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Contents

1 Acknowledgments

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PNG partner organisations' commitment and support were similarly essential for the conduct of the project and its outcomes. We thank the management and staff of the Ok Tedi Development Foundation, Pacific Islands Projects, the PNG Forest Authority, the PNG University of Technology, Ramu Agri Industries (Ramu Sugar at the time of project inception), and the Village Development Trust for their willing participation and assistance.

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- Simon Rollinson of PIP;
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A number of communities and community leaders in Madang, Markham and Western Provinces generously shared their time, knowledge and resources with the project team, and showed us great hospitality in the conduct of the research. We thank them most sincerely, and hope that the project outcomes eventually deliver the benefits to which they and we both aspire, for their and other communities in PNG.

1.1 Acronyms

ANU:	Australian National University
JANT:	Japan and New Guinea Timbers
OTDF:	Ok Tedi Development Foundation
PIP:	Pacific Islands Projects (PIP),
PNG:	Papua New Guinea
PNGFA;	PNG Forest Authority,
UniTech:	PNG University of Technology,
RAI:	Ramu Agri Industries (Ramu Sugar at the time of project inception)
VDT:	Village Development Trust

2 Executive summary

ACIAR Project FST/2004/050 *Value-adding to PNG agroforestry systems* was initiated in 2007, following a Scoping Study undertaken in 2005-6. The project was managed by the Australian National University, in partnership with the PNG Forest Authority, PNG University of Technology, Ok Tedi Development Foundation, Ramu Agri Industries and – in the initial stages – the Village Development Trust.

The underlying premise of the project, based on the results of the Scoping Study, was that PNG landowners (*syn.* "smallholders") are eager to generate both cash income and non-cash benefits from growing trees with commercial value for a variety of wood products, but – notwithstanding a benign policy context – are constrained from doing so by a number of factors. Thus, project objectives were to:

1. Define commercial tree production systems for priority species in pilot regions:
2. Assess landowner decision-making in the context of candidate tree species and production systems:
3. Develop business models and strategies to facilitate adoption, in conjunction with investment and implementation partners;
4. Implement strategies in the pilot regions in conjunction with landowners and investment and implementation partners;
5. Communicate project knowledge and learning to interested parties outside pilot regions.

Field research was conducted with the assistance of PNG partners in pilot regions of Madang, Morobe and Western Provinces. This research was conducted principally by three ACIAR John Allwright Fellows, Gorethy Dipsen, Francis Essacu and Kulala Mulung, during their enrolment as graduate students at ANU. They were supported by a project team of Australian researchers and PNG practitioners.

The key outcomes of the project were:

1. new knowledge, from household- and community-level research, of PNG landowners' attitudes to tree growing within the context of their livelihood and land use systems;
2. confirmation from this research of PNG landowners' willingness to engage in commercial tree growing, for both cash and subsistence economy benefits, so long as such tree growing is consistent with their values, priorities and constraints;
3. confirmation that access to suitable germplasm, plant production systems, management and market information, and physical access to markets were major constraints to the adoption of commercial tree growing;
4. confirmation that a small suite of species – *Acacia mangium*, *Eucalyptus pellita* and *Tectona grandis* –were of immediate commercial value in the pilot regions; modelling of the returns that landowners might expect from them; and the identification of characteristics of other species that would also be compatible with landowners' needs and constraints and in market demand;
5. provision of improved germplasm, of seed collection and propagule production knowledge, and community-level nursery production systems, where these were constraints to adoption;
6. the development of a PNG Tree Growers Tool Kit, available in both printed and online media (www.pip.com.pg/resources > tool-kit-for-tree-growers), as a primary vehicle for communication of project outputs.

Direct project impacts focused on the pilot study regions, and in the enhanced research and implementation capacity of PNG partners. The PNG Tree Growers Tool Kit provides an ongoing platform for sharing learning from the project. The key investments needed to capitalise on project outputs are community- or region-level facilitators who can catalyse landowner tree growing through both technical support and building links to markets.

3 Background

3.1 General context

PNG is believed to be one of the cradles of agriculture globally. Trees grown or managed for particular purposes are an integral part of traditional PNG farming and land use systems, and the diversity and dynamism of these systems reflect Papua New Guinean's high levels of innovation and adaptation in agriculture. These systems vary with geographic region, and within regions, involving what Filer and Sekhran (1998) described as "a bewildering variety of garden and tree crops".

Notwithstanding PNG's rich natural resource endowment, and the substantial contributions of the mining and forest industries to national income, PNG ranks poorly on the UN's Human Development Index. The reasons for this situation have been discussed extensively (e.g., AusAID 2006, Filer & Sekhran 1998 – Ch. 3); whilst analyses and proposed policy responses vary, there is broad agreement of the need for PNG landowners to generate income from land uses that are more sustainable and enduring than industrial scale logging has been (e.g., AusAID 2006, Chapter 9).

However, the income-generation options for many PNG landowners are very constrained. The area that can be developed as intensive agriculture is limited by inherent environmental constraints, particularly soils (Blaikie and Brookfield 1987), and by lack of infrastructure. Consequently, incorporation of other commercially valuable crops, such as trees, into land use systems is a good option for landowners in many parts of PNG (eg AusAID 2006). Growing commercial trees can build on PNG landowners' tradition of innovation in farming systems, and capitalize on the improving terms of trade for high-value tropical timber (Kanowski et al 2008).

Partly in recognition of these factors, PNG's Forest Authority has developed draft *National Eco-Forestry* and *Reforestation* policies; these are indicative of the emerging focus on forms of forestry activity other than industrial-scale logging. However, these policies have yet to be adopted formally and, as many analysts have noted (e.g., Bond 2006; Hunt 2000), policy implementation is severely constrained by capacity and resource limitations, and little of the good intent of policies is able to be realized by government agencies. For these reasons, as Filer and Sekhran (1998) have noted, community-based and non-governmental organizations have played, and continue to play, fundamentally important roles in policy implementation.

3.2 Research to inform commercial tree-growing by PNG landowners

The development of the research project was preceded by a scoping study (Kanowski *et al.* 2008) in which we reviewed the policy, institutional and social contexts relevant to landowner choices, and experiences with other commercial perennial crops in PNG. That study examined institutional and market contexts, landowner attitudes and behaviour, and tenure and gender issues in relation to the adoption of commercial tree-growing. In summary, it found in relation to these:

Policy, institutional and market environment

- Formal forest-related policies in PNG are supportive of commercial tree growing by landowners, but do not provide any incentive or support mechanisms to encourage adoption;
- Relevant PNG institutions support development of commercial tree growing by landowners;
- Real prices for high-value tropical timber are predicted to rise, in contrast to those for other PNG primary commodity products.

Landowner attitudes, behaviour and adoption

- Landowners are eager to adopt and sustain production of crops that will generate cash returns in the short term, for which markets are assured, and for which risks are comparatively low;
- Smallholders are already important growers for a number of tree crops - principally coffee, cocoa, and oil palm and - on a smaller scale, commodity production of acacia and eucalypts. Experience in each of these sectors is highly relevant to strategies seeking to facilitate the adoption of commercial tree crops;
- Traditional PNG agroforestry systems, and other PNG agricultural production systems, offer good platforms for adoption of commercial tree growing.

Land tenure, gender and resource management

- Customary land tenure does not preclude growing of tree crops on a commercial scale;
- Gender differences in terms of inheritance and use rights have some implications for investment strategies, but are not generally a constraint to commercial tree growing.

The principal constraints to adoption of commercial tree growing which emerged from this analysis were:

- Poor physical and market infrastructure are significant constraints to PNG primary production industries in general, and to commercial tree growing in particular;
- The lead time to income generation, the lack of financial information about tree growing options, the lack of access to investment finance, and the lack of market infrastructure, are the principal constraints to landowner adoption of many candidate tree species;
- The availability of suitable planting material of candidate species, and of relevant technical knowledge, are lesser but real constraints to adoption;
- Fire is a significant non-market related risk factor in grassland or adjacent environments.

ACIAR Project FST2004/050 was designed to address these key factors. Given the limits to public sector capacity, identifying PNG business partners outside the public sector was an important consideration. Project activities were therefore concentrated in two pilot regions: the Ramu and Markham Valleys, northwest of Lae, in conjunction with the publicly-listed company Ramu Agri Industries; and the Fly River region of Western Province, downstream from the Ok Tedi minesite, in conjunction with the Ok Tedi Development Foundation. We also conducted research in conjunction with the established JANT woodchip export business based at Madang. In all cases, we also worked with the PNG Forest Authority, in the conduct of its policy, regulatory and extension roles.

3.3 Adoption in the PNG context

The wealth of literature investigating adoption by farmers (eg, Pannell *et al*. 2006; Kanowski et al 2008) informs this research in the PNG context, where – similarly to Pannell *et al*.'s (2006) conclusions – adoption is dependent on goals that may vary widely between individual landowners, depending on their circumstances and personal preferences.

In the PNG context, food production for personal consumption and for exchange or sale, and creation and use of resources to generate cash income, are overarching goals in livelihood strategies, and thus in adoption decisions. There are also other factors influencing adoption, particularly the relationship between an individual's social status and their food production and consumption. Traditional village status systems elevated hard working, skilled and successful food producers (Morauta 1983); they also regarded what a person ate as a measure of that individual's worth and of their standard of living. The variety of an individual's diet is determined by food that they produce themselves, or receive as gifts or presentations. Consequently, these norms can both encourage innovation that is perceived to be likely to enhance status, but also discourage adoption that is judged to be too risky in these terms.

Other factors that are known to influence adoption by PNG landowners include the outcomes of trial-scale adoption by early innovators (eg Donaldson and Good 1982), the availability of substitute food and livelihood resources (eg Bourke 1997), and traditional knowledge and cultural practices (eg Kennedy and Clark 2005).

3.4. Tree production systems and business models relevant to PNG landowners

Prior research and practice had identified a number of commercially-valuable tree species likely to be appropriate for landowner tree growing in each pilot region; however, there had been little assessment of the financial feasibility of various tree production systems incorporating the candidate species. Nor had there been prior work on business models relevant to commercial tree growing, notwithstanding that a range of business models is already operating with perennial crops in PNG – notably coffee, cocoa, and oil palm. It was therefore necessary to review these and other potential models in the context of commercial tree growing.

3.5 Project strategy

The strategy that the project followed was based both on the strong culture of tree-growing and traditional ecological knowledge among PNG landowners, and on the assumption that addressing constraints to adoption will encourage landowners to adopt the growing of high-value trees, as they would that of any other commercially-valuable crop which could be integrated into their farming and land use system. Strategies based on this assumption have been successful in fostering commercial tree growing by farmers in many countries, both economically -developed and –developing (Kanowski et al 2006).

In Australia and elsewhere, identifying business partners with the interest and commitment to establish and sustain co-investment with landowners has proven to be the most critical factor in facilitating their adoption of commercial tree growing (e.g., CSIRO 2001, Schirmer *et al.* 2000). The strategy proposed here similarly recognised this as the fundamental constraint, and thus – on the basis of work under ACIAR Projects C2004/086 and C2005/189 – is premised on conducting work in pilot study regions where such partners exist, are committed to the goal of facilitating high-value tree growing by landowners, and have the capacity to deliver on this commitment. These private- and community-sector partners then act as the principal extension and implementation agents for project outputs; government agencies play important supporting and facilitating role, but implementation is not predicated on their capacity. Recognition of and giving effect to these complementary roles of the key actors has proven fundamental to the success of strategies for farmer adoption of commercial tree growing elsewhere (e.g., Australian Government 1997, CSIRO *et al.* 2001, Reid and Steven 2001).

The strategy for research and adoption was therefore built around collaboration between project researchers and partners in a small number of case study regions in which the potential to address fundamental constraints is greatest. The research approach follows that which has been established for similar work elsewhere (e.g., Fulton and Race 2000, Schirmer *et al.* 2001), including that ANU was conducting at the time on behalf of RIRDC into how Australian farmers might enhance the value of native forest on their properties (Field *et al.* 2001) – of research with landowners to identify constraints, and subsequent work with business and governments to develop strategies to address those constraints.

4 Objectives

The aim of the project was to foster the adoption of commercial-scale high-value tree growing by landowners of PNG. Specific objectives were to:

1. Define commercial tree production systems for priority species in pilot regions;
2. Assess landowner decision-making in the context of candidate tree species and production systems;
3. Develop business models and strategies to facilitate adoption, in conjunction with investment and implementation partners (businesses, government, NGOs & CBOs – community-based organizations);
4. Implement strategies in the pilot regions in conjunction with landowners and investment and implementation partners;
5. Communicate project knowledge and learning to interested parties outside pilot regions.

The associated expected outputs were:

- Identification of appropriate tree species, production systems, business models and institutional frameworks to achieve project objectives in each pilot region;
- Implementation activities within each pilot region, with investment and implementation partners and willing landowners, to establish first-stage plantings of high-value species;
- Development and implementation of a communications strategy to that ensure that project knowledge is widely disseminated to relevant parties in PNG;
- Identification of any further research, development and policy interventions necessary to foster adoption of commercial tree growing by landowners, in the pilot study regions and elsewhere in PNG.

5 Methodology

The project necessarily involved a multi- and inter-disciplinary approach, and strong partnerships between researchers and field-based staff and between different project partners. These are outlined below in relation to each project objective.

5.1 Pilot study regions

The project design envisaged research being conducted in two pilot study regions identified in ACIAR scoping study (C/2004/086; Kanowski *et al* 2006) as having the best potential for adoption of commercial tree growing – Western Province, in partnership with the Ok Tedi Development Foundation and PNG Sustainable Development Program; and the Ramu Valley, in Madang and Morobe provinces, in partnership with Ramu Sugar Ltd. It also envisaged baseline research with landowners being conduced in a third pilot region adjacent to the Ramu Valley, Waffa in Morobe Province, in conjunction with the Morobe Provincial Administration.

As implementation of the project proceeded, the location of pilot study regions evolved. The primary field research for the project, led by PhD scholar Kulala Mulung with support from other project team members and partners, was conducted over an 18 month period, from late 2007 to early 2009, at three case study sites (Figure 5.1). These sites were (1) Yeteni, Obo and Casa villages in the Middle Fly region of Western Province, (2a) Mari landowners in upper Ramu region of Madang Province; (2b) Ragigumpuan and Marawasa landowners in the upper Markham Valley region of Morobe Province; (4) Gogol, Naru and some North Coast villages in Madang Province. The sites were selected because of their proximity to development-related or commercial agricultural activities being undertaken by ACIAR project partners (sites 1 & 2), or because of the established history of commercial tree growing (site 3).

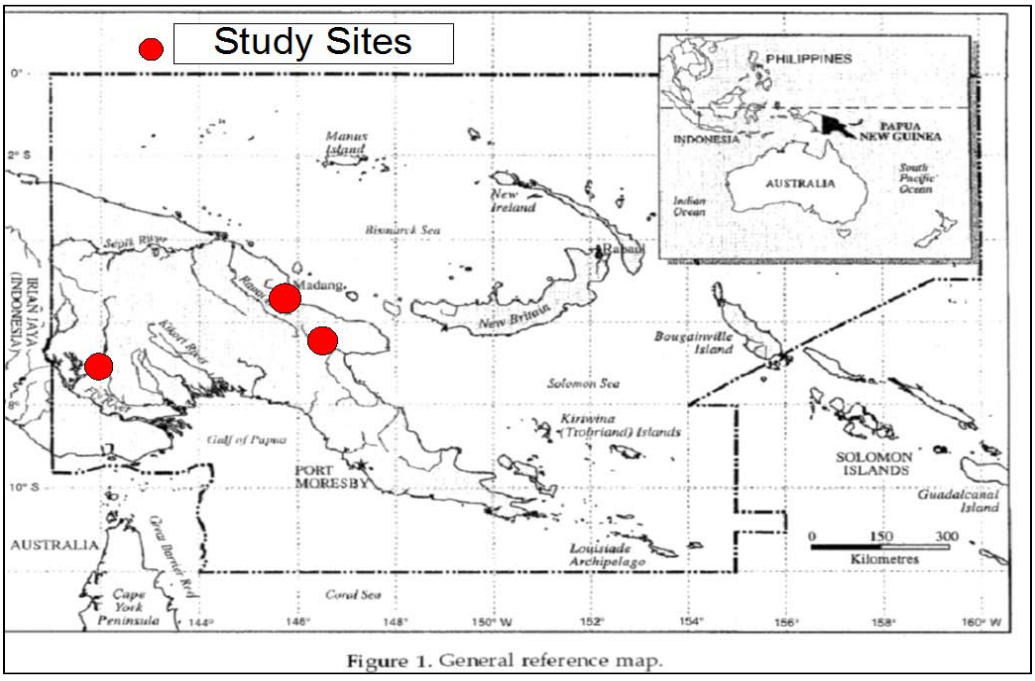


Figure 5.1. Location of project case study sites

(Map source: Nita (2006); case study site 1 is the western-most point; sites 2a&b are located close to each other and represented as the eastern-most point; site 4 is the northern-most point)

The original intention of conducting baseline research at Waffa was not pursued, as it became apparent this would be both logistically very difficult and less informative than the Madang site; the latter was substituted after initial field work informed methods and the time required for field research.

5.2 Methods specific to each project objective

5.2.1 Define commercial tree production systems for priority species in pilot regions.

The objective was pursued by reviewing existing information about species performance from relevant PNG and Australian sources, and developing biophysical and financial models of alternative production systems. It was conducted primarily by a forester (Braden Jenkin) and an economist (Michael Blyth), with data and assistance from PNG project partners, notably PNG FA and RAI.

Candidate commercially-valuable tree species with potential for integration into PNG land use systems were categorised into five groups (Kanowski *et al* 2008):

- longer-rotation indigenous species for solid wood production. Examples include kwila *(Intsia bijuga)* and hoop pine (*Araucaria cunninghamii*);
- shorter- to medium- rotation exotic species for solid wood production. Examples include teak (*Tectona grandis*) and rosewood (*Pterocarpus indicus*);
- short-rotation species, both indigenous or exotic, for solid wood, biofuel or pulp production. Examples include *Acacia mangium* or *Eucalyptus pellita*;
- species for which wood is a complementary, rather than a primary, product. Examples include the indigenous nuts, galip (*Canarium* spp) and okari (*Terminalia kaernbachii*), or exotics such as rubber (*Hevea brasiliensis*);
- species for fragrant wood and oil production, notably sandalwood (*Santalum* spp) and eaglewood (*Aquilaria* spp).

Based on consultation with PNG project partners and the preliminary results of household-level surveys, project work focused on short- and shorter-rotation species, reflecting the time preference of landowners. However, recognition of the longer term interests of many landowners also led us to include some analysis of longer-rotation species.

This work assessed conventional performance measures financial performance, such as NPV, IRR, land expectation value (LEV), annual equivalent value (AEV) and return to labour, but noted that these needed to be tempered by understanding the processes that smallholders apply when making land use decisions (i.e., outcomes of work conducted under Objective 2).

5.2.2 Assess landowner decision-making in the context of candidate tree species and production systems.

The core of work to inform this objective was conducted by ACIAR John Allwright Fellow/ UniTech staff member and ANU PhD scholar Kulala Mulung, with support from project team members Hartmut Holzknecht (anthropologist), Michael Blyth (economist) and Peter Kanowski (forester). It involved primary household and community survey research in case study communities in the pilot regions, and linking the outcomes of that work to that conducted for Objective 1. PNG partner organisations in each pilot region were instrumental in facilitating and supporting the fieldwork.

The research drew from three theoretical frameworks - Hierarchical Needs (Maslov 1954), Sustainable Livelihoods (Chambers and Conway 1992), and Farmer-Adoption-Decision (Pannell *et al* 2006, Rogers 1995) – to focus on the relationship between landowner intention and landowner behaviour. The study was based on the premise that this relationship must be fully understood for it to be the basis for informing interventions directed at promoting adoption of commercial tree growing by Papua New Guinea landowners.

On the basis of the three underlying theoretical frameworks identified, and literature review, the decision-making environment for PNG landowners was conceptualised in the terms presented in Figure 7.1. Research sought to illuminate each of the elements presented in Figure 7.1. It took the household as the unit of analysis and sought to understand land-use decisions and practices in the context of a household's aspirations, motives and behaviour. It therefore addressed the interface between subsistence food production and cash economy, and explored the process by which these two economies, as well as the biophysical and social environments, interact and influence the land-use choices of PNG rural households.

