates poor and shallow soils.	• Used in cheap furniture, packing, construction, plywood and veneers	• Poor substitute fodder for buffalo	• Nurse tree • Hardy and resilient	• Fuel and charcoal • Bark can be used for cordage • Gum is used as a diaphoretic and astringent. Gum-oleoresin (1-1.5 kg/yr).
Calamus manan (Rattan)	• Altitude: 600-1000 m. • It grows well on slopes of hill dipterocarp forest	• *C. manan* is the premier quality, most sought after rattan for large diameter cane used in the manufacture of furniture.			• Cane cultivated for furniture.
Calliandra Calothyrsus	• Alt: 250-1800 m, rainfall: 700-4000mm • Grows well on a wide range of soil types but prefers light textured, slightly acidic soils. Tolerates infertile and compacted or poorly aerated soils but does not tolerate waterlogged and alkaline soils.	• Wood suitable for pulp and papermaking	• Fodder: leaves and pods are rich in protein and are free of toxins.	• Rehabilitation and erosion control • Nurse tree and boundary marker	• Good firewood species: fast growing, multi-stemmed, easy to regenerate and thornless.
Ceiba pentandra (kapok)	• Alt: 0-900 m, rainfall: 750 – 3000 m • Soil type is deep permeable, volcanic loam, free from waterlogging.	• Timber not durable		• Edible foliage • Pressed cake used as protein-rich cattle feed (26% protein).	• Honey source • Seed oil used for cooking and soaps.
Commiphora myrrha (Myrrh)	• Alt: 250-1300 m. Rainfall: 230-300 mm • Prefers shallow soil, over limestone. • Normally found in open Acacia commiphora bushland on shallow soil, chiefly over limestone. • Native Range: Ethiopia, Kenya, Oman, Saudi Arabia, Somalia			• Shrub or small tree, usually with a distinct short trunk up to 4 m tall	• Gum or resin: The oleo-gum resin from the stem has an aromatic taste and odour. Its products are highly prized in Asia. • Numerous medicinal and homeopathic uses

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Dalbergia latifolia (Rosewood)	• Alt: 0-1500 m; rainfall 750-5000 mm. • Shade tolerant, sensitive to drought, fire and frost. • Common on deep loams or clays containing lime. Shallow dry soils and poor drainage stunt tree growth.	• Commonly grown in mixtures including teak and bamboo	• Nitrogen- rich foliage used as a green manure and fodder	• Intercropped with annual food crops and/or with fruit trees.	• Medicines for diarrhoea, worms, indigestion, and leprosy are made from the tannins in the bark. • Planted as a shade tree in coffee plantations and roadsides. • Nitrogen fixing.
Durio zibethinus (ambetan)	• Alt: 300-800 m, rainfall: 1500-2000 mm. Requires well-distributed rainfall, but a relatively dry spell stimulates and synchronizes flowering. • Soils should be deep, well-drained, light sandy or loamy, rather than heavy, to limit losses from root rot.	• Moderately durable – cheaper furniture			• Food (fruit) • Honey
Dyera costulata (Jelutung)	• The species occurs in primary evergreen lowland or hill forest, in well-drained locations up to 300 m	• Similar to balsa wood			• Roots used as cork substitute. • Latex/ Rubber production
Enterolobium cyclocarpum	• Alt: 0-1200 m, Rainfall: 750-2500 mm. • Subtropical, dry forest zones, restricted to disturbed areas in wetter forest types. It is a dominant species in all the tree associations in which it is found. Dry seasons of 1-6 months are usual in most of its habitats • Tolerates alkaline, calcareous and even acidic soils. Prefers medium-textured soils, but eroded deep moist clays, shallow sandy clays and porous limestone all allow good development.	• Heartwood is reddish-brown, coarse-textured and moderately durable; resistant to attack by dry-wood termites and Lyctus. • Used in housing for construction and interiors. • White sapwood is susceptible to insect attack. • Durable in water.		• Coppices well, but viability of repeated coppicing ability not known. • Nitrogen fixing • Potential for intercropping.	• Young pods and seed can be eaten