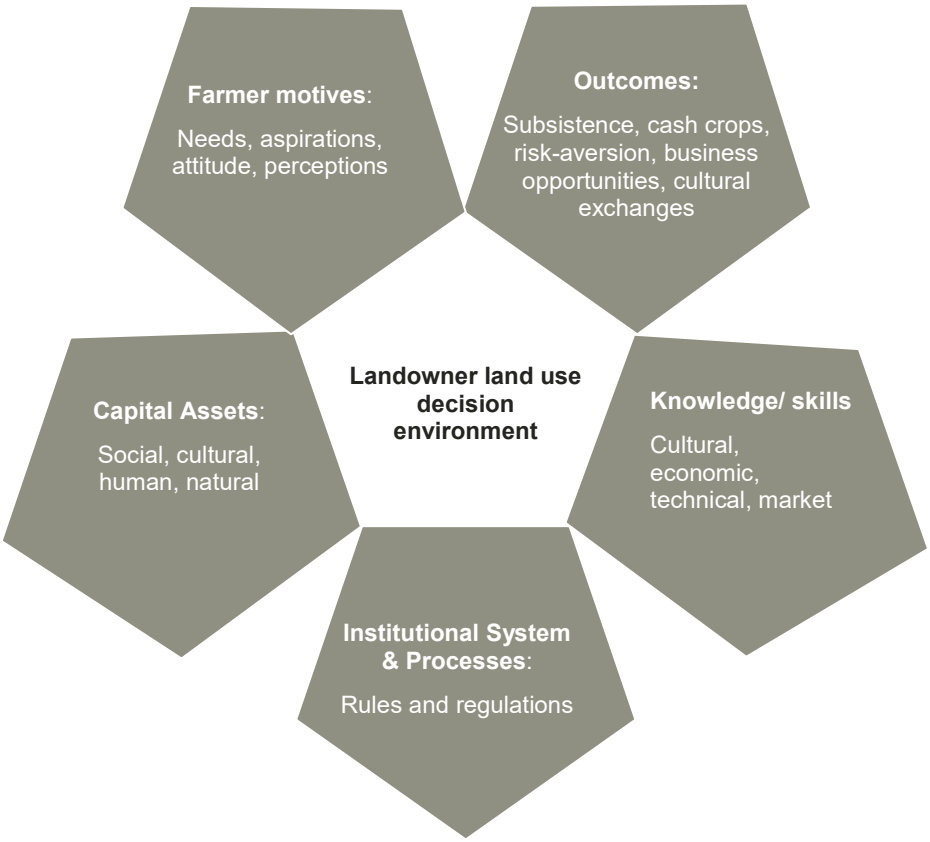


Figure 5.1. PNG landowners' decision-making environment
(from Mulung 2012)

The decision-making environment represented by Figure 5.1 was further conceptualised within the larger needs and institutional context illustrated by Figure 5.2, which explicitly related the individual's hierarchy of needs to the sustainable livelihoods framework and institutional contexts and processes.

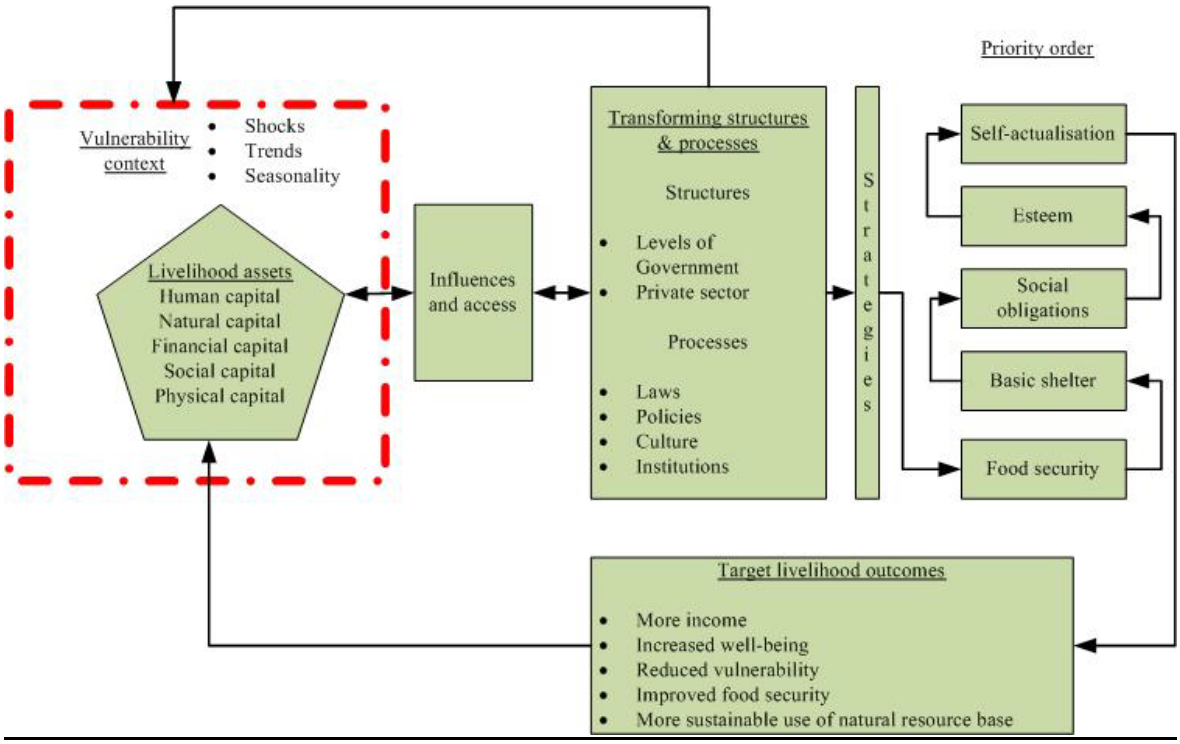


Figure 5.2. Conceptualisation of the relationship between livelihoods, needs and institutions. Source: Jenkin *et al* 2009.

In these contexts, the primary research question on which the work focused was:

- On what basis do Papua New Guinea landowners make land-use decisions relevant to tree growing?

This question was investigated through three subsidiary questions:

1. What are the livelihood assets of the landowners?
2. What motivates decisions about the use of these assets?
3. How does the interface between the subsistence and cash economies influence land-use decisions?

The secondary research question was:

- What are the implications these decision processes for the adoption of commercial tree growing?

Primary data to inform these questions was gathered from community meetings and household surveys. One or more community meetings held in each of 12 sampled villages or communities; these meetings outlined the purpose of the research and gathered community-level data. A purposeful sampling strategy (Maxwell 1996) was used to determine the households sampled in each village or community. Most case study villages or communities were small, comprising c. 20 households; data saturation was typically reached after around 20 interviews with households or individual representatives of them. In total, 229 participants representing 145 households were interviewed, comprising 155 male and 74 female farmers. The number of households sampled at a village or community level ranged from 7 to 30.

5.2.3 Develop business models and strategies to facilitate adoption, in conjunction with investment and implementation partners.

The outcomes of work undertaken for Objectives 1 and 2 informed the development of business models and strategies. Ultimately, exploration of the feasibility of these models and strategies was both enabled and constrained by the priorities, and commercial and operational realities, of implementing partner organisations in each region, and by broader national and provincial capacity and institutional issues.

Work towards this objective was led by project team members Braden Jenkin (forester & forest business analyst) and Michael Blyth (economist). It included contributions from the ANU PhD research, still ongoing at the time of preparation of this report, of ACIAR John Allwright Fellow Francis Essacu, formerly a staff member of OTDF. The methodology adopted for this research followed from that for Objective 2, and from approaches developed from work with smallholder adoption of tree growing in Australia and elsewhere (eg Schirmer *et al* 2000, Nawir and Santoso 2005).

5.2.4 Implement strategies in the pilot regions in conjunction with landowners and investment and implementation partners.

Work towards this objective was led by PNG implementation partners: OTDF in Western Province; and RAI, supported by UniTech, in Madang and Morobe Provinces. It involved collaboration directly with landowners in a number of communities in each region, to enhance their access to appropriate genetic resources, strengthen their capacity to raise plants in community or village nurseries, and develop nurseries where they were needed.

The project liaised with CSIRO and PNG FA to access additional genetic resources of teak, and with OTDF, RAI and UniTech to propagate and distribute these to participating communities. Project staff and collaborators worked with a number of communities to demonstrate basic nursery production systems, and RAI and UniTech established a community nursery to service the needs of communities in the Upper Markham and Upper Ramu regions.

Work under this objective included the completion of an ANU Masters of Forestry degree by Rami Agri Industries staff member and ACIAR John Allwright Fellow Gorethy Dipsen.

5.2.5 Communicate project knowledge and learning to interested parties outside pilot regions.

Five principal methodologies were adopted to realise this objectives, guided by a project communications strategy.

1. Direct engagement with and through the PNG Forest Authority, which has primary responsibility for communication about forestry issues across PNG. These activities included direct communication of project findings to both senior management and field staff, and the provision of hardcopies of material included in the PNG Tree Growers Toolkit to PNG Forest Authority staff across PNG.

2. Direct engagement between communities within and outside pilot regions, facilitated by project staff or partners. This work was led by OTDF in Western Province, and by Ramu Agri Industries and the PNG Forest Authority in Madang and Morobe Provinces. In the latter case, it also included engagement with local schools and communities engaged in tree growing in Eastern Highlands Province.

3. The development of a website to host all project-generated resources (www.pip.com.pg/resources > tool-kit-for-tree-growers). This site acts as a portal for both material generated by this project and that from other sources, including other ACIAR projects (notably FST/2007/008 and FST/2009/016).

The site and its resources were developed through a process which enabled project partners and landowner representatives to first describe (i) key messages, (ii) priority tools and (iii) cost-effective communication channels with reference to the project research findings. This provided a framework for assembling a set of tools in tok-pisin with specific information on the following topics:

- Choosing the right trees - this section contains a Tree Growers Check-List, a Tree Selector, and Tree Fact Sheets for species such as *Tectona grandis* and *Eucalyptus deglupta.*
- Growing the best trees - this section currently contains a Nursery Booklet for *Eucalyptus deglupta* and an Agroforestry with *Eucalyptus pellita* Fact Sheet.
- Making money from trees - this section contains a Tree Business Check-List, and a Cost and Returns Calculator.

The Tool Kit is communicated via each of a:

- Web-portal - for extension agencies and forestry partners
- E-bulletin - for extension agencies and forestry partners
- SMS texts - for alerting tree growers about new forestry extension services.

4. The incorporation of project learning into teaching of the forestry program at PNG UniTech, by staff who were directly engaged in the project. This involved both participation in project work by UniTech students and the incorporation of material and learning from the project into relevant teaching.

5. Presentation of project research results at scientific and professional conferences, as noted in Section 6, and publication in the academic and professional literature, as noted in Section 10.2.

6 Achievements against activities and outputs/milestones

Objective 1: To identify preferred tree species and potential production systems, and estimate associated financial costs and returns over the growing cycle

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	Identify preferred tree species and potential production systems, and estimate associated financial costs and returns over the growing cycle	**Outputs** 1. Shortlist of candidate tree species and technically feasible management regimes. 2. Financial analysis for production cycle for each species and regime **Milestones** Project reports to partners.	31.12.07	Progress reported informally to partners, and in 2007-8 Annual Report; final report incorporated into reports for Objective 3, because of interdependencies between Objectives 1 & 3. An overview assessment was presented as a paper for the 2009 IFA Conference and at the 2011 ANZIF Conference. Excel worksheets are presented at the PNG Tree Growers Tool Kit "Making Money from Trees" page; http://www.pip.com.pg > Resources > Making Money from Trees Final work is presented in Jenkin & Blyth (2014)

Objective 2: To assess landowner decision-making in the context of candidate tree species and production systems

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Survey landowners to understand decision-making about production and investment choices	**Outputs** 1. Reports based on fieldwork in each pilot region 2. Consolidated report across pilot study areas. **Milestones** Preliminary fieldwork reports and report to partners of preliminary analysis.	31.03.08	Fieldwork completed in 3 pilot regions, and preliminary reports provided to partners. A consolidated summary report (Appendix 1) was discussed at the 2009 annual project meeting, and forms the core of Kulala Mulung's PhD thesis; extracts have been reported in conference papers, and will be submitted for journal publication.
2.2	Identify key constraints to adoption of commercial tree growing.	As above	30.09.08	As above.

Objective 3: To develop business models and strategies to facilitate adoption, in conjunction with investment and implementation partners

No.	Activity	Outputs/ milestones	Completion date	Comments
3.1	Identify potential business models for commercial tree growing by landowners, including candidate investment and marketing mechanisms and strategies	**Outputs** Reports describing options for business models in each pilot region, and associated investment mechanisms and marketing strategies. **Milestones** Initial business models developed and discussed with partners	30.09.07	Preliminary models developed on the basis of Western Province fieldwork, and discussed with PNG partners directly and at 2008 and 2009 Project Workshops. Subsequent to presentation and discussion at the 2009 project annual, an overview assessment was presented as a paper for the 2009 IFA Conference and at the 2011 ANZIF Conference. A draft consolidated final report (Jenkin and Blyth 2014) is attached as Appendix 2.
3.2	Assess business models in terms of their capacity to facilitate landowner adoption and to meet investment partner objectives and constraints	**Outputs** Identification of preferred investment models for each pilot region. **Milestones** Reports to project partners on assessment of business models	31.03.08	As above.
3.3	Develop strategies to address constraints to landowner adoption, and minimise any potential social disbenefits	**Milestones** Reports to project partners recommending strategies for adoption of commercial tree growing	30.09.08	As above. In addition, project partners provided direct support under Objective 4; checklists and worksheets relevant to key tree grower decisions are presented at at the PNG Tree Growers Tool Kit "Making Money from Trees" page; http://www.pip.com.pg > Resources > Making Money from Trees

Objective 4: To implement strategies in the pilot regions, in conjunction with landowners and investment and implementation partners

No.	Activity	Outputs/ milestones	Completion date	Comments
4.1	Establish first stage of high-value commercial tree planting in Ramu and Western Province pilot regions by implementing preferred model(s) in partnership with willing landowners and investment and implementation partners	**Outputs** First phase of establishment of high-value trees by landowners in Ramu and Western Province pilot study regions, in partnership with Ramu Sugar Ltd. and Ok Tedi Foundation, respectively. **Milestones** Recommended planting material established in nurseries; sufficient landowners agree to establish planting material; initial plantings established and growing under appropriate management	31.12.08	Some 25000 seedlings (principally *Eucalyptus pellita*; some teak and casuarina) were distributed by RAI in Markham-Ramu in 2010/11, to c 200 households who had expressed interest in tree planting. A further 1000 seedlings were raised and distributed by UniTech. A project community nursery was established near Marawasa village in the Upper Markham by UniTech, with assistance from RAI. Operation of this nursery has continued after the conclusion of the project with support from RAI, UniTech and others. UniTech and RAI staff continued to conduct skills development sessions with communities which have expressed interest in tree planting. This task was assisted by the completion of a nursery booklet which was distributed to participants in training sessions conducted by UniTech and RAI staff, and though OTDF staff. The booklet forms part of the PNG Tree Growers ToolKit, which has been supplied to PNGFA staff and is available for download from the PIP website. OTDF staff continued to raise seedlings (principally eaglewood and teak) at two nurseries for planting by landowners in Western Province. Limited availability of teak seed continued to be a major constraint to project activities; the project has addressed this through seed purchase (6 kg 2010; 10 kg 2011[1]) from the Australian Tree Seed Centre, and supply of that seed to RAI. OTDF & RAI are gaining access to teak seed through their participation in ACIAR Project FST/2007/078.

[1] Seedlots represented (CSIRO Tree Seed Centre codes): 21114 CSO Chantaburi THAILAND; 21115 CSO Chantaburi THAILAND; 21130 Improved CSO Kaengben Province, Laos; 21139 CSO Donglan THAILAND; 21050 SPA Myanmar origin CH

Objective 5: To monitor and review adoption in pilot regions, and communicate project knowledge and learning to interested parties outside pilot regions

No.	Activity	Outputs/ milestones	Completion date	Comments
5.1	Monitor progress in research and adoption, and adapt strategies as necessary to facilitate adoption	Progress formally reviewed at annual workshops, and project adapted as appropriate	Ongoing through project life	These activities took place during project 'annual' meetings (2008, 2009, 2011), and during project fieldwork & related visits. Project implementation was adapted during the reporting period as a result of dialogue between Project partners.
5.2	Develop and implement communications strategy to disseminate project knowledge and learning	Communication strategy developed and implemented,	30.06.10	A communications strategy was completed in 2010, and subsequently implemented. This strategy identified as key elements direct communications (described below and in 5.3) and the development of a Tree Growers Toolkit website. Communications in the latter part of the project period focused on communities in the Upper Markham/ Ramu, in part through demonstration and training activities with households in participating communities, and in part through activities with schools. The latter comprised tree planting and awareness activities on days of particular significance (eg World Forestry Day, World Environment Day), including the distribution to school children of t-shirts recognising International Year of Forests. Project outputs were collated and made freely available through the PNG Tree Growers Toolkit website (www.pip.com.pg/resources).
5.3	Conduct workshops in PNG and contribute to relevant fora elsewhere.	Participation of project researchers in relevant fora, and reports and papers published	Throughout project life	Hartmut Holzknecht led a project 'roadshow' to 4 PNG locations in late 2011, and 'participated in a workshops in PNG under ACIAR FST/2007/078 in 2010/11. Project activities and outputs were showcased in both cases. Papers summarising aspects of project work were presented at two IUFRO IUFRO Small-Scale Forestry Conferences, in 2008 and 2011 (Kulala Mulung), and at IFA and ANZIF conferences in 2009 and 2011 (Braden Jenkin).

7 Key results and discussion

The key results achieved or facilitated by the project were:

1. the first detailed understanding of PNG landowners' motivations related to 'commercial' tree growing;
2. clarification of the likely financial returns associated with growing selected candidate tree species under likely management regimes;
3. clarification of feasible business models and strategies for commercial tree growing;
4. the pilot testing of implications of that understanding and knowledge for smallholder tree growing, through collaboration with a number of communities and implementation partners, primarily in the Upper Markham/ Upper Ramu regions;
5. the wider communication of project findings through the PNG Tree Growers Tool Kit web portal, and other media.

Each of these key results is discussed below.

7.1.1 Landowner motivations

These results were based on detailed case study research led by Kulala Mulung in three contrasting regions of PNG, following methods described in 5.2.2, and reported full in his PhD thesis[2]. This research was based on interviews and observations of landowners, their households and communities, to explore landowner decision processes relevant to the adoption of commercial tree growing. It explored how landowners assigned meaning to various farming activities, and how this determined their land-use decisions.

The particular combination of land, labour and financial resources available to each landowner were their most important assets. Decisions on how these resources are used were primary determinants of household prosperity and stability. The study confirmed that landowners' land-use decisions focused on integrating the subsistence and the cash economies. Land-use decisions about production focused on household's food needs, met largely but not always exclusively from the subsistence economy; and the household's clothing, education, health, transport and communication needs, which required participation in the cash economy. Landowners' social obligations and other aspirations were also important decision factors. While survival, self-sufficiency, risk minimisation and maximisation of the household income stream were the immediate foci of landowners' decisions, their longer-term goals centred on prosperity and on enhancing household stability and social values.

As reported by other studies of smallholders in PNG and elsewhere, labour availability was found to be a major constraint in terms of the production and adoption decisions of landowners. Landowners have planned their production activities over different time horizons to take account of these constraints. Food and immediate cash needs, such as children's education, take priority. Accordingly, appropriate activities are planned and land, labour and financial resources allocated towards these activities on an annual basis. Other needs, including cash income for non-food consumption, security and some social obligations, are the next highest priority rating, with activities planned and executed over a two to three year period. Other social obligations and intergenerational considerations are planned and executed over period of three or more years. Despite substantial cultural and regional differences, landowners' decision processes and planning horizons were largely consistent across regions.

[2] Mulung, K. 2012. *Wok diwai ken lukautim yumi, o nogat? Papua New Guinea landowners' decision processes relevant to commercial tree growing*. PhD thesis, Fenner School of Environment & Society, The Australian National University, Canberra. Attached as Appendix 3.

One of the attractions of commercial tree growing for landowners is that its labour demands are relatively low, and can be integrated with the pattern of labour use needed for food production and other livelihood activities. The appeal of commercial tree growing, in particular for high-value species such as teak, is further enhanced by the high returns to labour expected from tree growing. These compare favourably to returns from cocoa and coffee, both of which are currently considered the most attractive cash crops.

However, landowners' underlying willingness to grow commercial trees is mediated by a number of significant factors, notably access to relevant knowledge about candidate species, markets, and nursery techniques and management regimes; access to suitable germplasm or planting material; and, for wood products not being used locally, access to roadside for the transport of wood products to market. Features of the three pilot study regions in these terms are summarised in Table 7.1.

Table 7.1. Features of the three pilot study regions relevant to commercial tree growing

Pilot study region	Western Province	Markham/ Ramu	Madang
Access to knowledge	Largely limited to traditional species and those established in cultivation, eg rubber.	Largely limited to traditional species and those established in cultivation, eg *Acacia mangium, Eucalyptus pellita*; but extent of knowledge limited.	Good level of knowledge about established commercial species *Acacia mangium*, and some about other species (eg *Eucalyptus deglupta*)
Access to planting material	Primarily rubber, and for other species promoted by OTDF (eg *Tectona grandis*)	Primarily for species sought/ promoted by RAI, viz *Acacia mangium, Eucalyptus pellita;* some experimentation with other species.	Good for *Acacia mangium* and a small number of other species (eg *Eucalyptus deglupta*); otherwise limited.
Access to markets	Poor	Good, in terms of access to Highlands Highway.	Good, in terms of access to Madang and port facilities.

As evident from Table 7.1, knowledge and planting material constraints were significant in all cases, beyond a small number of species. Access to markets varied; it was very limited in Western Province, where it represented a major constraint to commercial tree growing.

7.1.2 Likely financial returns

Small-scale commercial tree growing for timber products is one of several household livelihood strategies available to farmers in suitable locations throughout PNG. The financial performance of a selection of potential tree species and product options was assessed using discounted cash flow analysis. The aim was to see how the returns from growing trees for timber products compared with the returns from other lowland crop products within the context of household livelihood goals, factors in the institutional environment and risks and uncertainties facing farming households. Tree species evaluated were: acacia (*Acacia mangium*), teak (*Tectona grandis*), eucalyptus (*Eucalyptus pellita*), kwila (*Instia bijuga*), hoop pine (*Auracaria cunninghamii*) and taun (*Pometia pinnata*). Tree products include pulp wood, construction poles, fuel wood and sawlog. The importance of financial performance was evaluated relative to other factors influencing the decision to invest in commercial tree growing.

Measures of financial performance used in the analyses were: Net Present Value (NPV), Annual Equivalent Value (AEV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) and Return to Labour (RTL). Details on each of these measures are described in Appendix 4.

Values of key parameters used in each of the tree production systems analyse are presented in Table 7.2.

Table 7.2. Values of key parameters for the tree production systems

	Acacia fuelwood	Acacia sawlog	Eucalyptus sawlog	Teak sawlog	Hoop sawlog
Rotation length	5	10	15	15	20
Labour used for tree establishment (person days/ha)	46.5	46.5	46.5	46.5	46.5
Labour cost (PGK/pd)	15	15	15	15	15
Planting rate (seedlings/ha)	833	833	833	833	833
Replanting rate	10%	10%	10%	10%	10%
Fertilizer (kg/seedling)	0	0	0	0	0
Pruning	No	Years 2, 6 and 9	Years 2, 6 and 9	Years 2, 6 and 9	Years 2, 6 and 9
Commercial thinning	No	25% in year 4	25% in year 4	25% in year 4	25% in year 4
Total yield (m^3/ha)	75	250	750	405	400
Price received for thinnings (PGK/m^3)	na	45	42	40	67
Price received for sawlogs (PGK/m^3)	65	45	42	150	67

Other important assumptions relevant to the financial analyses include:

- Infrastructure (road, transportation, nursery seedling production and distribution system are already available. Where any of these is constrained, costs of production will increase and there may be difficulties transferring logs to buyers.
- Costs are based on the current National Forest Authority's costings for plantation establishment
- Prices are based on the National Forestry Authority log export prices

The financial performance of the timber production systems are presented in Table 7.3.

Table 7.3 Financial performance of selected small-scale timber production systems

Performance measure	Potential tree species for agroforestry project and types of end use products														
	Acacia fuel wood			*Acacia sawlog*			*Eucalyptus sawlog*			*Teak sawlog*			*Hoop sawlog*		
Discount Rate (%)	7.5	10	20	7.5	10	20	7.5	10	20	7.5	10	20	7.5	10	20
NPV (Kina/ha)	1337	1078	304	877	306	-976	8569	6323	2005	13445	9213	1494	6354	4520	1053
AEV (kina /ha/year)	330	285	102	128	50	-233	971	831	429	1523	1211	320	623	531	216
IRR (%)		26%			12%			39%			26%			29%	
Return to labour (Kina/person/day)	24.84	23.19	17.58	16.55	15.6	12.33	26.79	24.8	19.6	32.03	28.48	18.5	24.2	22.4	17.5
Return relative to current wage rate (K15.00)	1.66	1.55	1.17	1.10	1.04	0.82	1.79	1.66	1.31	2.14	1.90	1.23	1.61	1.49	1.17
BCR	1.58	1.48	1.15	1.15	1.06	0.77	2.35	2.09	1.46	3.11	2.58	1.34	2.00	1.89	1.27

The results presented in Table 7.3 reveal that teak sawlog production out-performs the other production options for most measures of financial performance. This reflects the relatively high price for teak sawlogs compared to acacia, eucalyptus and hoop pine. However, while some income is received from thinnings in the first five years, the main income flow does not occur until 15 years after planting when the trees are harvested. Teak is unlikely to be an attractive option for poor farmers who have a high time preference for income. This preference would also rule out hoop pine, despite its reasonable financial performance under each of the discount rates. Eucalyptus sawlog is the next best performer, although this reflects the price received for thinnings in year 4, which is assumed to be equivalent to the price for final harvest logs (PGK42/m^3). If the price of thinnings is reduced PGK25/m^3 the IRR falls to 21%, NPV at 7.5% discount rate is just over PGK 6000/ha, the AEV is PGK680/ha and the BCR is 1.94. The high yield of eucalyptus is an important factor in its attractive financial performance.

Acacia for fuelwood is likely to be an attractive timber production system for smallholders, providing a good return after five years. However, a key element in the attractiveness of this option is the relatively high price paid to growers of the product, compared to sawlog prices. The price used was based on actual payments to growers for fuel wood by Ramu Agri Industries in the Ramu and Markham Valleys. At prices above PGK41 per m^3, acacia production for fuelwood is profitable (at the 7.5% discount rate, which is moderate in terms of risk). At a price of PGK45/m^3, which is the price received for acacia sawlogs, the acacia fuelwood option at the 7.5% discount rate returns an AEV of PGK 53/ha/year, a BCR of 1.09 and an IRR of 11%. This would make it slightly less attractive than acacia for sawlog production, reflecting a higher annual growth rate of the sawlog option

Production of acacia for sawlogs looks least attractive, based on the results in Table 7.3. However, the price received by growers is the key factor in this result. If acacia sawlog growers were paid the same price that fuelwood growers received in the Markham Valley the results would be more attractive. For example, at the 7.5% discount rate and a price of PGK65/m^3 the BCR is 1.66, the IRR is 24%, the NPV is PGK3,839/ha and the AEV is PGK559/ha/year. This would be attractive, although the 10 year waiting period before the main income flow is received may be a deterrent to investment for many smallholders. The fuelwood option is more attractive in terms of return to labour which is an important consideration for PNG households where labour is often the most limiting resource.

These results reveal the sensitivity of tree growing to the prices received. Prices paid to growers reflect both demand conditions and costs involved in accessing timber resources. Location of the grower is important. Where demand is strong and growing and costs of access are low, tree growing is likely to be financially attractive, especially if demand is for short-rotation products. To sustain a household livelihood over a long rotation, farmers need to diversify their production system, with trees integrated into annual cash crop production systems, or short-rotation tree species inter-planted with longer rotation species. Other key factors to consider for smallholders are access to sufficient (family or community) labour resources, especially in the first two years of a tree crop and access to sufficient land to support annual cash crops and a long term tree crop.

The data used in these financial analyses are subject to revision based on results of empirical studies on growth and yield for different plantation species and on prices received at the stump for resources of different age and wood properties. The available of production and market data will be monitored and the financial models revised for use in decision support tools to support household land use decision making regarding commercial tree growing (see, eg Appendix 5).

7.1.3 Business models and strategies to promote adoption of commercial tree growing

A range of business models was surveyed[3], included independent players competing in open markets, growers supplying processors under various forms of agreement, and full control of the supply chain by a single entity. Possible alternative structures were assessed in terms of feasibility and likely success. The scale of available land and the balance of the decision-making between the growers and the purchasers are key factors influencing choice of business structure. As for estate tree crops in PNG (eg balsa, cocoa, oil palm), our research concluded that a range a business structures are feasible so long as they provide growers with access to market; it is the latter criterion that is the defining issue for smallholders. Assuming access to market, return on investment compared to feasible alternatives becomes the deciding factor in determining landholder adoption.

Contrasting results for adoption of and withdrawal from commercial tree growing in two of the case study regions illustrate these conclusions. Near Madang, where landowners had good access to markets for acacia pulp, they were willing to continue to invest in tree growing where they judged returns to be adequate in relation to their investment of land and labour. During the course of project research, the sole buyer in Madang changed its business model to require growers to carry a greater share of the harvesting and transport costs, without a concomitant increase in wood price. The consequence was an emerging reluctance on the part of landowners to continue engaging in acacia growing (Appendix 2). Conversely, in the Upper Markham and Ramu regions, landowners had land surplus to their gardening needs that was not productive for other uses, reasonable access to a major highway and to some existing markets for wood products, and growing household need for building timbers. In these circumstances, and based on returns currently received for sale of trees, they saw tree growing for both household use and sale as a desirable complement to their other livelihood activities.

Consistent with the results reported above, both business models and strategies for commercial tree growing should be articulated and aligned with landowners' production systems and planning horizons. Short-term tree crops can be directed at landowners' immediate and mid-term time horizons, while longer-term tree crops, which are typically of higher-value species, can be directed at landowners' longer-term time horizons and

[3] Jenkin, B and Blyth, M. ibid.

fulfilling their goals. The results of landowner surveys suggested that, while landowners were eager to generate returns in the short term where possible, they were not averse to investing resources in growing trees with longer return times to satisfy aspirations associated with their longer time horizons.

In this context, for example, fast-growing species such as *Acacia mangium* and *Eucalyptus pellita* could be grown for end-uses such as fuelwood, pulpwood and poles over production cycles as short as two to four years, while higher-value species such as teak (*Tectona grandis*) or kwila (*Instia bijuga*) would be grown for sawn or veneer wood products over longer cycles consistent with the longer-term planning horizons of landowners. Assuming access to markets, both short- and long-term tree crops offer income-generation opportunities for landowners over their different time horizons. Commercial tree growing offers options for diversification of household income streams because it is compatible with landowners' production systems, and because it is flexible in term of labour inputs.

7.1.4 Pilot testing of smallholder tree growing systems

This work focused on a number of communities in the Upper Markham and Ramu Valleys, in partnership with Ramu Agri Industries and UniTech. These communities had been informed about the potential of tree growing for both livelihood and commercial purposes by the project partners and project staff, and were keen to engage with tree growing for both these purposes. The project supported raising and distribution of more than 25,000 seedlings by Ramu Agri Industries and UniTech, to c. 200 households in these communities. Capitalising on RAI's and UniTech's existing relationships with these communities, and on their nursery production capability, was an effective way of facilitating quick access to germplasm of useful species.

There was also strong interest in these communities in community-based production of tree seedlings and propagules, primarily of species which landowners knew from experience would grow well and satisfy household or market needs – *Acacia mangium*, *Eucalyptus pellita*, and *Tectona grandis*. In response to this interest, UniTech led – with support from Ramu Agri Industries – the establishment of a community nursery near Marawasa village in the Upper Markham. This nursery continued to be supported by the local partners after the project concluded. It is also notable that individual landowners in these communities also established plantings of kwile (*Instia bijuga*), a high-value native species with a long harvest cycle.

In total, some 210 landowners in these communities engaged with the project to establish c. 58,00 trees during the life of the project. Some 175 participated in training in nursery production and the management of planted trees.

In Western Province, OTDF produced and distributed around 4,000 seedlings annually during the project period. The majority of these were indigenous species with traditional uses, such as betel nut and *Canarium*. Preference for these species reflected in part the lack of access in Western Province to markets for 'new' commercially valuable species, such as teak, as well as the limited supply of the latter.

These project activities provided proof of concept for knowledge generated in support of results 1-3. However, they also demonstrated the need for external support for communities, firstly to develop knowledge and skills essential for commercial tree growing, complementing those which landowners have traditionally and from other sources, and secondly in the provision of suitable genetic material for propagation.

7.1.5 Communication of project findings

These activities are described in #8 below.

7.2 Implications for tree growing by landowners in PNG

On the basis of project results, it is apparent that strategies for commercial tree growing by landowners in PNG should be articulated and aligned with landowners' production systems and planning horizons. Short-term tree crops can be directed at landowners' immediate and mid-term time horizons, while longer-term tree crops, which are typically of higher-value species, can be directed at landowners' longer-term time horizons and fulfilling their higher-level goals. For example, fast-growing species such as *Acacia mangium* and *Eucalyptus pellita* could be grown for end-uses such as fuelwood, pulpwood and poles over production cycles as short as two to four years, while higher-value species such as teak (*Tectona grandis*) or kwila (*Instia bijuga*) could be grown for sawn or veneer wood products over longer cycles consistent with the longer-term planning horizons of landowners. Assuming access to markets, both short- and long-term tree crops offer income-generation opportunities for landowners over their different time horizons. Commercial tree growing offers options for diversification of household income streams because it is compatible with landowners' production systems, and because it is flexible in term of labour inputs. Thus, the results of the study suggest considerable potential for commercial tree growing by landowners in Papua New Guinea.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The principal scientific impacts of the project are those that will result from the deep knowledge of PNG landowner decision processes relevant to tree growing, , in the context of their livelihood systems, that the project has generated. This is foundational knowledge for all subsequent work directed at adoption of tree growing, for both household and commercial purposes, by PNG landowners. It is the first documented research on this topic for PNG, and will represent an important contribution to the stock of knowledge about smallholder tree growing globally when it is published. Identification of the existence and consequences of the different time horizons of PNG landowners in relation to livelihood and land use decisions is new and significant, and has implications much wider than the project and tree growing per se. The finding that adoption of tree growing is dependent on it complementing other livelihood activities and labour demands was expected on the basis of research in other countries for trees, and in PNG for other farming systems, but had not previously been confirmed for timber tree growing in PNG. Research also found significant risk-management benefits for trees grown as part of farming systems – these included low opportunity costs for labour inputs into tree management, and protection of trees from fire because landowners were ensuring the protection of crops.

The incorporation of knowledge about PNG landowner tree growing into business models and strategies for commercial tree growing is a second important impact of the project; the impact is likely to be in the longer term, as opportunities for smallholder commercial tree growing arise in various regions of PNG.

The project introduced significant new genetic resources of teak (*Tectona grandis*) to PNG, through seed importation from CSIRO and distribution to project partners (OTDF, RAI, UniTech) for propagation (see Section 6.4.1). The scientific value of these introductions is the broadening of the genetic base of teak in PNG, which had been identified as a priority by PNG project partners and other stakeholders.

8.2 Capacity impacts – now and in 5 years

The project realised significant capacity impacts in a number of respects:

- the participation in graduate degree programs by PNG project partner staff, each enabled by ACIAR John Allwright Fellowships: completion of a PhD by Dr Kulala Mulung (UniTech) and of a Masters by Gorethy Dipsen (Ramu Agri Industries), and enrolment in a PhD by Francis Essacu (OTDF). In these cases, the primary capacity impacts are the enhanced knowledge and research-related skills of participants, their capacity for both independent and collaborative research, and the broadening and strengthening of their research networks and horizons;
- the participation by other PNG project partner staff in aspects of the project: notably David Adzab (Ramu Agri Industries), Samuel Famiok (OTDF), Eko Maigo(UniTech) and Paul Marai (PNG FA). Their capacity for research within a project context, their knowledge and skill bases, and their research and professional networks were considerably strengthened by the project;
- strengthening the capacity of a number of Australian researchers engaged in the project to work effectively with PNG counterparts and in the PNG context. The project served as a vehicle for a number of Australian researchers to develop these capacities in a context supported by both PNG partners and colleagues with longer experience of research in PNG. In this sense, the project helped build the

capacity of a 'next generation' of Australian researchers, complementing this function for PNG researchers noted above;
- the project's work with communities in the Upper Markham/ Ramu region, principally the Marasasa, Ragizumang, Waritzian and Wankun villages. Here, capacity impacts were primarily the enhanced understanding of these communities of the potential of tree growing to add value to their farming systems, and their capacity to raise tree seedling and cultivate trees with potential commercial value;
- the participation of UniTech forestry students in various project activities enhanced their learning and capacity for conducting research;
- the communication and knowledge sharing skills of project staff were enhanced by their engagement, in the later stages of the project, with Pacific Islands Projects' communications team.

The consequence of a number of these capacity impacts is already evident, in – for example – the participation of many project researchers in the ongoing ACIAR Balsa Project in East New Britain (FST/2009/016), in subsequent work undertaken by Ramu Agri Industries, in the further development of the web-based resources of the PNG Tree Growers Tool Kit, and in the continuation of project-initiated community nursery activities in the Upper Markham region.

In the longer term, the group of researchers whose capacity was fostered by the project can be expected to continue to make significant impacts in forest-related issues in PNG. In particular, the social sciences research skills that were the foundation of Dr Mulung's and Mr Essacu's PhDs were not previously well-represented in the community of PNG forest researchers.

8.3 Community impacts – now and in 5 years

Direct community impacts during the life of the project were focused on the communities of the Upper Markham/ Ramu Valley regions, largely because their geographic proximity to Ramu Agri Industries and UniTech allowed frequent contact between researchers and communities, and which could build on the established relationships between Ramu Agri Industries and these communities.

In these communities, especially the Marasasa, Ragizumang, Waritzian and Wankun villages, the principal immediate impacts were the project's provision of scientific knowledge to complement that already embodied in the communities; the strengthening of self-image in the communities and households through their participation in project activities; significantly enhanced awareness of the potential benefits of tree growing and how they might be realised; some of this awareness extended to school children, who were targeted by a number of project communication activities; the establishment of an economic resource for many households, in the form of trees raised or planted with project assistance.

Over the longer run, these impacts maybe expected to foster improved livelihoods for households whose activities have expanded to include tree growing as part of their farming systems and commercially-valuable trees as a part of their household assets. The project aslo aspired to catalyse sufficient momentum around tree growing in these communities so that they could attract the interest of, and inform, other communities.

There were also more restricted projects impacts on other case study communities, in Madang and Western Provinces, in terms of greater awareness of the potential and diversity of forms of commercial tree growing, and through the provision of improved germplasm of some species. The enhanced knowledge of some Eastern Highlands communities, engaged in learning about project activities from the Upper Markham community members, should also benefit those communities' engagement in adding value to their farming systems through tree growing.

8.3.1 Economic impacts

Project objectives focused primarily on generating and sharing knowledge as the basis for longer-term economic impacts, rather than on more immediate economic impacts. The project's work on likely returns from tree growing and on business models to facilitate it, and on understanding the basis of landowner adoption decisions, provide the foundations for future economic impacts across PNG.

In the focal case study regions of the Upper Markham/ Ramu and Western Province, localised economic impacts can be expected in participating communities, associated with the tree growing (c. 30,000 plants) facilitated by the project. Particularly in the Upper Markham/ Ramu, these benefits extend beyond the value of the trees planted during the life of the project, to the benefits that will follow from communities' capacities to successfully raise and cultivate trees of livelihood and commercial value. However, at the end of the project it was already evident that landowners were receiving income from selling of *Eucalyptus pellita* poles or, conversely, they no longer had to buy poles from elsewhere when constructing new houses in their villages.