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Gliricidia sepium (gamal,liriksidia)	• Alt: 0-1600 m, rainfall: 600-3500 mm. • A native of the seasonally dry Pacific coast of Central America. Soil type ranging from pure sand to deep alluvial lake-bed deposits. In much of its natural range the soils are acidic (pH 4.5-6.2). However, where parent material is limestone, the soils are slightly alkaline. It performs well on marginally saline vertisols but will not tolerate very acidic soils.	• Very durable, termite resistant	• Leaves rich in protein, highly digestible, low in fibre and tannin. • Boosts animal production (milk, meat) when used as a supplement. • Poisonous to non-ruminants. • Variable palatability.	• Nitrogen fixing • Live fence posts • Shade tree in agroforestry systems – enhance groundnut health	• Food: Flowers • Desirable firewood • Honey • Processed leaves are poisonous to rodents and humans • Fungicide extract • medicinal
Gmelina arborea (Beechwood)	• Alt: 0-1200 m. Rainfall: 750-4500 mm • Preference for moist, fertile, freely drained acid, calcareous and laterite soils.	• Good dimensional stability. • Used for furniture, plywood, mine props, matches and timber for light construction.	• Leaves are regarded as good fodder and cattle eat the fruit.	• Light-demanding. Regenerates naturally only in the open.	• Bark, leaves and roots contain traces of alkaloids and are used medicinally. • Tannin or dyestuff: Both wood ash and fruit yield a persistent yellow dye. • High honey production
Gnetum gnemon (bagoe)	• Alt: 0-1200 m. Rainfall: 750-5000 mm. • Can grow on soils high in clay or sand content or calcareous rocks. • Moisture must be available during the dry season.	• Wood used in Indonesia for pulp and house construction		• Nitrogen fixing	• Seeds, leaves, flowers fruits and associated fungus are eaten. Active trade in the seeds exists in Indonesia. • Bark fibre for cordage • Medicinal – eye, mosquito repellent

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Hevea brasiliensis (Rubber)	• Alt: 300-500 m, Rainfall: 1500-4000 mm • Tolerates some waterlogging and a wide pH range (4-8), but does better in acid soils. • Lime is harmful, and shallow, poorly drained or peaty soils should be avoided. Thrives best in deep, well-drained loamy soil covered by natural undergrowth or a leguminous cover crop and protected from erosion.	• Timber is only moderately durable		• Can be grown with rice in establishment phase	• Honey • Seed oil for lighting & insecticide
Instia bijuga (merbau)	• Alt: 0-600 m. Rainfall: 1934 mm. • Prefers sandy, medium-loamy deep acrisols and alisols • Salt tolerant but susceptible to frost. • Moderately resistant to drought. • Suitable for eroded gullies and buffer strips along creeks. • Often found on sand and coral beaches, but also features in periodically inundated localities further inland. It also occurs in dryland mangroves.	• Prized timber useful for heavy construction, ornaments and utensils. • Strong, durable, stable and workable with service life of 6-11 years in ground, and up to 20 years under temperate conditions. • Resistant to termites *Cryptotermes cynocephalus* and *Coptotermes curvignathus*.		• Highly regarded fence post provider • Nitrogen fixing	• The seeds can be eaten after preparation. Un-processed seed oil is insecticidal. • Produces honey. • The small branches of felled trees are used as firewood. • A brown dye is obtained from an oily substance present in the wood and bark. • Medicine: various
Leucaena leucocephala (lamtoro)	• Alt: 0-2100 m. Rainfall: 650-3000 mm. • Performs optimally on calcareous soils but can be found on saline soils and on alkaline soils up to pH 8. Intolerant of acid soils, waterlogged conditions, low phosphorus, low calcium, high salinity, high aluminium saturation. • *L. diversifolia* is a closely related species with lower toxicity, and lower fodder value	• Timber is not durable, but is of otherwise excellent quality and workability. It is only limited by small log size.	• Palatable fodder tree. Feed should be <20% lamtoro, to avoid mimosine toxicity, hair loss and stomach problems. • International market exists for fodder	• Shade tree • Tolerates extended dry season • Widely used in intercropping	• Food – issues with toxins, but foodstuffs can be obtained • Honey • Alternative to gum arabic

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Macadamia spp	• Alt: 0-2000 m, Rainfall: 700-3000 mm. • Can be grown in a wide range of soils including poor soils, but not on heavy, impermeable clays and saline or calcareous soils. Most suited to deep, well-drained loams and sandy loams with good organic matter content, medium cation exchange capacity and pH of 5-6. • Temperature range is important for nut production – hybrid selection can assist	• Limited production, but decorative timber suitable for ornamental work		• Cash crop • May be intercropped with minimal depression in crop yield. • Nut production depends on light penetration • Allelopathic to papaya	• Husk contains approximately 14% of substances suitable for tanning leather. • Honey • Shell : fuel • Husk: mulch
Melaleuca quinquenervia	• Alt: 0-1000 m. Rainfall: 800-3440 mm. • It can tolerate a dry season of 0-7 months a year. Grows on most soil types varying from wet clays to saline and dry. • Growth is poor in marginal conditions	• Mine timber, fence posts and rails, flooring and house timbers.			• Honey • Cajeput oil – via steam distillation
Metroxylon sagu (Sago)	• Alt: 0-700 m, Rainfall: over 2000 mm. • Occurs in permanent or seasonal lowland freshwater swamps, preferably on mineral soils with a pH higher than 4.5. Groundwater should be within 50 cm of the soil surface. Mixed with upland trees, it can also be found on dry soils, where it grows even taller. • Clay soils with high organic-matter content give best results		• Ground pith may be used as fodder		• Food: Sago & Palm heart • Fibre
Myristica fragrans (nutmeg	• Grows to a height of 40 to 50 feet and thrives at elevations of 1500 to 2500 ft. in rich volcanic soil in sheltered valleys • Good, well drained soil				• spice