There will also be economic benefits from the introduction of new teak germplasm, although the magnitude of these will not be apparent until the genetic quality of the resultant plants can be assessed as they mature.

8.3.2 Social impacts

The social impacts generated by the project are associated with those discussed in 8.2 and 8.3.1, and with the communities with whom the project worked most closely in the Upper Markham/ Ramu Valleys. These impacts are primarily those following from enhanced household income, from 'farming' (i.e, tree growing) activities that productively occupy surplus labour when it is available, and from enhanced individual and community self-esteem associated with engagement in activities which both participants and others see as innovative and worthwhile. Each of these impacts was apparent in the Upper Markham/ Ramu communities during the life of the project.

Over the longer term, these benefits might be expected to accrue to households and communities elsewhere who similarly adopted tree growing as a means of adding value to their farming systems and livelihood portfolios.

8.3.3 Environmental impacts

In the forms of tree growing researched and facilitated by the project, in which trees are incorporated into farming systems, environmental impacts at both the plot and landscape scales should be benign or positive. In particular landscapes, notably the anthropogenic grasslands of the Upper Markham/ Ramu Valleys, the establishment of trees that need protection from fire might be expected to facilitate a reduction in the scale of burning, and lead to its more discriminating use. Positive environmental impacts would follow from this change in land management practices. In some of the hillslope areas of the same region, re-establishment of trees and attendant changes in burning practices should reduce erosion risk and impacts.

8.4 Communication and dissemination activities

Communication and dissemination activities took five principal forms, guided by a project communications strategy[4]. The strategy emphasised the importance of different modes of communication for different audiences, the primary importance of person-to-person communication at individual and community levels for landowners, and the reach of radio

[4] *Holzknecht, H. 2011. ACIAR FST/2004/050 Project communications and information strategy.*

and mobile telephones compared to other media in rural PNG. It also noted both the intended role and limited capacity of national and provincial governments, and the roles of other actors – eg in the private and community/ non-government sectors – in providing relevant extension and facilitation services.

In these contexts, the project initiated development of a "PNG Tree Growers Toolkit", envisaged as a package of Pidgin-language resources to meet the needs of both landholders and those engaged in extension and facilitation. The project also initiated development of a website to host all project-generated resources (www.pip.com.pg/resources > tool-kit-for-tree-growers). This site, which continues to be developed and populated following conclusion of the project, acts as a portal for both material generated by this project and that from other sources, including other ACIAR projects (notably FST/2007/008 and FST/2009/016).

Table 8.1 summarises visits to-date to the web portal. Visitor numbers are expected to gradually increase once the communication channels become fully operational (i.e. after the field-testing is completed). Visitor numbers are also expected to increase year by year, as the initial tool-kit is further developed and extended in collaboration with other projects (e.g. ACIAR Projects FST-2007-078 and FST-2009-016).

Table 8.1 Summary of web-portal visits to 31 December 2013

Page	Page views	Unique page views	Average time on page
Choosing the right trees	200	99	0:02:42
Welcome and Acknowledgements	173	125	0:02:28
Tree growers check-list	132	65	0:04:16
Growing the best trees	101	57	0:01:41
Making money from trees	98	52	0:01:51
Tree fact sheets	70	42	0:03:19
Tree business check-list	44	25	0:02:54
Tree production fact sheets	43	30	0:03:54
Communicating with you	45	26	0:05:12
Tree selector	33	23	0:01:20
Tree growers guidelines	26	20	0:02:00
Costs and returns calculator	26	18	0:04:19
Tree business guidelines	12	9	0:02:18
Tree growers check-list	6	1	0:01:33
Nursery guidelines for Kamarere	3	2	0:01:50
Total	**1012**	**594**	**0:02:46**

A second strand of communication activity was direct engagement with and through the PNG Forest Authority, which has primary responsibility for communication about forestry issues across PNG, and with staff of provincial government and other relevant organisations. These activities included direct communication of project findings to both senior management and field staff, in small groups and through a 'roadshow' of workshops showcasing project findings, participation of local and national stakeholders in project annual meetings, and the provision of hardcopies (c. 400) of publications included in the PNG Tree Growers Toolkit to PNG Forest Authority staff across PNG.

A third strand was direct engagement between communities within and outside pilot regions, facilitated by project staff or partners. This work was led by OTDF in Western Province, and by Ramu Agri Industries and the PNG Forest Authority in Madang and Morobe Provinces. In the latter case, it also included engagement with local schools in the Upper Markham/ Ramu region, and with communities engaged in tree growing in Eastern Highlands Province. Hard copy booklets of the first two publications in the Tool Kit, on growing eucalypts and teak, were also distributed to landowners in the Upper Markham/ Ramu region. The scale of these activities was necessarily modest, but results in participating communities were very positive.

The fourth strand was the incorporation of project learning into teaching of the forestry program at PNG UniTech, by staff who were directly engaged in the project. This involved both participation in project work by UniTech students and the incorporation of material and learning from the project into relevant teaching. UniTech students assisted with community surveys in the Upper Markham/ Ramu, and in the establishment of the community nursery and facilitation of landowner knowledge about growing trees.

The fifth strand was presentation of project research results at international scientific and professional conferences, and publication in the academic and professional literature. Project staff participated in and presented project work to two meetings of the IUFRO Working Group on Small-Scale Forestry, in 2008 and 2011, and presented papers on project work to Institute of Foresters of Australia/ Australian and New Zealand Institutes of Forestry conferences in 2009 and 2011. Publications are listed in #10.2.

9 Conclusions and recommendations

9.1 Conclusions

Key conclusions in terms of each of the project objectives are:

1. Define commercial tree production systems for priority species in pilot regions
Based on analysis of landowners' interests, informed by #2 below, and of livelihood needs and market opportunities, the project focused on a small number of priority species that were widely adaptable in the case study regions, fast growing, and of high value in the short- and medium- terms: *Acacia mangium*, *Eucalyptus pellita*, and *Tectona grandis*. Acacia and eucalypt poles and wood are of high value for household uses such as construction and fuelwood, as well as being commercially valuable for these and other uses. Genetic material is readily available and seedling are relatively easily propagated. Genetic resources of teak are less abundant, and its propagation by cuttings requires more skill than the seedling propagation of the other species. However, its wood is of high value and in strong demand in international markets, where it can be sold in relatively small (eg container-load) batches.

The incorporation of these tree species into farming and land use systems in the case study region was straightforward, primarily because these species were grown in various configurations on land that was not being used for food, or at low densities that did not impact on food crop production. The project did not investigate alternative agroforestry systems per se, as landowners in the case study regions were confident in the use of the tree species consistent with their other farming activities. The project also investigated the possible use of higher value, slower growing species such as *Instia bijuga*, in conjunction with some landowners who were already adopting it.

As noted in #2 below, tree species that reach harvestable age on a range of time scales are compatible with the range of time horizons that underpin landowners' adoption decisions. The results obtained for specific species are, therefore, generalizable to other species and farming systems that respect the principles for adoption of tree growing established by project research.

The more general conclusion that can be drawn in relation to this objective is that, under the circumstances that typified the case study regions, which were of relatively low population density compared to land availability, accessing land for landowner-scale tree growing within the context of farming systems is not a limiting factor. Labour availability in the case study communities was sufficient for tree growing. Thus, the tree production system is determined by a conjunction of each of land availability and food production systems, species-site suitability, the availability of planting material, household needs for tree products, infrastructure and markets for trees, and access to knowledge and information about markets and tree growing.

2. Assess landowner decision-making in the context of candidate tree species and production systems
It was possible to conceptualise the decision-making environment for PNG landowners in terms informed by three theoretical frameworks: Hierarchical Needs, Sustainable Livelihoods, and Farmer-Adoption-Decision. These were integrated into a conceptual model, the "PNG Landowner Decision Environment". This model identified landowners' livelihood assets, their knowledge and skills, their motives and the outcomes they sought, in the context of formal and informal systems and processes, as the basis for landowner decisions.

Decisions on how land, labour and financial resources are used determined household prosperity and stability. Landowners' land-use decisions focused on integrating the subsistence and the cash economies. Land-use decisions about production focused on household's food needs, met largely but not always exclusively from the subsistence economy; and the household's clothing, education, health, transport and communication needs, which required participation in the cash economy. Landowners' social obligations and other aspirations were also important decision factors. While survival, self-sufficiency, risk minimisation and maximisation of the household income stream were the immediate foci of landowners' decisions, their longer-term goals centred on prosperity and on enhancing household stability and social values.

Labour availability was a major constraint in terms of the production and adoption decisions of landowners. Landowners have planned their production activities over different time horizons to take account of these constraints. Food and immediate cash needs, such as children's education, take priority. Accordingly, appropriate activities are planned and land, labour and financial resources allocated towards these activities on an annual basis. Other needs, including cash income for non-food consumption, security and some social obligations, are the next highest priority rating, with activities planned and executed over a two to three year period. Other social obligations and intergenerational considerations are planned and executed over period of three or more years. Despite substantial cultural and regional differences, landowners' decision processes and planning horizons were largely consistent across regions.

One of the attractions of commercial tree growing for landowners is that its labour demands are relatively low, and can be integrated with the pattern of labour use needed for food production and other livelihood activities. The appeal of commercial tree growing, in particular for high-value species such as teak, is further enhanced by the high returns to labour expected from tree growing. These compare favourably to returns from cocoa and coffee, both of which are currently considered the most attractive cash crops (Bourke and Harwood 2009).

The conclusions related to this objective are broadly consistent with expectations from research with smallholder farmers elsewhere, but offer new insights and a deeper understanding of PNG landowner decision making relevant to tree growing than previously reported.

3. Develop business models and strategies to facilitate adoption, in conjunction with investment and implementation partners

Project work directed at this objective drew from the two preceding activities, and identified likely returns and potential business models in the context of project findings relevant to objectives #1 & 2. A central principle that emerged from these findings relevant to business models and strategies was that landowners would adopt tree growing only to the extent that it did not impinge upon, and was complementary to, labour, land and financial requirements to satisfy households' subsistence and cash needs. Our analyses also demonstrated that financial returns from tree growing were attractive provided growers had access to markets – which may vary from local roadside markets to international markets for round, sawn or chipped wood.

These result reflected and confirmed the premise inherent in the conception and design of the project, viz. that the best prospects for adding value to PNG farming systems through commercial tree growing is by developing and implementing production systems, enabled by business models and strategies, that foster the integration of desired tree crops into landowners' decision and land use systems, and respect their hierarchy of needs. Our research confirmed that limited knowledge of candidate tree species, their management for high-value products, and of markets; and poor access to suitable germplasm and/ or propagation technologies, were major constraints to adoption. Thus, business models and strategies, whatever their particular form, will need to address these constraints to be

successful. Project work noted the lessons that might be draw from other sectors, notably coffee and oil palm, in this regard.

4. Implement strategies in the pilot regions in conjunction with landowners and investment and implementation partners

During the implementation of the project, it became apparent that the best focus for pilot implementation strategies was in the Upper Markham/ Ramu Valley region of Morobe and Madang Provinces, largely because their geographic proximity to and established relationships with project partners. Ramu Agri Industries played the critical role of a co-investment partner, building on its pre-project activities; UniTech staff provided complementary, knowledge-focused, inputs. Implementation activities in Western Province, facilitated by OTDF, were on a smaller scale.

Implementation activities demonstrated each of the value of the insights gained from research in support of objectives #1-3 and 5, the receptivity of landowners in the terms expected from that research, and the importance of committed implementation and supporting partners. Some 70,000 seedlings and propagules were distributed to communities during the life of the project, c. 80% in the Upper Markham/ Ramu Valley region.

5. Communicate project knowledge and learning to interested parties outside pilot regions

The project communication strategy guided these activities, which were diverse and proactive. This experience offers learnings for future work. As the project scoping study and communications strategy noted, PNG landowners are generally eager to learn and innovate in their production and livelihood systems, but are constrained in doing so by the severe contraction and limitations of public sector extension services. Use of new media and technologies, such as those the project developed, can be an effective complement to 'traditional' extension approaches. However, the project also found the latter to be necessary to assist landowners develop nursery and tree management skills for 'new' commercially-valuable species.

The "PNG Tree Growers Tool Kit" developed by the project serves as a repository for project-generated and related knowledge, most of it in Pidgin, and is freely available on the internet[5] or through direct provision of material to inquirers. The website received nearly 600 unique visitors up to 31 December 2013. A copy of the first of the Tool-Kit publications, *10 STEP VILES NESERI TEKNIK: Kamarere na Akasia*, was distributed both to landowners in the Markham/ Ramu pilot site and to all (c. 400) PNG Forest Authority forest officers in the field.

The second major focus of communication of project results to parties outside the project region was through presentations at project meetings, and to national and international conferences. This was an effective strategy for stakeholders with more of a research or policy focus. In a related initiative, the 'project roadshow' conducted workshops in a number of major centers at around the time of the final project meeting, and served as a vehicle for direct communication of results to stakeholders in national and provincial government agencies, and to NGOs and industry actors.

[5] http://www.pip.com.pg/resources > tool-kit-for-tree-growers

Summary

The key outcomes of the project were:

1. new knowledge, from household- and community-level research, of PNG landowners' attitudes to tree growing within the context of their livelihood and land use systems;
2. confirmation from this research of PNG landowners' willingness to engage in commercial tree growing, for both cash and subsistence economy benefits, so long as such tree growing is consistent with their values, priorities and constraints;
3. confirmation that access to suitable germplasm, plant production systems, management and market information, and physical access to markets were major constraints to the adoption of commercial tree growing;
4. confirmation that a small suite of tree species – *Acacia mangium*, *Eucalyptus pellita* and *Tectona grandis* –were of immediate commercial value in the pilot regions; modelling of the returns that landowners might expect from them; and the identification of characteristics of other species that would also be compatible with landowners' needs and constraints and in market demand;
5. provision of improved germplasm, of seed collection and propagule production knowledge, and community-level nursery production systems, where these were constraints to adoption;
6. the development of a PNG Tree Growers Tool Kit, available in both printed and online media (www.pip.com.pg/resources > tool-kit-for-tree-growers), as a primary vehicle for ongoing communication of project outputs.

9.2 Recommendations

The research conducted by the project confirmed the initial premise on which the project was based, viz. that PNG landowners are receptive to adding value to their farming systems by incorporating tree growing in ways that are consistent with their food production and cash income generation priorities, their time horizons and aspirations, and the constraints of labour and other assets. It also identified a number of priorities that should be addressed if adoption of tree growing by PNG landowners is to be fostered, for either household use or sale. A number of these were also evident at the time of project development:

1. Market infrastructure: access to markets and to good market information
   The first priority to foster tree growing is for landowners to be, and remain, better informed about markets for tree products they might grow, and to have access to those markets. Markets may range from local roadside markets for products such as fuelwood and poles to major town and export markets for round logs or sawn timber.

   Government agencies, such as PNG Forest Authority and national and provincial extension services; universities; community-based organisations and NGOs; and grower organisations, where they exist, have roles as 'honest broker' sources of information, complementing that which may be available from prospective buyers. "Middlemen" may also have an important role in accessing products and sharing information. Established systems in other sectors, such as cocoa and coffee, offer examples of locally-appropriate and functional processes.

   As elsewhere, including for Australian smallholder tree growers, these depend fundamentally on access to timely and unbiased market information. The project's legacy website has a role in providing such information, but sharing it effectively depends on other mechanisms, for example the use of radio or mobile phone updates, as noted in the project communications strategy.

The transparency of market information, and other information about the value chain for tree products, is also important to foster landowner adoption of tree growing. In our case study research, landowners near Madang withdrew from growing acacia, despite the presence of markets, in response to reduced returns and their perception that they were bearing a disproportionate share of the reduction compared to other actors in the value chain. Similarly, ACIAR FST/2009/016 research with smallholder balsa growers in East New Britain revealed their disinclination to participate in tree growing where they perceived that they were not receiving a fair return for their product.

In summary, the development of market infrastructure sufficient to inform current and prospective tree growers, and to facilitate their access to markets, is fundamental to foster the adoption of tree growing by PNG landowners.

2. Access to genetic resources, planting material, and relevant knowledge

   Landowners are handicapped by lack of access to high quality genetic resources in a number of species with high market value and high potential for growing in many parts of PNG; teak is one example, but this constraint also applies to most species other than a small number of acacia and eucalypts. Notwithstanding their excellent gardening skills, they are also likely to be handicapped by limited knowledge of raising and managing commercially valuable species with which they are unfamiliar (eg teak).

   Public sector agencies such as the PNG Forest Research Institute and PNG Forest Authority, universities, NGOs and development organisations (eg OTDF), and private sector actors each have roles in addressing these constraints - through the acquisition and wider provision of high quality germplasm, extension to communities, and support for nursery development and maintenance. The project's community nursery, established as a partnership between local communities, a private sector partner, and a university is one example of a collaborative endeavour to address these issues.

   It is generally acknowledged that access to agricultural extension services for PNG landowners has been diminishing, other than where the private sector provides these services as part of outgrower schemes or related initiatives. Addressing this constraint is also fundamental to fostering adoption of tree growing by PNG landowners. The project's development of a resource web site with material in Pidgin, complemented by other forms of knowledge sharing, is one element of how this constraint can be addressed.

10 References

10.1 References cited in report

AusAID (2006) *Pacific 2020 Review*. AusAID, Canberra. www.ausaid.gov.au

Australian Government 1997. *Plantations 2020 Vision*; www.plantations2020.com.au

Blaikie, P. and Brookfield, H.C (1987) (eds.) *Land degradation and society*. Methuen.

Bond, A. (2006) *Pacific 2020 Background Paper: Forestry*. AusAID, Canberra. www.ausaid.gov.au/hottopics/pacific2020/papers.cfm

Bourke, R.M (1997) *Management of fallow species composition with tree planting in Papua New Guinea*. Resource Management in Asia Pacific Working Paper No. 5, Australian National University, Canberra.

Bourke, R.M. and Harwood, T. (eds) (2009). *Food and Agriculture in Papua New Guinea*. ANU E Press, The Australian National University, Canberra.

Chambers, R. and Conway, G.R (1992) *Sustainable rural livelihoods: practical concepts for the 21st century*. IDS discussion Paper No. 296. IDS Brighton.

CSIRO *et al.* 2001 *The contribution of mid- to low-rainfall forestry and agroforestry to contribute to greenhouse and natural resource management outcomes.* AGO/MDBC. 72 pp.. Dept. of Agriculture, Fisheries and Forestry.

Donaldson, M., and Good, K. 1981. The Eastern Highlands: Coffee and Class. In: Denoon, D and Snowden, C. (eds.). *A History of Agriculture in Papua New Guinea a time to plant and a time to uproot*. Institute of Papua New Guinea Studies, Port Moresby.

Field, J, B Turner and J Banks. 2001. *Assessing the extent, ecological condition, wood values and other tangible and intangible forest values of privately owned dry sclerophyll forests.* Project document. RIRDC Project AFT101-61. RIRDC, Canberra.

Fulton,A and D. Race 2000. Farm forestry in Australia. Chapter 20 in: JL Herbohn, SR Harrison, KF Herbohn & DB Smorfit (eds). *Developing policies to encourage small-scale forestry*. Proc.Meeting IUFRO Working Group 3.08, Kuranda, Queensland, 9-13 January 2000. 100-108.

Filer, C., and Sekran, N., (1998) *Loggers, donors and resource owners*. Policy that works for forest and people series, No.2 (Papua New Guinea Country Study). IIED, London.

Kanowski, P, H. Holzknecht and A. McGregor. 2006 *Value-adding to Papua New Guinea agroforestry systems through the incorporation of high-value tree species*. Final Report, ACIAR Project C/2004/086. Canberra: ACIAR.

Kennedy, J. and Clarke, W. 2004. *Cultivated Landscapes of the Southwest Pacific*. Resource Management in Asia-Pacific Working Paper No. 50. Research School of Pacific and Asian Studies, The Australian National University, Canberra. http://rspas.anu.edu.au/papers/rmap/Wpapers/rmap_wp50.pdf

Maslow. A.H. (1954) *Motivation and personality*. Harper and Brother, New York.

Maxwell, J.A. (1996) *Qualitative research design: an interactive approach*. Sage Publications, Thousand Oaks, California.

Midgley S., Blyth M., Howcroft N., Midgley D. and Brown A. (2010) *Balsa: biology, production and economics in Papua New Guinea*. ACIAR Technical Report No. 73. ACIAR, Canberra. www.aciar.gov.au

Morauta, L. 1983. The social, cultural and local political context. In: *Profile and Planning Study for subsistence food production* .Volume 2: Appendixes, UNDP project: PNG 82/002, Port Moresby.

Nawir, A. and Santoso, L. 2005. Mutually beneficial company-community partnerships in plantation development: emerging lessons from Indonesia. *International Forestry Review* 7:177-192

Pannell, D.J., Marshall, R., Barr, N., Cutis, A., Vanclay, F. and Wilkinson, R. (2006) Understanding and promoting adoption of conservation practices by rural landholders. *Australian J Experimental Agriculture* **46**: 1407-1424.

Reid, R and Steven, P. 2001.*The farmer's forest*. RIRDC, Canberra. R/01-33

Schirmer, J, PJ Kanowski and D Race. 2000. Factors affecting adoption of plantation forestry on farms: implications for farm forestry development in Australia. *Australian Forestry* **63**: 44-51.

Roger, E.M. (1995) *Diffusion of innovations*. Free Press, New York.

10.2 List of publications produced by project

Blyth, M. 2007. Financing options for small-scale farm forestry plantation establishment and management. ACIAR FST/2004/050 Working Paper. 15 p.

Dipsen, G. 2010. *The potential for carbon sequestration in grassland areas in Ramu/Markham valley in Papua New Guinea*. Master of Forestry major essay, Fenner School of Environment & Society, The Australian National University, Canberra.

Jenkin, B and Blyth, M. 2014. *Choosing production systems and business structures to enhance livelihoods of smallholder commercial tree growers in Papua New Guinea*. ACIAR FST/2004/050 Working Paper.

Jenkin, B, Blyth, M, Kanowski, P and Yakuma, D. 2009. An integrated approach to species regime selection in PNG: beginning with local people's needs. Paper presented at: *The Institute of Foresters of Australia 2009 Conference*, 6 – 10 September 2009, Caloundra, Qld. 19 p.

Jenkin, B, Blyth, M, Famiok, S, Mulung, K, Sam, N and Yakuma, D. 2011. Tree planting as an informed activity: the role of extension services based on experiences in Australia, Papua New Guinea and India. In Simpson, A (Ed). *Proceedings*, *Joint Conference of the New Zealand Institute of Forestry and Australian Institute of Foresters,* Auckland, NZ, 2-5 May 2011. 218-227.

Kanowski, P, Holzknecht, H, Mulung, K, Blyth, M, Jenkin, B and McGregor, A. 2008. Fostering commercial tree growing by small-scale landowners in Papua New Guinea from a base in traditional agroforestry systems. In: Buttoud, G. (Ed.): *Small-scale rural forest use and management: global policies versus local knowledge*. Proc. International Symposium, IUFRO Working Groups 3.08 & 6.12, Gerardmer, France, 23 – 27 June 2008. ENGREF, Nancy. 9 p.

Mulung, K. 2012. *Wok diwai ken lukautim yumi, o nogat*? *Papua New Guinea landowners' decision processes relevant to commercial tree growing.* PhD thesis, Fenner School of Environment & Society, The Australian National University, Canberra.

Mulung, K and Holzknecht, H. 2011. *Wok neseri: pasin bilong planim na lukautim pikinini diwai*. Booklet, ACIAR FST/2004/050. www.pip.com.pg/resources/tool-kit-for-tree-growers/growing-the-best-trees/52-production-fact-sheets.html

Mulung, K, Kanowski, P & Holzknecht, H. 2011. *Landowners' decision-making and small-scale commercial forestry in Papua New Guinea.* Paper presented at *IUFRO Small-Scale Forestry Conference*, Freiburg, Germany, 24-28 July 2011. 7 p.

Pacific Islands Projects. 2011 and subsequently. *PNG Tree Growers Toolkit*. . *http://www.pip.com.pg/resources* > *tool-kit-for-tree-growers:*

- *10 STEP VILES NESERI TEKNIK: Kamarere na Akasia*.
- *Making money from trees: Costs and returns calculator.* Workbook
- *Rot bilong skelim diwai: Tok yu mas save - wanem diwai em gutpela*? *Teak (Tectona grandis).*
- *Rot bilong skelim diwai: Tok yu mas save - wanem diwai em gutpela? Kamarere (Eucalyptus deglupta)*.
- *Rot bilong skelim diwai: Sekim pastaim - wanem diwai imoa gutpela?*
- *Rot bilong lukautim diwai: Tok yu mas save - wanem rot em gutpela? Wok agroforestri wantaim pellita.*
- *Rot bilong salim diwai: Sekim pastaim - yu redi long statim diwai bisnis?*

11 Appendixes

11.1 Appendix 1: Understanding how Papua New Guinean farmers make land-use decisions – key to informing decisions for options in commercial tree growing

Paper presented at 2009 project meeting,
Divine Word University, Madang, 22-24 July 2009.

Kulala Mulung

1. Introduction

In spite of the well established traditional knowledge base in agro-forestry practices (Kennedy and Clarke, 1989), harnessing this into opportunities for commercial tree growing had however, lagged over the years in Papua New Guinea. This is attributed in part as a result of lacking to understand the inner perspective of causal relationship between farmers' land-use decision, farmer-behaviour and farmer-motive and, in another is the lacking of appropriate policy initiatives by the government in supporting such opportunities. It is known fact that different farmers have different priorities, different understanding, different values, different problems and different ways of working. These aspects influence farmers' choices and styles of farming. Vanclay (2004) notes that concept of styles of farming practices is heuristic that allows for an understanding of the range of world views about how to farm. Appreciating the existence of these views are important. The scoping study on PNG Agroforestry system, ACIAR FST 2004/ 050 Project identified this as one of the primary research need that required further investigation (Kanowski e*t al.,* 2006). As a follow on from that study, this research investigation seeks a more sensitive understanding of how famers in Papua New Guinea assign meaning to various farming activities and how their land-use decisions follow from this. The study proposed the premise that the relationship between farmer-decisions, farmer-behaviour and farmer-motive must be fully appreciated, analysed, learnt, understood, adopted and applied in making forestry investment decisions, should meaningful adoption and participation by farmer's are to be achieved.

To test this premise, a study examining the farmer attitude, behaviour and the choices they make to tree growing as part of the farming system, was carried between 2007 and beginning of 2009. The study paid particular attention to establishing connection between antecedent behaviour and the desired outcomes of the farmers with respect to their existing production practices. This involved examining behavioural actions of the farmer engagement/or commitment to various practices such as gardening, food-getting strategies, traditional agroforestry practices, cash cropping, social organisations, sources and types of food produced, consumed and exchanged, how were time and labour distributed and managed between each activities to achieve the various outcome. Different level of right to property including land and other resources was also investigated. To inform these understanding the study probed these overarching questions; on what basis do farmers make their land-use decision? What type of decisions are made and by whom? When and where do these activities occur? The study strategy included examining in detail the farmer motives, adoptions strategies, intentions, experiences, values system, goals in life, role of trees in the farming system and other

livelihood issues farmers' sought when making land-use decision. Field data collection involved combination of methodologies including semi structured interviews, focus group meetings, field days, analysis of published literature, speech recordings and photographs. Data collected from multiple sources enabled cross-validation and triangulation of the data. These sets of data were brought together to construct a picture the different land-use choices farmers make in light of the changing socio-economic and cultural situations they faced with. Three case study sites; Yeteni in Westren Province, Trans Gogol, North Coast and Upper Ramu valley areas in the Madang Province were selected as focal point for data collection, and from this, detailed analysis of farmers land use decision and the processes within the context of village production system, livelihood system and other dominant political, economic, cultural, and social system that are functioning and operating, were evaluated.

Diversity in farmer decisions

The study revealed that farmers' intuitively define strategic goals and work consistently towards achieving them. These goals can be categorised as short term and long term. Their land-use and cropping adoption decision depended on a wide variety of goals. These goals varied considerably between individual farmers, depending on their circumstances and personal preferences. This diversity is a characteristic feature quite common among farmers in different farming societies elsewhere as well, not just in PNG. For example see (Pannell *et al,* 2006; Ridley, 2004; Mercer 2004; Busck, 2002; Vanclay, 2004). Vanclay (2004) in studying to understanding social issues, social nature of farming and social basis for adoption to agricultural practices, notes the farmer diversity as an important factor that must be fully appreciated in the delivery of extension services. He calls this principle number 2 in the social principles of agriculture extension services.

Immediate/short term to long-term

This study results revealed that although farmer's land-use decisions were very localised and varied considerably amongst the farmers, they share some important common characteristics though. For example, if the decision outcomes are defined by time horizon, farmers' land-use decision could be categorised into immediate and long term goal. The immediate or short term goals are ones that involve decision-duration which spanned up to a year. These decisions represents annually re-occurring needs such as school fees issues, food security issues, buying of trade store items such as new clothing, food items, kerosene (energy), soap, salt, transportation, and means to having good health services and other livelihood issues that were affecting farmers' life on a daily basis. The short term-goals were found to be common and were wide spread across all the case study sites.

On the hand the long term goals, for which decision duration spanned two years or beyond varied considerably between different age grouping and also between different case study sites. For example, in the Western Province preparing of bride price and building a permanent house before getting married was found to be a common goal among circles of young man. While at the family level, security issues related with; food, steady income, education for children, having permanent housing, were found to be common. In Madang, particularly along North Coast area where demand for available land is acute, maximisation of return on investment of labour, land and time was more critical consideration for the farmers. Farmers in the case study region appear to be always alert and on the look out for innovative interventions and opportunities that will facilitate achieving these ends. For example I asked one young man why he had to chop down aged coconut trees in order to grow *Acacia* trees for to supply export wood chip production. His reply was,

> "..*mipela save mekim bikpela hatwork long katim grass, bungim kokonas, katim, draim kopra, tasol moni mipela kisim taim mipela salim kopra ino nap wantaim hatwok mipela mekim".*

The copra production involves lot of labour for tending, harvesting, and processing but the return we get for selling copra does not equate with the amount of labour and time spent in the production. In Ramu region and parts of Trans Gogol area, building permanent residential house or re-investment to other business opportunities were the main long–term goals pursued by the farmers. The Other issues, that did not fall under long-term or short-term goals but arose in between and for which land-use decision required was the need for ceremonial activities. Feasting and other culturally obligated duties kept appearing as one of the land-use-activity decision in each of the case study sites. For these, the land use decision including its preparations may span up to 3 years duration, depending on the size and significance of the feast. This is one-of-event that once it is done and achieved, is forgotten until new need arises and then the same process would repeat again. The study shows that these issues have a critical influence in farmers' judgment, perceptions and ultimately the land-use decision that they make.

These findings run parallel with the conclusions observed in other studies conducted elsewhere. For example see (Pannell *et al,* 2006; Ridley, 2004; Mercer 2004; Busck, 2002). Examples specific to small scale tree growing for both utilitarian or conservation values included reports of work by (Byron date?; Shirmer *et.al* 1999; Djamhuri *et al* 2008) covering studies in Australia and neighbouring regions while Kennedy and Clarke (1989) report on tree planting as livelihood adaptation strategies in the Southwest Pacific including Papua New Guinea. Moulik (1973) concluded major cause for the failure in the introduction and adoption of cash cropping activities in PNG (Madang, Morobe, Chimbu and Milne Bay Provinces) in the early 1970's was as result of mismatch between farmer values, feelings, thoughts, aspiration, needs and the agriculture development initiatives driven by the state.

Sources of factors influencing farmers' decisions

The factors influencing farmer-decision were driven from two sources; the first one being the externally driven factors and were arising as result of system processes such as economic, social, cultural and environmental and the second source of factors arose internally within the farmer and this were driven as a result of farmer-motive, intention, beliefs, experiences and the goals they pursue in life. For example in Madang the commercial tree growing activities are actively pursued by the farmers and this is driven as a result of export wood chip market. Farmer are actively pursuing commercial tree farming activities because of the external market forces motivating and driving farmers to engage in tree growing activities. Similarly with farmer in Ramu area, the sugar market was a driving factor driving factor in the farmers land use decisions. The other common externally driven factor influencing farmer decision is the sense of insecurity to the farmer. This was a major demoralising factor for many farmers. This was openly expressed among the farmer in the Ramu region, particularly with land ownership disputes between the farmers and other rival tribal grouping competing for land ownership over the land where sugar cane is produced. Similarly with tree growers and land leasers in the Gogol and Naru areas, where the price offered for their farmed trees are much lower than their expected price, they lost interest in continuing with tree growing activities. The farmer-internal factors included personal goals, motives and aspiration of individual farmers. In Madang (North Coast area), one young man was asked on one to one basis about why he took up the decision to commercially grow *Acacia* trees on his land. He immediate reaction was, "I want to be recognized as some one being Boss" He implied about status, authority and recognition that he anticipated to be accorded him by his community as a result of his decision and that will yield the expected likelihood of improved circumstances for his people. He replied that with the money that

he would bring in to his community as a result of growing trees, make him special and looked upon as a leader by his community.

1.2 Why this study?

There are number of reason why this study is important. Firstly, in Papua New Guinea more than 97 percent of the land resources is owned and maintained under customary tenure and kinship arrangements. Which means land available for large scale forestry program similar to Palm oil development schemes is very limited. Even governments successive attempts to mobilise customary land from traditional owners for the purposes of development proved very difficult. Gosarevski *et al.,* (2004), Ward (1981), Quin (1981) regard customary ownership as the primary cause for the limitations to investment and increase in productivity, because of the perceived reluctance by the investors in recognising unregistered customary land as collateral security against financial loans for development purposes. An alternate pathway advocated here is to congregate critical mass of many small holder farmers to produce the required quantity needed in the scale of economy. This view is further supported (Bond 2006, Kanowski e*t al.,* 2006) as a pathway to address the concerns for unsustainable forest management and utilisation situation currently practiced in Papua New Guinea. Leading on from this argument, the very first step in congregating the required critical mass is to gain insight understanding of factors and processes driving and influencing farmer decision, influencing farmer-behaviour and farmer-motive. Based on these understanding, projects can be tailored-design to meet the specific needs and other pursuits farmers follow. This should inspire and cause greater level of participation by the farmers since farmer interest is at the core of the decision consideration. The underlying assumption with this approach is that with a developed understanding of farmers' needs, intentions, feelings and motives, development initiatives such as agroforestry projects are planned with deliberate intentions to suit farmer needs. This should offer greater prospects for farmers' involvement as these activities are within their interest. In this way the opportunity for farmer participation is greatly enhanced as farmer interest are key issues in decision consideration. Access to customary land can be achieved, via land owners whilst at same time increasing productivity and contributing to sustainable management practices of natural resources. Secondly, it is hoped that informed understanding inner perspective of farmer motive and behaviour should lead relevant government agencies to develop appropriate policy initiatives that will encourage farmers to actively use their land to increase production and productivity. Furthermore, such study as this one contributes and adds to the gap in the information base, in which case for PNG is greatly lacking, to the scientific community and policy makers.

1.3 Connection between farmer decision, farmer behaviour and Farmer-motive

Farmer's decision to adopt a new farming system, cash cropping or any other livelihood activity-decision is normally associated with goal-orient outcomes. The expectant result is a fully comprehended future outcome and culminates from a thinking process. A process in which farmers consciously use available information, experiences, feelings and observations from past events to make a judgement for the future outcome and based on this a decision option for different land-use is taken. Following on from the opted decision, the intent of the decision-maker leads that person to direct and conduct his actions and activities (time, energy, resources) in a certain way in order to achieve the desired result. This human phenomenon is explained by the theory of planned behaviour (Ajzen 1991). The theory makes two assumptions; first is human beings are rational beings and make systematic use of information available to them and, second is human beings consider the implications of their action before they decide to engage or not engage in certain behaviours (Ajzen 1991). Pannell *et al* (2006) observed that farmers'

purposiveness of a given goal is often revealed through the way he organises his thought and conduct his actions (behaviour) towards a particular outcome that is pursued. In other words, a farmer's particular decision taken to use his land for the desired outcome is a result of a conscious process. The conceived outcome is a "visionary product" that is well comprehended with specific details of what the final form, shape and size will be. Following on from the opted decision, the farmers' behavioural actions and commitment of resources (time, energy and space) is influenced, shaped, guided and directed towards the envisaged future product. The antecedent action (behaviour) of the farmer transmits and expresses that visionary-product. Over time, famers' decision of the imagined product is conceived into a reality.

Based on this assumption, it is hypothesised here that by asking series of carefully worded and objectively-designed semi-structured questions, combined together with detailed and discrete observation of Papua New Guinean farmer's daily farming activities and lifestyle, farm and village landscape, cropping systems cultivated, trading and cultural system that are functioning and operating within the given environmental context, one could with inductive analyses unravel the connectedness between farmers' patterns of behavioural action and his motivational factors. The research investigation in this study examines this hypothesis further to objectively gain an in-depth understanding about what factors or multiplicity of factors that cause, arise, inspire and motivate Papua New Guinean land owner/ farmers land use decisions.

1.4 Decision-making as a concept

The concept of "decision-making" is broadly defined as a process whereby alternate courses of actions are evaluated and a decision taken (Johnson et. al. 1994). From Human geography perspective, the concept asserts that individual evaluate their environment from their given state of attitudes, beliefs, perceptions and preferences: they formulate their goal and then choose to act to realise as they can given the unique opportunities in their environment (Ruston, 1977). This view assumes the role of cognitive and decision-making as mediating the relationship between the environment and spatial behaviour. The concept of decision-making is now broadened to become more realistic with respect to human practice at present. For instance, the concept of satisficing behaviour offers an alternative to the unrealistic optimisation capacity advanced by conventional economic formulation (rational choice theory).

Contemporary research involving qualitative methods seek a more sensitive understanding of how people assign meaning to various aspects of their life and how decisions follow from this (Johnston et.al., 1994). This perspective assumes that a decision arrive at is a result of conscious process that took place in the mind of the decision-maker, and such thoughts can be best explained in terms of their role in behaviour regulations and motives of the person making the decision. In other words the antecedent behaviour (actions) of the decision-maker connects the desired outcome with the premeditated motive (thought) of the decision. For the purpose of this report I will use the concept "decision-making" to refer to the concept just explained.

2.0 Field Study Sites – Context description

This section attempts to provide the relevant background context of each of the case study region in order that the over all picture of social, cultural, political and economic situation is reconstructed. Understanding of the general pictures should assist in appreciating the context of farmers' operating environment. This should relate to explain how the broader dominant factors within the operating environment are influencing farmer choices and land use decisions of the farmer. The map provided in figure 1 below identifies the site locations where the field case studies were carried out. The field study sites were located at;

- Western Province: The communities included in the study were; Yeteni and Yuluwas Clans in Moain number two village, Obo and Kasa villages in the Middle Fly Region
- Upper Ramu Valley in Madang province; The included in this study were four Mari communities; Bumbu, Bopirumpun, Sankiang and Musuamp villages. Part of this study extended into the part of Upper Markahm valley in adjacent Morobe Province to include tree farmers at Wankung community. Inclusion of this community in study resulted from the strong community interest in the subsistence tree growing activities. Its inclusion in the study aims to ascertain what factors are driving the community interest in tree growing as this will be compared against the other regions originally selected in the research design.
- Madang Province: The study focussed in three primary commercial tree growing regions. They include; the farmers in Gogol, Naru and parts of North Coast region of the province.