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Paraserianthes falcataria (Albizia)	• Alt: 0-1200 m. Rainfall: 2000-4,000 mm, averaging 2800 mm. • Prefers deep, well drained fertile soils, such as friable clay loam, but can tolerate poor sites and survive without fertilizer. Does not thrive in poorly drained, flooded or waterlogged soils. • Growth of trees in a P-deficient soil is promoted by inoculation with mycorrhizal fungi *Gigaspora margarita* and *Glomus fasciculatum* in combination with Rhizobium. • Widely known by its former name *Albizia falcataria,* but has been also been called *A. moluccana* and *A. falcata.*	• The comparatively soft timber is an important source of veneer and plywood etc. good pulp • Produces sawdust that may cause sneezing. • Easily damaged by high wind • High density plantings may cause soil erosion • Paraserianthes trunk borer is major issue in Indonesia – annual outbreaks.	• In early wet season has polysaccharides that increase palatability of bark for cattle. • Leaves are used to feed chickens and goats. • Trees coppice fairly well.	• Coffee shade tree. • Soil improver, rehabilitation • Nitrogen fixing • Water use may be an issue during drought • Erosion control	• Tannin or dyestuff: the bark has tanning properties. • Fuelwood and charcoal • The wide-ranging roots are said to taint the water supply with characteristic odour
Pinus merkusii	• Alt: Up to 2000 m. Rainfall: 1000-2800(-3500) mm. • Strongly light-demanding and habitually grow in monoculture.	• General-purpose timber which can also be used for construction work, flooring and boat building as it is fairly durable and heavy.		• The tree is used to shade out alang-alang grass with fairly good results	• Medicine: Ethyl alcohol extracts of P. merkusii showed anti-cancer activity in tests in the Philippines. • Gum or resin: Good quality oleoresin is collected from this species, often on plantation scale.
Pometia pinnata (mendek)	• Alt: 0-500m elevation. Rainfall: 1000-4,600 mm. • Can handle 1-3 month dry season • Best on slightly acidic to neutral, well drained loams and clays	• The timber is used as kasai • Wood is good for general construction, boat building, tool handles, moulding		• Component in mixed food gardens	• Fruit and seeds are edible • Firewood/charcoal
Pterocarpus indicus	• Alt: From sea level. Rainfall: 900 to 2200 mm. • It is commonly found on sandy or clay loams with neutral or slightly acid reaction.	• Highly sought after		• Nitrogen fixing	• Leaves and flowers can possibly be eaten • Red dye from wood • Honey • Various medicinal uses

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Santalum album (Sandalwood)	• Alt: 600-1200m. Rainfall: 450-3000mm • Tolerates wide range of soils but most common in sandy or rocky red soils. Not found on black soil. Growth is poor on shallow stony and gravely soils. In Timor it grows on stony, well drained, coral-derived grey clay and red loam soils, having a pH of 8-9. • Endemic range of sandalwood includes Nusa Tengarra.	• Processing infrastructure exists on Timor Island • Marketing/social issues may require careful assessment due to the long history and value of the wood products.	• Fodder: Trees are sometimes lopped for fodder; the foliage is palatable to grazing animals such as rabbits, sheep, goats, cattle, pigs, horses and camels.	• Because of its deep rooting habit, this tree could offer shade or support services yet compete minimally with other crops. Caution should be taken on account of its parasitic attributes.	• The bark contains 12 - 14% tannin, has potential in the tanning industry. • Seeds yield oil that can be used in paint manufacture. • Shade or shelter • Soil improver • Boundary or barrier or support: trees can be planted along hedges and field boundaries. • Food: fruits are edible.
Schima wallichii	• Alt: Up to 3900 m. Rainfall: 1400-5000 mm. • Can grow in a wide range of soils. It usually prefers well-drained soils but has been observed in swamps and along rivers, and is not choosy about soil texture or fertility.	• Suitable for pulp • Moderately durable and dry-wood termite resistant • used as a cover crop in plantations of *Pinus merkusii* and *Agathis dammara.*			• Good firewood • Bark is used in dyeing, tanning, and as a fish poison.
Senna siamea (bujuk,dulang)	• Previously *cassia siamea* • Alt: 0-1200 m. Rainfall: 400-2800 mm. • Well-suited to lowland monsoonal tropics. Succeeds only where roots access groundwater, and the dry period does not exceed 8 months. • Susceptible to frost and does not thrive above 1300 m. Light demanding. • Performs best on deep well-drained fertile soils with pH 5.5-7.5, but will grow on degraded lateritic soils provided drainage is not impeded. Intolerant of saline soils.	• Wood is hard, strong, durable, and resistant to termite.	• Fodder for ruminants – toxic to others. • Coppices well and grows fast • Leaves are used as green manure, and a well-grown tree can yield 500 kg/year of fresh leaves.	• Sandalwood host • It is pruned into hedgerows and used as a live fence around food crops where it increases topsoil infiltration and combats erosion	• Leaves and fruits are toxic, but can be eaten after processing