Figure 1 Map of Papua New Guinea showing study sites

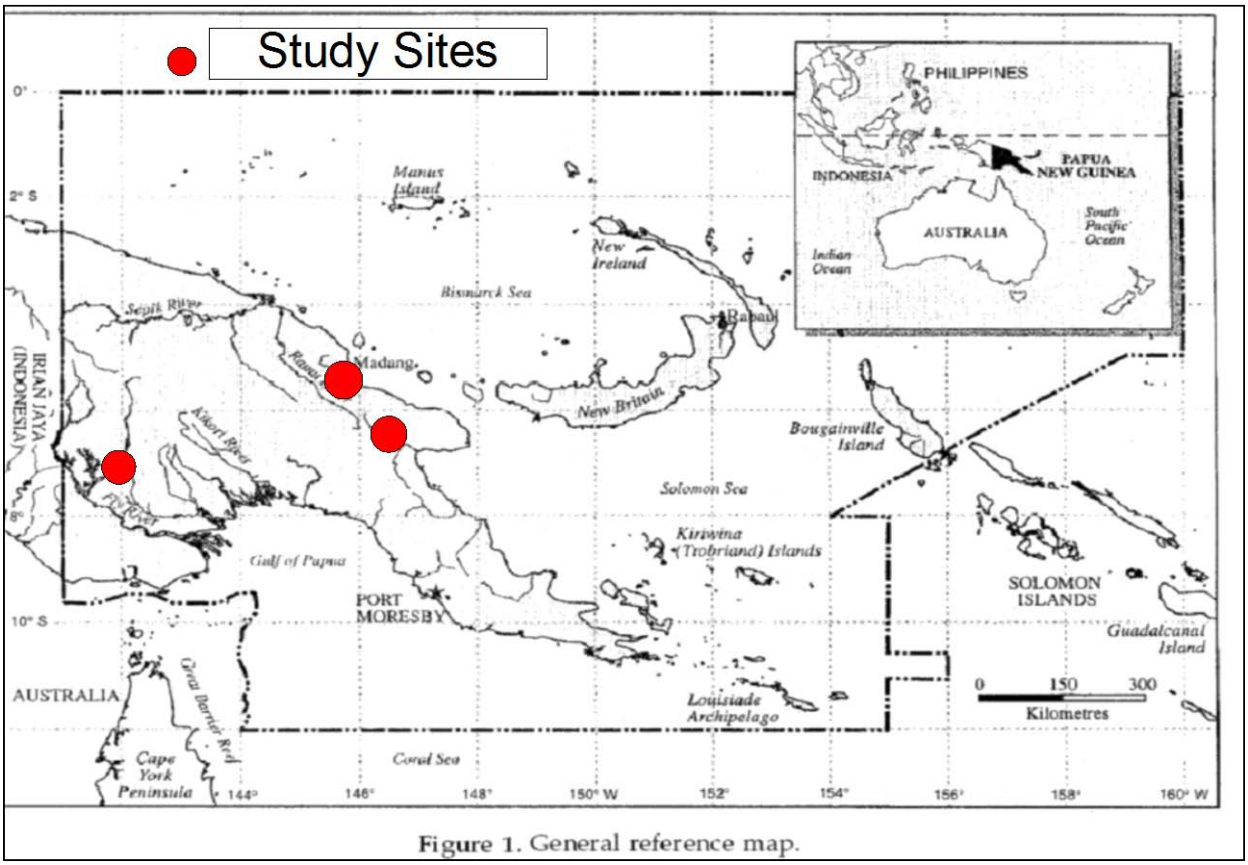


Figure 1. General reference map.

2.1. Yeteni/Koimova – Western Province

2.1.1 Food production system

Allen *et al.* (2002) in a study on Agricultural systems in PNG - working paper number 4, provide a province-wide coverage of agricultural system in practice. The study described 16 different types of agriculture system, all of which were different form of swedden/shifting cultivation system. Sago starch production and consumption was common in almost all the systems. Probable exceptions to this are areas north of Tabubil including Olsobip and Telefomin. Although shifting

cultivation (or swedden) production systems are main forms of practice, the method of cultivation, crop configuration, crop segregation, fallow type and period varied considerably between each of the systems described. The variability is explained by number of factors including; condition of the physical environmental, cultural practices and introduction and adoption of new crops and cultivation techniques. The staple food cultivated in most of the system included banana, taro (Chinese and Colocasis), sweet potato, cassava, coconut, yams (*D. esculanta* and *D.alata*) , sugar cane and creepers such as cucumbers and pumpkin. Stuart (1991) in a doctoral study thesis observes that wild forest products contribute significantly to the Yonggom diet. Plants and tree food include seasonal fruits and berries, nuts, palm hearts, and flower buds. Sago starch is a staple food throughout the province and is obtained from planted or wild sources. Co-existing and complementary with sweden or shifting cultivation systems, some of the tribal people also devote equal amount of time to foraging and hunting activities as part of their food production strategy (Stuart 1991; Otsuka 1983). In these activities, men attend to hunting activities while women attend to pounding and production of sago starch.

The food production strategies described above are slowly changing as observed in the case of Moian village. The story about OK Tedi mine closure is awakening and signalling minds of the people with lot of challenging questions about their survival and future livelihood. The issue of mine closure surfaced in almost all interviews and discussion held with farmers living downstream of Fly River system and other tributaries. The concern expressed ranged widely from mine related dieback problems leading to decline in food (sago/ fish) productions, its sources and availability, changing habits in food and dietary composition. People are now having to travel longer distances to get their food (sago and fish) supply and in many instances are claiming that yield of starch contents per trunk of harvested sago palms are declining. These set of issues are tipping people to react and behave differently from their usual or traditional way of getting food and cash income. For instance, the tendency to make bigger gardens with increased combinations of food cropping (including introduced food crops). Although in many instances of the gardens observed, the cleared land intended for cultivation is not completely planted, as is the case in other parts of the country where shifting cultivation is the main from of production.

2.1.2 Issue of Land owner/user and its implication for agriculture

From the interviews with different people including Sir Warren Dutton (pers com.) and some of the Yonggom men at Moian village, an underlying issues with agriculture production is the conflict between land-user and landowner. Under Administrative direction people living in remote settlement were moved from their traditional land and relocated in the settlements along the main access system where they could be conveniently reached, organised and serviced by administration with health care, education and other services. However, there is increasing tension between re-settlers and principle settler's over the resource rights and use issues including the agriculture land. Furthermore, while they are often permitted to build a house and grow food crops for subsistence purposes, land users are often prohibited from utilising other natural products (such as sago or bamboo) or planting perennial crops such as rubber. Thus, many people do not have access to the natural resources which surround them. The issue is not confined to Moian area only, but have been reported be common elsewhere in the province too. Part Four of the Social and Economic Report prepared for OK Tedi Mining Limited by Project Design and Management Limited (2006) also notes that access to agricultural land in the North Fly, is however, inequitable. Part of the statement is quoted from this report exemplifies this issue

> *"The local population includes landowners and land-users, with the land-users thought to outnumber the landowners. The landowners have permitted the land-users to grow food crops, and in some cases grow perennial crops. Land-users are also a source of labour to landowners. As population pressure increases, land-users may be further restricted in what they can grow, or may have to enter into production-sharing arrangements that are common between landlords and tenants in much of South East Asia. The landowner/land-user issue is common to both the North and Middle Fly, including the Lake Murray area, and will"*

2.1.3 Traditional agroforestry Systems and its potential for development

Integration of annual and perennial crops together for variety of end uses tailored to the environmental conditions is a feature common in many of the productions systems throughout different societies in Papua New Guinea. Applying definitions and description of the Agroforestry systems by Clarke and Thaman (1993) and comparing this to the description of food production systems in Western province by Allen *at al.* (2002), these are in fact one and the same thing - agroforestry system. One was reported from food perspective while other was reported from wood and forest product perspective. From these consideration it can be said that Western province have number of tradition agroforestry system in practice. The question to ask and, paraphrasing question posed by Clarke and Thaman (1993) in a study on agroforestry systems in the Pacific "How can the Agroforestry system in Western province be encouraged so that the many advantages of tree-rich agro-ecosystem are more widely realised?" This is the same question ACIAR FST 2004/050 is seeking to find explanations for. For the purpose of these report and in an attempt to answer first part of the question "on the agroforestry system", I and will confine the discussion to the description of practices at Yeteni, Aiambak, Suki and Nomad areas. Stuart (1991) observed that Yonggom people planted Pandanas (marita), breadfruit, and Terminalia trees close to garden sites, where they benefit from exposure to sunlight, although these trees may not bear fruit until after the gardens have been abandoned. In my field studies, I also observed that fruit and nut trees including coconut, breadfruit, pandanas and Okari nuts were widely planted beside houses and along trails through the rainforest. Three of the 10 men interviewed at least planted a sago sucker for each of their children while three others had planted at least one each. Bread fruit *Artocarpus* and *Terminalia* sp Okari were found to be growing in the backyards and old garden sites and were said to be have bee planted. Planting of Betel (*Areca sp) tree* which wasn't part of their cultural practice are now becoming common practice and widely planted in the backyard and the surrounding landscapes for sales at local market. Black palm are left standing in the process of garden clearing or young ones are tended and exposed to sunlight to encourage growth. Apart from planting annual food crops such as sweet potato, banana, vegetables and other tuber crops, Yonngom and Awin people are also planting perennial tree crop such as the ones mention earlier in the paragraph. Photographs of some of these practices are shown.

2.1.4 Ok Tedi Mining Limited and its strategies in supporting mine affected communities

Ok Tedi Mining Limited (OTML) commenced production in 1984. Since this period the company has been heavily involved in supporting the process of community and regional development in the mine impacted communities. Strategies promoting the processes for the regional development are bullet-point as follow:

- The promotion of non-mining sources of income remains a high priority;
- Improvements to housing, water supply and sanitation – and health services – are required if health standards are to substantially improve;
- Improvements in education are important and require an increase in school attendance and better education services;
- Transportation and other basic infrastructure must be improved to support social and economic development;
- Food security is an important consideration and development priority for impacted communities;
- Personal Viability Training (PVT) is likely to be an important development tool to motivate and empower people and communities to improve social and economic outcomes.

These efforts have direct influence over farmers in the way they participate in the programs. These also have considerable influence on the way they make land use decisions are made.

2.2. Trans Gogol/Naru and North Coast Area

This section provides a brief background to the case study region. It presents a brief description of forestry activities over 30 year period as these account of events, had greatly impacted, influenced shaped farmers' current land use choices and farming strategy adoption decision. It aims to reconstruct the various stages in the progression of forestry development and other livelihood system the Gogol and Naru Valley.

2.2.1 Jant's Operations and its influence on the livelihood system of the people.

Jant is the acronym for Japan and New Guinea Timber. Its Operations in the Gogol and Naru valleys began prior to 1975 and involved extensive clear felling and logging of primary tropical rain forest to supply the export wood chip market. The operation from field (logging, transportation, processing) were highly mechanised and required lot labour input. The local inhabitants were recruited to provide much needed labour requirement of the company. Valley was made accessible for the local inhabitants to bring their produce out to urban market in the local Madang Town and other government services moving into the area. The local inhabitants in the Gogol/ Naru timber areas supplied most of the unskilled and semi-skilled labour requirement for company's field activities. These ranged from forest nursery to plantation establishment, maintenance, harvesting and transportation. Salaried income from employment services provided the economic and social livelihood of the people. This also led to development of employment culture which had negative implication on the people to cash cropping and other production activities.

Among other development, Gogol Reforestation Company was formed to take reforest the logged over areas. About 12,000 ha of forest plantation was established on the leased customary land with various species including, *Eucalyptus deglupta, Acacia mangium, Gmelina arborea*, and various other local indigenous species. Since exhausting natural timber resources from the concession, Jant is entirely dependent on planted forest. Most of these lease land are nearing their expiry dates (July 2009), and nearly 50 percent of the harvested leased land is returned to the customary owners. Implication of this is uncertainty and question of sustainability for the company, people and industry as a whole in the future.

New Management took over the company in 2004. New initiatives were introduced to circumvent the looming problem. One of these initiatives was contract tree farming and delegation of plantation maintenance responsibility to the various local group's through contract arrangement. This was partly to reduce company's overhead cost and also remove the burden of working directly with the local. Second initiative was introduction of Manual harvesting system. In this initiative local tree farmers harvest their own farmed trees and sell to the company. Intention is to pass on the value harvesting cost to the farmer. Harvesting cost represents felling, barking, transfer from stump to the landing, loading and transportation to the processing plant in Madang town.

2.2.2 Land use system.

Jant's forest plantations are mostly established on customary land on 30 year, 25 year and 15 year arrangements. Under this arrangement, land owners lease their land to Jant for commercial tree growing. In return land owners expect Jant to pay them K1.00 per hectare annually for the use of land. These system has not yielded any meaning benefit to the land owners and this has caused frustration to the land owners, leading into farmers not willing to lease their land to Jant for commercial tree growing.

2.2.3 Emerging Patterns

Strong interest in tree farming, BUT issues listed below are major cause for poor level of adoption by the farmer in tree growing activities;

- Lack of transparency by company in revealing relevant records of village tree farm harvest to the farmers. Farmers
- Lack of poor dialogue from government forestry officers and land owners on technical advises
- Low rate of return on their farmed trees
- Transparency in awarding of contracts. Jant employees are taking out contracts
- Preference of selling labour services to Jant is declining.
- Poor contract rates on contract payments
- People wish to engage in commercial tree growing, however rate of return compared against labour is very low, thus demoralising.

2.3. Mari Communities – Upper Ramu Valley Madang province

2.4. Wangkung Community – Upper Markham Valley Morobe Province

3. 0.0 Research design

The research design was based on a combination of methodologies involving semi-structured interviews, case studies, focus group meetings, analysis of published literature. The research relied heavily on the in-depth interviews with the farmers and their families. The multi-method approach enabled comprehensive understanding of factors influencing farmer land-use choices in the subsistence and cash cropping production system, adoption strategies, and other resource use decision-making processes. The approach also provided means of cross-checking and validating information across farmers as well as providing leads into important areas of enquiries.

Key research participants in the research included;

1. farmers (men, women,)
2. land owners
3. Private industry Representative (OK Tedi, Ramu Sugar and Jant)
4. Government Forestry officers

3.1 Pilot Study

Between November 2007 and Januray 2008 I carried a pilot study at Ramu Valley in the Madang Province, with the farmers, Ramu agro-Indutsry staff and other government extension officer in the district. The purpose of the pilot study was to firstly test out the draft social survey instrument in the field and, secondly to gain an initial impression of the farmers attitude and behaviours in the land use choices they make. A revised survey instrument used in the field is attached as appendix 1. The social survey questionnaire was tested purposely to assess how the farmers (respondent) would cope with the questions with respect to the following.

- Translation and interpretation. That is to asses how accurately meaning of the questions were interpreted given the cross-language translation barriers (i.e from; English to pidgin to local dialect-than back to pidgin and to English again),
- Duration of interview. To plan for field logistics in the subsequent field work I needed to know how long an interview would take.
- Understanding of questions as intended. To assess whether or not questions were understood as intended, without ambiguity, difficulty often associated with language problem, literacy issues, cultural issues

- Any other ethical issues. To assess if there was oversight in any of the ethical issues not adequately addressed prior to commencement of my work.
- To build up the necessary confidence and rapport with the farmers in the course of field work.

3.2. Field work

Field data collection work was carried in two stages. The first stage took place in Western province. From late July to mid August 2008, I spent one week at Moian and Yuluwas village communities in the Upper Fly River Region, 1 week at Hobo and Kasa in the Middle Fly Region and 1 week at Kiunga in Western Province. During this period I held group meetings, discussions, individual household interviews with farmers (men, women, youths) and various stake holder members in the community.

The second of the major field work took place in Madang Province, at three different locations; Gogol/Naru, North Coast and Upper Ramu regions. This field work commenced in late October 2008 and completed in late march 2009. Three weeks each at Gogol/ Naru areas and North Caost area, and two weeks at Upper Ramu Valley. In this field work, I held various discussions, focus group meetings, interviews, case studies, making field observations in gardens, cash crop plots, review of relevant literatures and questionnaire surveys. Data collection activities included taking notes of meetings, digital recording of meeting proceedings, taking photographs and making descriptions of observations.

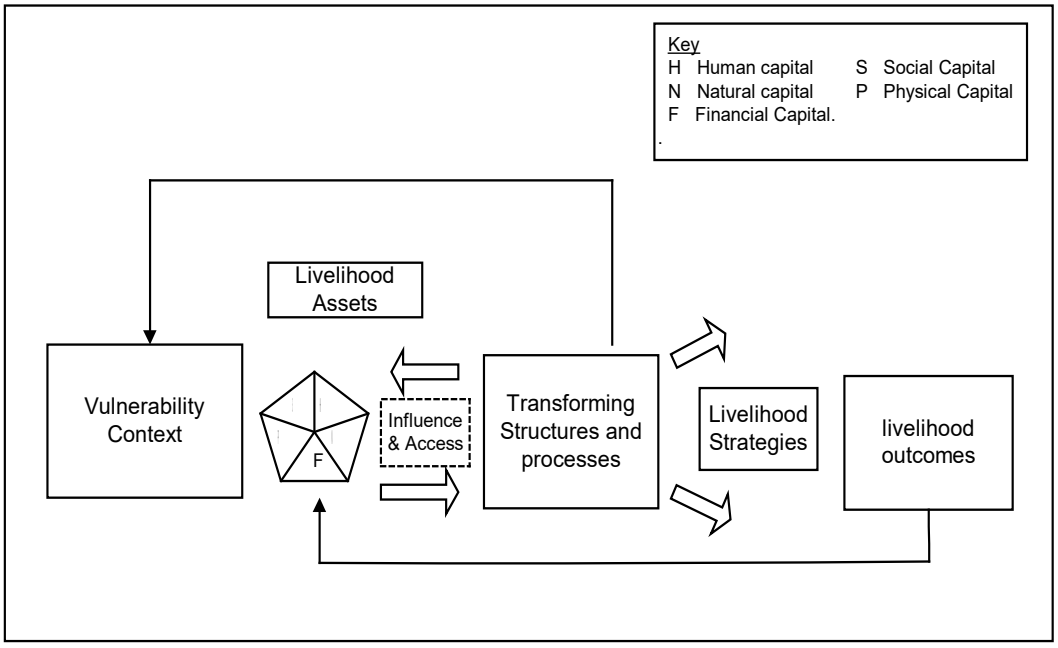
3.2.1 Method: Case study evaluation – decision making framework

In this study, the Livelihood framework (Chambers, R, and G Conway, 1992) and Farmer adoption framework (Pannell *et al,* 2006; Vanclay and Lawrence, 1995), served as a useful tool for assessing, analysing and describing farmers' land-use decision-making processes. How each of the two frameworks was applied and used in the analysis farmer's land-use decision- making processes is described below.

(i) Livelihood Framework

Livelihood is comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. Livelihood is sustainable when it can cope with and recover from shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conway, 1992). The assumption is that PNG small holder farmers pursue wide range of livelihood outcomes to better their situation. To improve health care services, increase opportunities for cash income, better housing, better educational opportunities, good communication, infrastructure system and accessibility to services such as markets by drawing on a range of assets within their environment. Farmer resource-use decision is the core aspect in various processes. By using the livelihood framework in evaluating farmers' livelihood outcome, one could gain insights into the inner perspective of farmer motives, goals in life, needs, feelings and intentions which all account equally and are interwoven together into farmers land-use decision-making processes.

Figure 1 Livelihood framework



Source: DFID, adopted from Chambers, R, and G Conway (1992)

The objective of using livelihood framework or rather the relevant components, were to:

- Firstly, to identify what capital assets are available to the farmers in the case study units and how these capital assets are accessed, managed and utilised in achieving the day to day livelihood outcome of the farmers. Because land and other resources including social networking are integral part of capital asset system within farmer domain. Farmer's decision-making processes involving their use is core subject of this investigation and therefore should be evaluated within the framework of farmers' livelihood outcome. The farmers' livelihood outcomes and issues are the main drivers of the decisions and choices farmers make. The forces within the livelihood outcomes should also inform how such assets or resources are influencing farmers decisions,
- Secondly to examine and reveal understanding of the drivers influencing decisions on what strategies are adopted/ or how these capital assets are used towards achieving the livelihood outcome. Strategy adoption is a function of a decision that is made by the decision maker. Therefore by examining and analysing those strategies that are adopted and in operation as a farming practice will provide the anatomy of farmers' decision consideration. Its understanding is critical to this study.
- Thirdly to identify processes and structure (social, economic, political, and environmental systems) that control and regulate use of the capital or resources and. In the earlier section of this paper I alluded to the factors influencing farmer decision as arriving from two sources. One that directly concerns with this is wider dominant forces. These forces are institutional in nature and are embedded in the processes and system of those institutions. Knowing about this processes and systems should benefit the understanding of how the institutional systems and processed influence farmer choices and land-use decisions.
- Fourthly to assess what vulnerability situation people are exposed to in the different circumstance and what are the responsive behaviour of people in adapting to such situation. As implied earlier, strategy adoption is influenced by a range of factors and issues. Shocks of natural catastrophes and other issues affecting livelihood system makes people become vulnerable. In response to these

shocks people behave differently as an adjustment processes in circumventing these experiences. The adjustment people making are part of the decision process that must be understood as well.

(ii) Farmer Adoption Framework

The farmer adoption decision framework assumes that the decision to whether or not adopt a new farming practice depends on the range of perceptual, social, cultural, and economic factors, Pannell *et al*. (2006), Vanclay and Lawrence (1995). Innovative ideas, novel crops or other similar interventions are more likely to be adopted when they have a "relative advantage" (perceived superiority to the idea or that it supersedes), and when they are readily trialable (easy to test and learn about before adoption). The primary objective of using this framework is to assess and identify what are the "*relative advantages*" as perceived or experienced by the individual farmers, in the range of cropping system, farming techniques that have been adopted already and are practiced in their production system. As mentioned earlier a strategy adoption is a function of decision processes. Using this framework in the analysis should assist in providing insights to the basis of adoption decisions. Understanding the basis for farmer choices in the decision processes has implications that are critical in informing decision about option for commercial tree growing opportunities.

3.2.2 Research Methods - Qualitative approaches in data collection and analysis

This research investigation seeks a more sensitive understanding of how famers in Papua New Guinea assign meaning to various farming activities and how their land-use decisions follow from this. Sources of data required to inform this understanding includes; the system processes and farmer internal factors. The system processes data derives from the institutional systems such as (economic, social, cultural, political and environmental) that regulate and control the farmer behaviour with regard to using, accessing land and other resources. The data set deriving from farmer internal factors includes; farmer goal, aspiration, motive, feelings, values and others which influence farmer attitude, behaviour and the associated interaction in achieving livelihood outcomes. With given research purpose and research question, qualitative methodological approach was considered most appropriate for conducting this inquiry. The discussions presented in the next paragraphs argue the case for my choice in selecting qualitative approach in this study inquiry.

3.2.2 Sampling strategies - Purposeful Sampling (maximum variation sampling)

While the logic and strength of probability sampling depends on selecting a truly random and statistically representative sample that will present confident generalisation from a sample to a larger population, the qualitative inquiry on the other hand, typically focuses in depth on relatively small samples, selected purposefully. The logic and strength of purposeful sampling lies in selecting information-rich cases for an in depth study (Patton 1990; Maxwell 1990). Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the study and Patton (1990) terms this approach of sampling as "purposeful sampling". In purposeful sampling the aim is to select information-rich cases whose study will illuminate the question explored in the study inquiry. This is a strategy in which particular settings, persons, or events are selected deliberately in order to provide important information that cannot be obtained as well from other choices. Patton (1990) argues the logic of purposeful sampling however, is often wrongly judged on the basis of logic, purpose and recommended sample size of probability sampling. Instead, like all other qualitative

inquiry the sample should be judged on the basis of the purpose, and rational for the study and sampling strategy used to achieve the purpose of the study. In other words sample should be judged in context – the same principle that underpins analysis and presentation of qualitative data. Maxwell (1990) in support to this perspective identifies four possible goals for purposeful sampling in qualitative research.

- First is in achieving representativeness or typicality of settings, individual, or situations selected. A small sample that has been systematically selected for typicality and relative homogeneity provides more confidence that the conclusions adequately represent the average members of the population.
- The second goal that purposeful sampling can achieve is contrary to the first and that is to adequately capture heterogeneity in the population. The argument is that the conclusion adequately represents the entire range of variation, rather than only typical members of some subset of range. This is achieved by defining the characteristics of variation in the population that are most relevant to the study and systematically selecting individual, times or settings that represents the most important possible variation dimension on these characteristics. The process may require stratification in sampling.
- The third goal is select sample to deliberately examine cases that are critical for the theories that one began the study with or with that was subsequently developed from prior study.
- The fourth goal for purposeful sampling is to establish particular comparison to illuminate the reasons for differences between settings or individual.

3.2.3 Selection of sample - sample size and unit of analysis

Decisions about sample size and sampling strategies depend on the prior decisions about appropriate unit of analysis. In this research investigation the unit of analysis included individual farmers (man, women, young adults), households, family units and farmers collectively as farming communities. The primary focus of data collection is observing, interpreting meanings, describing and making notes on what was happening to the individual farmers' and farming community, with respect to their choices of cropping system, livelihood adoption strategies, and other resource use decisions they make, within the context of their setting (case study regions) and how individuals farmers' land-use decision's are affected by the setting. The farmer-setting in this case included the various systems of; political, social, cultural, economic and biophysical environment they operate within. Individual farmer variation is the primary qualitative research issues. By comparing and aggregating data for individual farmers, generalisation for each of the case study regions was generated.

Guided by the assumption offered by (Patton, 1990) regarding when purposeful sampling is useful in qualitative surveys, this assumption is exemplified in paragraph 3.2.2 and, the prior decision about question of what is the appropriate sampling size and unit of analysis, samples presented in table 1 and 2 were selected for each of the case study regions. Mixed methods were used in the selection of individual farmers for the purpose of survey. Selection of research participants involved number of strategies;

- In any community, group meeting was the first activity to be organised. The purpose of this meeting was firstly to inform the community about what, I as a researcher, was doing in their community and secondly to recruit survey participants for in dept interviews later on.
- After group meetings and initial enquiries I asked for volunteers who could make themselves available for an in dept interviews later on.
- From these I randomly selected those individual to be included for the in depth interviews.

- The random selection involved representations from young (unmarried man), men, family units, women (if willing), Senior (elderly) members within the community.
- In some situation where I came across any member of the community who was not present at the initial group meeting, but wished to talk of about his/her issues I also included them as interview participants and proceeded interview with them.
- I continued with this process until same type of stories kept repeating from different farmers' interviewed. This signalled me that data saturation point was reached and I should cease with the interview process.
- At this stage I would continue with other activities like making landscape observations, taking photographs, visiting gardens or other production sites.

Table 1 : Number of Household and individual farmers interviewed

Case study Site	Unit of analysis	Number of Participants/ or household interviewed		
Western Province		Man	women	Total
	Yeteni/ Moian	10	2	12
	Others (Komoiva/Kasa	5	2	7
Madang Province	Trans Gogol villages	25	10	35
	Naru Villages (Barum)	25	15	35
	North Coast			
	Wasap	25	10	35
	Riwo/Airihaven	10	10	20
Ramu	Bumbu,	15	10	25
	Sangkiang	15	8	23
	Bopirumpun	15	7	22
	Musuamp	10	-	10
Upper Markham Valley	Wangkum	20	5	25

Group Meetings

Aside from interviews I also conducted group meetings. Two types of group meeting were conducted. The first group meeting agenda was to inform the community about who I was and what I was doing in the community. These meetings served a very important critical role of telling the participants about who I was and what I was doing in the area, who I will be working with, where and for how long I will stay in the community. The meeting also offered opportunity for me to make assessment of and raise question on any cultural issues that I had not considered in my planning process but was of critical importance to my research as well as the research participant interest. In this meeting I also made recruitments of would-be participants for the detailed interviews later on.

The second meeting was focussed more on the research objectives and this involved assessing group feelings, group perceptions, attitude, and behaviour on the choices of cropping, livelihood adoption strategies, resource use decisions and other issues that were affecting and influencing their land use decisions. These meetings provided group perspectives rather than individual.

Table 2 Number of Groups Meeting Conducted

Case study Site			Number of people attended		
Western Province	Unit of analysis	No Group meetings conducted	Man	women	Children
	Yeteni/ Moian	1	10	5	15
	Others (Komoiva/Kasa	-	5	-	5
Madang Province	Trans Gogol villages	3	60	10	40
	Naru Villages (Barum)	3	60	20	45
	North Coast	2	30	10	35
	Wasap	2	40	10	35
	Riwo/Airihaven	2	10	10	20
Ramu	Bumbu,	2	20	10	25
	Sangkiang	1	15	10	15
	Bopirumpun	2	15	10	15
	Musuamp	1	10	10	20
Upper Markham Valley	Wangkung	1	20	5	25

3.2.4 Field work - daily Interviews, group meeting, survey of households

The main purpose of the daily survey/ interview was to find out what is in and on the framers mind. As (Patton, 1990) notes the purpose of interviewing in social survey is not to put things on some ones mind, but to access perspective of the person interviewed. In this study, the intent of interviews was to develop understanding of the choices farmer make as far as land-use decisions are concerned. It focussed on understanding the household or group to reveal the socio-economic dynamics within and between household/ and groups. This was to contribute to an understanding of the range of issues including resources base, agronomic practices, questions on social and cultural aspects, question on trading and exchanging activities, and division of labour, including how land owners respond to and accommodate new initiative to their production system, hence the decision making in the use of land. Apart from group meeting, I also conducted household and individual interviews. Table 1 provides the summary of participants interviewed in each of the case study units. Using qualitative interview techniques, each interview generally took between 45 minutes to two hours. This allowed for three to four interviews per day. Before I commenced with any meeting I would explain as clearly as possible who I was and what was my purpose of doing the research, this is done with a aim of not creating any unintended hopes and secondly for the farmers to feel at ease about my engagement with them. The actual process of interview included introduction of who I was and what I was doing. This followed with asking interview questions. The prepared interview question, copy of which is attached as appendix one, served as the basis for probing farmers. The questions were not asked in the order as they appeared in the questionnaire, but rather how farmer conversed. The participants were encouraged to talk about their own experiences as much as possible and in between I would re-iterate on any points of issues only to get clarification or confirmation of what they were saying. If I feel that they completed talking on a particular sub theme, I would then reintroduce another not discussed earlier. The interview would continue in this manner until all the questions in the interview questionnaire ere exhausted. We would then introduce an on Farmer would questions were not asked in. Although then go into interview question.

3.2.5 Field work -interview process

The daily visit to farming communities combined semi-structured interviews with short standardised quantitative survey. The daily survey recorded: demography and education, resource base and accessibility – with focus on plants and tree crops, land ownership and decision making processes over land use decisions, different types of land uses, commitment and engagement of labour to various activities, gauging level of interests, values and factors motivating cash cropping opportunities or discouraging efforts in such activities, income, (from paid employment, marketing, customary exchanges) expenditure and food consumption (the latter to assess the relative importance of garden and store bought foods as well as to relate labour engagement in subsistence needs). Survey questions usually were interspersed in general conversation. In responding and iteration of questions, participants were not discouraged from digressing to related issues or other important matters that had arisen earlier in the discussion. This often uncovered new information that would not be revealed through the standardised survey and provided insights what people themselves felt were important issues. Unfortunately, could not do more of this survey as other people were always around and participants some times felt uncomfortable talking about the deeply aspirations and other deeply embed issues in the presence of other community members. The main emphasis of the interviews was to gain an understanding of every day life issues through people's own stories from their own perspectives and see connectivity of these issues and their decision relating to land use. This helped build a picture of what

influences people's land use decision and behaviour. Also, as discussion and visits progressed, people came to view my visit as opportunity to express their concern and ideas. The interview explored the following topics:

- Land ownership and decision-making processes
- Livelihood outcomes and adoption strategies
- Engagement of labour and time into various activities including farming
- Levels of clan cohesion and cooperation in land use decision making
- Factors influencing household and family members', participation in paid employment and other cash cropping;
- Additional and or competing labour and income demands
- Constraints
- Vulnerability situations
- Impacts and perceptions to various cash cropping practised in the case study region.

Towards the end of each interview, I summarised the discussions and general findings and sought their feed back on my summary. This process helped ensure the data collected were accurate reflection of the situations and concerns of the farmers and the communities.

4.0 Study Finding - Factors driving farmer decisions

This section examines the diverse range of livelihood strategies and other forces driving farmers' land-use choices. The livelihood strategies are defined as those activities undertaken by farmers to provide means of living. The key finding of this study is that farmers intuitively define their goals and consistently work toward achieving them. Furthermore, faced by shock and other vulnerable circumstances, farmers develop adoption strategies in response to such condition. Identifying what these gaols are, the circumstance they are in and, understanding how farmers' strategise in achieving these gaols and circumstances will assist an informing appreciation to farmers' land use decisions. This has implications for investment decision in agroforestry opportunities and other consequent policy formulations. Important to note is that study of farmers land-use decision-making processes could benefit from focusing more on livelihood strategies as this strategies indirectly influence the land use decision, through their impact on social and economic well being of the farmers. Acknowledging farmers' livelihood issues, motive, needs, aspirations and goals they pursue in life and understanding why farmers undertake diverse economic and social activities may assist in formulating appropriate interventions compatible to the farmers' needs.

The discussion following on from here presents summary of case analysis of each of the case study regions. It presents the forces interacting and driving farmers' land-use decision. This is important information to the understanding of what is happening at farmer level, this can assist in the formulations and development of appropriate interventions aimed at increasing production and productivity in agroforestry and commercial tree growing opportunities.

4.1 Western Province

Vulnerability condition - experiences

The discussion presented in paragraphs 2.1.1 to 2.1.4 provides a context-specific background environment in which the farmers in Western province (Yeteni, Obo, and Kasa) practice land-use decisions. Main feature to note about this case study region is the impact of mining activities on the livelihood system and how its is influencing farmers land use decision processes. The main ones include the following; mine-related damages to the food supply sources, changing life style and the emerging cash dependency culture. These issues had direct implication on the farmers and land use choices they make. The

issue with damaged food supply sources was claimed as result of mine related sedimentation causing blockage to river drainage system, which consequently led to and caused flooding and dieback to the food supply sources such as sago stock, fishing and hunting grounds. Implication of these included food security issues and other livelihood issues affecting both the quantity and quality of livelihood system previously enjoyed by the farmers in the region. Changing lifestyle - nomadic way of life to sedentary agriculture practices. The tribal Yonggom and Awin people, who make up the current communities at Yeteni, foci for this case study, were leading a forager and hunter lifestyle as part of their food production strategy (Stuart 1991; Otsuka 1983). This way of life style is changing and these groups of people are moving into sedentary agriculture practices. These changes are thought to be externally driven and interrelated with mining activities. Cash dependency culture is another mine related impact on the lives of the people. It is an emerging one and is partly contributed as a result of cash income and material good (housing and water supply) influence in the form of compensation payments or other employment opportunities provided from mining activities. Large sums of money are paid to the mine impacted communities, who are now have disposable income, are opting for option in purchasing trade store goods to satisfy their daily needs. This is causing the drive for more and more money. These issues have affected livelihood system and shocked farming families. They feel vulnerable and threatened as a result of these impacts and their land use decisions and associated farming behaviour is a direct response to these circumstances. The condition of vulnerability was expressed by a 51 year old man at Moian number 2 village with this sentiment;

> … b*ipo papa na mama save sindaun wantaim hamamas, wankain olsem tubuna. Papa save amamas planti na mipela save stap gut. Tasol, nau mipele kisim bikpela pen na bagarap. Ples bilong kisim kaikai i bagarap pinis, mipela bai kisim kaikai we?*
>
> In the past my parent were happy and contend with life, it was good. We enjoyed our childhood. However, at this present time our food sources are destroyed and we are pained by its loss. We are asking where we can get our food.

4.1.1 Subsistence production and various adoption decisions

Food garden production remains extremely important activity in terms of labour demand and household consumption of the farmer in the case study region. Household grow sufficient food to meet most of their requirement and if there are surplus, women often sell garden produce at local market. The range of food cultivated is broad, but dominated by root crops such as sweet potato, taro (*Colocasis esculenta and Xanthosoma sagittifolium*), cassava (*Manihot esculenta*), yams (*D. esculanta* and *D.alata*) and banana. Sugar cane, pitpits and creepers such as cucumbers and pumpkin also cultivated. The range of cultivated crops has broadened significantly in the recent years with the introduction of improved, high yielding variety of crops under OK Tedi's Regional Development and mine agreement programme.

With the increasing family sizes, and vulnerability exposure as a result of mine related destruction to food sources, people are now opting to making bigger sized garden plots than what their parents made in the past. This is in order that family food need are secured and maintained in the required quantity. Another development observed with adoption decision was the intensity in the gardening activities and increased diversity of crops cultivated. Inter cropping of cash and food cropping is another important adoption strategy observed in the farming practices. Incorporating of rubber trees, *Havea brasilensis* together with the food crops is common feature of the gardens visited. Few months after the establishment of food crops, rubber trees are intercropped together with the food crops on the same garden plot. Garden is converted to Rubber plot after food crops are exhausted. These behavioural activities are opposed to the nomadic life style

their parents and grand parents led in the past. Photograph below illustrate this intercropping system.

Figure Intercropping of rubber and food crops

Row of three months old rubber trees planted among the food crops.

Apart from food garden production, Sago starch production, fishing and hunting are equally important part of farmers' life, with equal amount of time and labour devoted to these activities. In terms of labour division for these activities, men do the gardening, hunting and felling of sago palms while women attend to sago starch production and fishing activities. Sago starch production, fishing and hunting activities is weekly event for average family size. Average family size is about husband wife and up to four or five children and perhaps additional 2 or 3 other extended family members.

Figure Intercropping of food and tree crops at Obo – Middle Fly Region

Source: Francis Essacu, 2008

The shock and vulnerability condition described in the previous paragraph lead to number of adoption strategy decisions in the subsistence production system;

- increased garden plot sizes. Family units are making bigger and practice more intensive or sedentary agriculture as opposed to foraging, hunting and fishing activities. For example the above photographs represent part of 10 hectare plot of garden owned by one single man and his family. This could be an extreme case but average garden sizes are in the order of half to 1 ha;

- Variety of crop cultivated broadened. Non traditional crops such as rice, different varieties of introduced sweet potatoes, taro, yams and various fruit and nut tree are voluntarily accepted and incorporated into garden systems.
- Acceptance and practicing of above meant introduction and adoption of new farming and crop husbandry skills
- Sense of economic and social security. With this adoption decision, people feel more secured for the future

4.1.2 Cash income

Money has become such an important part of our every day life, and people at Moian, Yeteni, Obo and Kasa case study regions are no exception to this fact. Many of the farmers and their families talked to in the interviews conducted, expressed the need for cash income as the underlying reason to various adoption strategy decision. This included cash cropping and other such activities as marketing. Money is needed for various reasons, common ones that kept reoccurring in the interviews included; issues of school fees, new clothing, purchase of food items and range of other trade store goods, services such as health care, transportation need, sense of security, capital for business start-up capitals, family livelihood and many more. Decision in mobilising important resources such as land and labour were made in order that monetary needs can be met. Motivation and incentives for adapting to new patterns of work, aside from the usual subsistence activities, is required in the cash economy. Dynamics of these aspects at different levels; farmer, institutional and private sector are discussed in this section.

Rubber *Havea brasilensis* Tree

Growing and tapping of Rubber *Havea brasilensis* tree for its latex is perhaps the only cash cropping activity currently practised in the North and Middle Fly Regions of Western Province. At farmer level, growing and tapping of rubber trees are undertaken for several reasons. Important reasons for the decisions in cash cropping was to increase opportunities for cash income in one part and, in another the prospect that such decision would reduce their anticipated vulnerability situation as a result of Ok Tedi mine closure in 20012/13. A 53 year old man at Moian village expressed his experience and stated why he wanted a large scale rubber farm project at Yeteni;

> "…….*bipo mi save lukim mama save kam bek wantaim planti kaikai, inap long lukautim miplea long 1 pela wik or moa, behain long taim em save igo painim saksak na abus. Tasol, nau mi wantaim meri igo long dispela bus graun mama save igo long en, ino nap bringim bek kaikai inap blong 3 pela dei, mipela mas igo painim kaikai ken tupela taim insait long 1 pela wik. Sapos mipela igat moni, mipela ken baim kaikai long stua. Long dispela as na mipela laik kirapim dispela project long planim diwai raba. Dispela bai helpim mipela long kisim moni na helpim long baim kaikai."*
>
> The amount of food we get now from the same food sources where my mum in the past would bring back a week's supply of food, referring to sago starch and various sources of protein, is much less. My wife and I must collect food twice a week to feed our children. If we have the money, we could buy food from the store to supplement our family's food need. That is the reason for our decision in engaging our land and labour to planting Rubber trees so that money we receive from selling latex can supplement our food need as well as other needs such as school fees for children education.