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Sesbania grandiflora (Turi)	• Alt: 0-1000 m. Rainfall: 800–4000 mm • Tolerant of waterlogging and seasonal flooding. Prefers a bimodal rainfall distribution, with rapid growth during the wet season, but survives dry seasons up to 9 months. Not wind resistant. • Grows on a wide range of soils including poor and waterlogged soils. Tolerates saline, alkaline soils and acidic soils down to water pH 4.5.	• Timber is light, and of low durability.	• Produces fodder within 4 months. High protein, best mixed in fodder. • Dried fodder can be stored. • Leaves are toxic to chickens, and should not be fed to monogastric animals.	• Can be grown in creek lines and gullies in home gardens and in mixed croplands.	• Edible leaves, seeds, pods and flowers, especially white flowers. Young leaves are also eaten. Tender pods are eaten as string beans. • Bark exudate and seed endosperm gums are produced. Clear gum from bark is used in foods and adhesives as a substitute for gum arabic. Bark also yields tannin. • Some medicinal values
Swietenia macrophylla (Mahogany)	• Alt: 0-1500 m. Rainfall: 1600-2500 (max 4,000) mm • Big leaf mahogany *has been grown in Indonesia for more than 100 years.* • Grows best on well-drained sites with medium to heavy soils.	• There are over 54,000 ha of plantations in Indonesia, mainly in West Java. • Mahogany can out-compete teak in mixed stands – but can be used as an under-crop for teak to facilitate heavy thinning. • Shade tree (e.g. dipterocarp plantations)		• May be planted among subsistence crops such as corn, beans, bananas, sweet potatoes and cassava. • Used successfully in reforestation projects without protection from grazing	• Mahogany is among the pioneer species reoccupying degraded agricultural land • Gum or resin may be collected and sold to India • The bark is used for dyeing and tanning leather. Various medicinal uses are reported from Central America.
Tamarindus indica (Tamarind)	• Alt: 0-1500 m. Rainfall: 350-2700 mm • Young trees are killed by the slightest frost, but older trees seem more cold resistant than mango, avocado or lime. A long, well-marked dry season is necessary for fruiting. • Grows in most soils but prefers well-drained deep alluvial soil.	• Hard, durable and strong	• Foliage and cooked seed can be used as fodder	• Allellopathic and strongly shading. • Grass will not grow under the canopy	• Firewood • 2nd grade honey • food • Medicinal – including manufactured medicines.

Spp	Edaphic requirements	Integration compatibility (TFLA)			
		Timber	Fodder/Livestock	Agriculture	NTFP
Tectona grandis (Teak)	• Alt: 0-1200 m, Rainfall: 1200-2500mm. • Best soil is deep, well-drained, fertile alluvial-colluvial soil with a pH of 6.5-8 and a high calcium and phosphorous content. • Does not tolerate waterlogging or infertile lateritic soils	• Indonesia has over one million ha of teak • Rosewood is commonly grown with teak. • Young trees may be susceptible to termite attack • Annual insect attack common in Indonesia – severity related to host density.		• Intercropping with soybean improves teak growth.	• Numerous medicinal uses • Both the root bark and the young leaves produce a yellowish-brown or reddish dye, which is used for paper, clothes and matting. • Incense: sawdust - Java • Multiculture improves soil & can reduce fire risk
Theobroma cacao (Cacao)	• Alt 100-300 m. Mean annual rainfall: 1 000-3 000 mm. • Requires deep well-drained soils, free from iron concretions, high in nutrient content and a topsoil rich in organic matter.	• Shade trees may provide timber	• Shade trees may provide fodder	• Commonly intercropped. • Susceptible to cocoa pod borer and several fungi.	• firewood
Vitex pubescens	• Alt: 400-1000m; Rainfall: 590-1500 mm • Common in comparatively dry regions in lowland forest. It occurs in secondary forest and is a pioneer species in *Imperata cylindrica* vegetation and recently burnt grasslands. • It is moderately fire resistant.	• Highly durable timber			• good charcoal