This is a sentiment expressed by a 53 year old man from Moian village regarding his experience of livelihood enjoyed in the past and comparing that to the anticipated vulnerability he is faced with now and future.

A question was posed, how many blocks or rubber trees have you planted?

> "I own three blocks, each of them having between 300 and 600 hundred trees. Because my rubber trees are located further away from the accessible transport system, bringing cup lumps to the nearest pick up point is a difficult task. If we (as in group) increase the quantity of supply from our production area, we may get the buyer to come closure to our production area to pick up cup lumps. Our intention is to increase the production on our land to attract the buyer, the North Fly

Rubber, to come closer to our door step to buy rubber from us. In this way we can sustain our livelihood. This is our reason to bring about the Yeteni rubber project on our land."

Such comments when combined with the data presented further on in this paragraph (increasing trend in planting of rubber blocks) illustrate that farmers' livelihood strategies promote household and social security by;

- increasing opportunities for cash income
- strengthening farmers capacity to meet their needs
- broadening the options and choices available to households
- increasing food security
- lowering risk
- maintaining a sense of community

Institutional perspective of rubber cropping

From (pers.com) with number of Agriculture officers including the Provincial Agriculture Advisor and Rubber Co-ordinator for the North Fly Region, there are over 3,800 smallholder rubber growers with combined planting area of some 3,681 hectares, representing some 137 villages. The production figure for 2002 was over 16,500 tons of cup lump of latex produced in a year with an income of K710,750.00 PNG Kina going to the farmers. Conversion of cup lump to actual tonnage for export was not obtained. However, export figures for March quarter 2008 is 1,100 tons and this is valued at 2,545.00 PNG Kina per ton, Bank of PNG Quarterly Bulletin (2008). Of the total area planted with rubber crop, planting on customary land represents only 6 percent.

In recognition of the crops potential and its significance to the well being of the province, Western provincial administration under its economic investment and diversification agenda of its Provincial plan WP2010, placed high priority to encourage and promote village based small scale agriculture income earning opportunities. In line with its visionary focus, the Administration is in the process of providing detailed statements on the sectoral plans for rubber, fisheries, agroforestry, livestock and other cash cropping activities in the province. ACIAR FST 2004/050 agroforestry projects involvement in the province and reporting of findings may contribute these sets of provincial development strategies.

Other Cash income activities

Apart from cash cropping, farmers also sell fish and other hunted wild life products at the local market to bring home cash income. In the past betel nut (*Areca sp*) growing was not part of the cultural system at Maian village, but has been adopted and successfully grown around village landscape with the intent of selling nuts at the local market for cash income.

Figure Young betel stands in the village landscape at Yeteni

4.1.3 Social and other customary economy

Socialising, especially for men is an important activity that takes much of farmers time. Maintaining social relationship with relatives and friends, thus strengthening social networks and maintaining social harmony through day to day resolution of social conflicts is an important part of farmers' activity. This is particularly important when it comes to the issues of land owner and land user rights issues, access to resources etc. Security to land, food gardens, stands of sago stock, fishing rights are very critical and therefore a continued dialogue between kinship and friendship groups forms an important part of the strategy. Social and economic security of the farmer's are depended on this aspects in the farming community. Particularly with respect to land owner land user right issues in which important decision on using, accessing and owning of land is concerned. These forums provide avenue for raising and discussing this issues.

4.1.4 Young mans perspective - why money is needed

In Western province, particularly in the case study region it a customary obligation for young man to pay a bride price at marriage. This was found to be the common reason amongst the young men why money is needed. Sentiment from one such young man expressing the need for money "…."

4.1.5 House Construction

Building a good house before getting married is dream for many young man. This is to show young mans maturity, independence, strength, courage, success and above all confidence and security for the would-be bride.

4.2 Madang province – Trans Gogol/ Naru and North Coast

4.2.1 Need for regular cash income

Need for regular cash income in light of the current money-driven livelihood system was found to be a major driver within household units.

4.2.2 Money needed to pay for school fees for children

4.2.3 Money need clothing, food and health services

4.2.4 Needed money for construction of long-lasting, with permanent-structured or semi permanent houses was also a major factor

4.3.5 Family security, especially with the future uncertainties about children education, livelihood, settlement were the drivers for land use decision that involved cash cropping

4.3.6 **Setting up business opportunities to improve family livelihood system** that can also improve the livelihood of the village in general. For example, family decides to purchase PMV truck, this will not only improve the family livelihood system, but will also improve village livelihood as well through the provided transportation service. These were inspiration for farmers in cash cropping or land use decision that involved with a return that is the form of money.

4.3.7 **Security of Land, with the growing population there is always a fear** that unused or idle piece of clan land being used by someone else. These inspired farmers making land use decisions

4.3.8 **Land-use activities included cocoa, acacia trees, fresh food marketing,** betel nut trees, coconut and variety of other fruit and nut trees.

4.3.9 Customary economy

The indigenous economy consists of various exchanges that take place between kin. These include exchange of goods, services, labour, traditional wealth items and cash. The aim of these exchanges is to foster individual and groups into various network of social relationship and obligations. Customary exchange can be in a form of daily gift of cooked

or uncooked food, labour for garden or cash cropping activities, various services and cash contributions to signify major events like initiation, death, marriages, adoptions and dispute settlements. In certain regions, this exchange system is increasing being used to raise capital for business venture. Current version of this form of exchange is "Senis basket" which is translated to the exchanging of basket and deviates from its traditional form of exchange between kin grouping, has now broadened to exchanges that take place between groups of women within and across different regions. It is mostly women groups who take part in these exchanges.

Significance of this to land-use decision-making process is the manner and influence this exchange has on to the way labour, land and other resources are mobilised in the preparation for this exchanges.

For example one tree farmer in Naru area of Madang told me about how his labour and time was organised between various activities. One of these activities was contributing to the maintenance of community cattle paddock as he had two cattle's grazing in the community paddock. His motive for grazing cattle was in preparation towards customary obligation that marked death of his father some four years earlier. His decision with grazing cattle started a year later after his father dead.

4.3.10 **Main source of income; tree framing, fresh food marketing, cocoa,** coconut, employment opportunities provided by the company and

4.3 Ramu

4.3.1 School fees

4.3.2 Improvement to livelihood systems, particularly with dual system of subsistence as well cash income

4.3.3 Constructions of permanent homes

4.3.4 Explore opportunities to make more money; purchase of trucks and tractors

4.3.5 Customary economy - Feasting and other cultural obligations

4.3.6 Main source of cash income is through cane farming, peanut cultivation and employment opportunities provided by RAI

5.0 Conclusions and implications

5.1 Monetary versus traditional economy and social systems and implications on farmer choices.

Although the dependency of farming communities on the cash economy has risen over the years, it has not reached the point where they can choose either to retain their traditional social and economic organisation and values or to follow those demanded by the cash economy. Money economy and monetary exchange accounts for only certain part of the livelihood system of the people, while traditional subsistence economy and social system make up the balance. Precise proportions of each of the system in terms its contribution to the farmers' livelihood system was difficult to establish it was beyond the scope of this study. (May be a subject of different study???). The dualistic behaviour of farming communities observed suggests how dominant external factors and the underlying psychological factors are interacting and influencing farmer decision. Implication of this finding is that so long as the conditions of subsistence affluence continue to remain, the economy dualism will continue to operate in Papua New Guinea rural areas. Of course, there are differences in the individual farmers and groups who have different degree of adoption depending on the linkages and nature of contact with modern economy. At the same time shock and vulnerability influences can also lead to adoption. The examples in Western Province and Madang case study regions are clear examples of these conditions.

Implications

A strategy would be to identify farmers in this category and work through them to influence participation, in order that diffusion of agroforestry or commercial tree growing opportunity intervention is achieved. A suggestion would be to work with farmers at Naru project site in Madang Province and the Wangkung communities in the Upper Markham valley. Certain members of Tree farmers in these case study regions appear to fall in the category described above. Identifying them and working with them to influence the wider communities in accepting and adaptation of opportunities in commercial tree growing.

Although there is evident of individual willingness in the Western Province, Obo and perhaps Yeteni, and Mari villagers, there needs further evaluation in light of wider dominant forces. The conditions of wider economic, social and political environment are perhaps not conducive as yet for farmer decision in the choice for commercial tree growing in these regions. For example, the infrastructure system, political system must be carefully evaluated and assessed in order to confirm these uncertainties.

11.2 Appendix 2: Choosing production systems and business structures to enhance livelihoods of smallholder commercial tree growers in Papua New Guinea

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June 2014

Report on research conducted under ACIAR Project FST/2004/050: "*Value adding to PNG agroforestry systems" NB: Full report is available from ACIAR*

Summary

Opportunities for the development of smallholder planted forests in PNG are increasing as access to natural forests declines, markets for environmental services grow and demand for sustainably produced forest products increases. In fact, tree planting has been an integral part of customary land use systems throughout PNG. Changes in supply and demand conditions for forest products create opportunities for land owners to increase the scale and/or intensity of tree farming. Several critical choices confront landowners in their decision to grow trees: what tree species to plant and where, what area to plant, what production system to adopt, what maintenance practices to apply, and where and how to sell harvested timber resources. This report reviews the factors and conditions that influence the choices that smallholders make in relation to growing trees and evaluates a number of business structure options. Decision guides are developed to assist smallholder investors and advisors to tree-growers in the selection of tree species regimes and the choice of business structures. Specific applications are illustrated for three sites: the Ramu Valley in Morobe Province, sites along the Fly River corridor in Western Province and sites in Madang Province within economic reach of established timber processing and port facilities.

In the course of this project it was found that improved tree species can be incorporated into traditional cultivation systems. Suitable tree species can be selected to occupy the fallow period of the garden rotation system, which otherwise is left to regenerate naturally for some years before it is cleared again for cultivation. Fallow periods range from five years in some districts to 15 years or more in others. Trees also may be selected as a core land use option in association with other land uses. Of course, the choice of tree species is not based purely on rotation length and other physical conditions. The existence of timber markets and efficient access to those markets are critical decision factors. Availability of key inputs including suitable land, labour, finance, improved

germplasm and technology are also important factors. However, above all these factors the decision by a smallholder to grow trees is determined primarily by their household livelihood goals and strategies.

Research for this report was conducted as part of the ACIAR Project FST/2004/050 'Value-adding to PNG agroforestry systems'. The overall objective of the ACIAR project is to foster the adoption of high-value tree growing on a commercial scale by landowners in PNG. This report addresses two of project's specific objectives:

- Define commercial tree production systems for priority species in pilot regions
  - identify preferred tree species and potential production systems, and estimate associated financial costs and returns over the growing cycle
- Develop business models and strategies to facilitate adoption, in conjunction with investment and implementation partners (businesses, government, NGOs & CBOs):
  - Identify potential business models for commercial tree growing by landowners, including candidate investment and marketing mechanisms and strategies
  - Assess business models in terms of their capacity to facilitate landowner adoption and to meet investment partner objectives and constraints
  - Develop strategies to address constraints to landowner adoption.

Choosing tree-growing for a better livelihood

To understand why poor landowners choose to grow trees depends on understanding the objectives or targets that their livelihood strategies address. Our research revealed the benefits of extending the sustainable livelihoods framework to include prioritising the allocation of household resources or assets to needs and targets. We incorporated Maslow's hierarchy of needs into the sustainable livelihoods framework.

Not surprisingly, trees in PNG are grown by many households for fuelwood, which is mainly used for cooking, and for poles which are used in house construction, satisfying the most basic physiological needs of a household. Therefore tree-growing is likely to be a fundamental element in many households' livelihood strategies. Planting trees for income is gaining interest among smallholders in PNG while planting trees as a form of savings or insurance is an established practice. In the absence of a better savings or insurance alternative, land owners will be attracted to grow trees for longer term savings to meet expected and unexpected future expenses such as school fees, a brideprice or for providing income support during periods of drought or other hardships.

The decision to grow trees is affected by the stage of life of the household or head of the household, access to key production and management inputs, market access and the household's attitude towards risk. Differences between households in their stage of life,

relative resource or asset availabilities (land, labour, capital and knowledge) and livelihood goals can explain differences in their rationales for growing trees. However, depending on local conditions, access to services and awareness of options, smallholders growing trees for different purposes may plant the same tree species and use similar management regimes. This may not be the best choice for all purposes. Therefore, the next critical choice a household must make after deciding to grow trees, is which tree species to plant.

Species regime choice

The choice of species regime depends on access to: quality germplasm of suitable species and other technologies, knowledge and specialist advice for tree-growing, financial resources, labour resources, markets and market intelligence and infrastructure. Households' risk management is a further factor influencing tree planting decisions. The significance of each of these factors in the species regime selection decision varies according to the role of tree-growing in household's livelihood strategy.

In PNG households grow trees for many different purposes: fuelwood, construction poles, savings, insurance, cash income, environmental services and tradition. Tradition is usually associated with one or more of the other purposes. Often trees are grown for more than one purpose. In these situations one species may be planted to satisfy multiple purposes or a mix of species may be planted. The choice of species is not a simple one and the better informed the decision maker the more likely the choice will deliver the expected outputs.

Access to quality germplasm for a range of species and the availability of technical advice and suitable technologies for establishing and maintaining a plantation are fundamental to all purposes for growing trees. Access to finance, infrastructure, markets and market intelligence are not relevant for households growing trees for their own fuelwood and construction needs. These factors are vital to achieving a successful outcome where households are growing trees for savings or cash income.

The choice of species regime for households seeking to meet their own basic physiological needs related to food/cooking and shelter/construction may be different for households choosing trees for savings and income. Both households will benefit from specialist technical advice on species selection and the appropriate management regime for the intended purpose and production conditions. This can be provided by a government extension service or a private company that has a supply agreement with the individual grower. The timeframe, resource availabilities and livelihood objective are relevant as well.

The time lag between tree planting and yielding a useable or saleable product is another factor in the choice of species. The species choice for a household expecting a viable product within five to ten years is limited to fast-growing species that can meet desired product characteristics. The species choice for a household wishing to benefit future generations or satisfy longer-term needs is for slower-growing species suitable for sawlogs or peeler logs. However, the more time required to produce a desired end product the greater the likelihood of changes in prices, seasonal conditions, policies and resource availabilities and the greater the uncertainty of the outcome. To avoid unrealistic and overly ambitious expectations tree-growers need to be aware of the likelihood of changes in physical and market conditions. Relevant information may be available from government extension services for independent growers and from private sources, especially where a grower has a supply contract or other arrangement with a large plantation estate or timber processor. In the absence of reliable information and advisory services, tree growing can be a highly risky land use option for smallholders.

It is critical that the choice of species regime matches the household's needs and expectations. However, decisions are often made in an environment of uncertainty especially relating to species experience and markets. The more operational experience there is for a particular species the more certainty there is about its performance. The existence of a market for forest products is important for accessing information on prices, product specifications and user preferences. Uncertainty for a particular species regime is highest where there is little or no previous local growing experience and where markets for products from the species do not exist. Other factors considered in the analysis of species regime suitability at the project sites included the age of the household head relative to the rotation length of a species and the risk of tree growing to food security associated with the labour requirements to establish and manage the trees. Our analysis found that suitable species for the project sites are:

Western Province: Teak for sawn timber and rubber for cup lump production (and sawn timber)

Ramu Valley: Teak for sawn timber and *E. pellita* for fuelwood

Madang area: Teak for sawn timber and *Acacia* mangium for woodchips.

Business structures

A business structure is the form of organisation that characterises the relationship between key players in an industry, market or region. For timber production the key players are growers, traders, processors and end users or consumers. Outcomes for smallholder growers vary under different business structures, which reflect local conditions. The choice of business structure is influenced by various factors including land

tenure, labour supply, financial capital source, source of knowledge and technology, market access, grower proximity to buyers, the nature of the organisation or collaboration between growers and between growers and other market players, the mechanism used for determining price, the degree of processing conducted prior to sale, quality assurance, grower income source under the arrangement, dependence of the processor on resource supplies from its own land and the balance of power between the parties to the arrangement.

Structures in the forestry and timber sector include independent growers competing in open markets, growers supplying processors under various forms of agreement, and full control of the supply chain by a single entity. A decision support framework was developed to determine which structures are possible for a given situation. The short-listed structures can be further evaluated by the developer. For a processor security of resource supply is a critical issue, while for smallholders certainty of a market, access to quality tree seedlings, assistance with establishment costs and technical support are attractive features of a partnership arrangement over independent operation. The scale of available land is an important factor in the choice of business structure.

A business structure or arrangement that delivers benefits to smallholders involves a formal agreement between a smallholder tree grower and a processor or large estate owner. The first step in defining an effective arrangement is to identify the interested parties and then to understand their respective needs and motivation, which will not necessarily coincide. From a processor's perspective, management of the planted trees by smallholders is likely to be less intense than that applied to an industrial planted forest due to difference in grower objectives and motivations and the higher priority of food crops, ensuring food security and cash income. In developing a relationship between the parties, the aim is to create an enduring agreement. A check list of factors that should be considered in the choice of a business arrangement includes factors affecting uncertainty and risk especially related to markets, transparency of the arrangement, the nature of existing organisational arrangements within PNG communities, social aspects including spillover benefits for community members, ecological aspects, the role of the company partner and the support of government and government policy. Effective arrangements address certainty and transparency in relation to the basis for sharing risks and returns.

One significant benefit for small-scale tree growers from involvement in a business arrangement with a large plantation estate owner or timber processor is the potential to reduce the financial burden of tree establishment and ongoing maintenance. This is a form of equity financing where the smallholder contributes land and other resources as determined by the conditions of the arrangement in return for financial assistance which may cover establishment costs and ongoing costs of plantation management Alternatively,

a smallholder may finance tree planting from household savings generated from the diversified use of household assets, especially land and labour. Another financing option is to borrow a portion of the funds needed to establish and sustain their planted trees. However, few financial organisations provide loans for forestry investments due to the long time to harvest and the associated risk and uncertainty.

The success of agroforestry and other tree-planting ventures involving smallholders can be enhanced by provision of incentives. Direct incentives are designed specifically to support afforestation or reforestation or community forestry. Direct incentives can be provided by government in the form of payments to households or communities for forestry projects, concessional loans to support tree planting, provision of forestry extension and information services and the supply of tree seedlings at concessional prices or free of charge. Other forms of incentives are described as enabling incentives. These are non-specific and operate at a more macro level. An important enabling incentive for plantation forestry development is the establishment and maintenance of critical infrastructure. The decision to provide direct incentives to facilitate tree planting is justified where market forces are insufficient to encourage investment, but where this a long-term social benefit.

11.3 Appendix 3: Mulung, K. 2012. *Wok diwai ken lukautim yumi, o nogat? Papua New Guinea landowners' decision processes relevant to commercial tree growing*.

Livelihood and land-use choices of Papua New Guinean Landowners, and implications for decisions relevant to commercial tree growing.

Kulala Mulung

Excerpts from thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy of the Australian National University August 2012

Chapter 1: Introduction

1.1 Introduction

Papua New Guinea (PNG) is globally distinctive in many respects. It has very high levels of biological and cultural diversity, reflecting in part its geography and topography. It is one of the cradles of agriculture globally (Groube 1989) and its landscapes are cultivated to varying degrees (Kennedy and Clarke 2004). Its customary land tenure systems are enshrined in the 1975 National Constitution, providing customary landowners with full rights to the land and resources traditionally held by their land groups, such as clans. However, despite the richness of its natural resources, including forests and minerals, PNG remains amongst the lowest-ranked countries globally in terms of human development indicators – for example, the UN's Human Development Index score for PNG for 2011 is 0.431, ranking the country at 157 of 187, and in the low category of this index (UNDP 2011).

More than 85% of Papua New Guineans live in rural areas and depend on agriculture of various forms for both subsistence and income generation (Allen and Bourke 2009). This thesis investigates the livelihood strategies and associated land-use choices of these rural people. It also considers the potential implications of these strategies and choices for decisions that rural Papua New Guineans might make about the incorporation of commercial tree growing into their land use systems, as a means of enhancing their livelihoods.

1.2 Contexts for the study

There are a number of contexts for this study. The first is the role of crops and trees in the livelihoods of rural Papua New Guineans; the second is the role and future prospects of forestry in contributing to economic development and rural livelihoods in PNG; and the third is the immediate research context of this PhD study. Each of these is discussed below. In this section, as throughout the thesis, rural Papua New Guineans who farm on a small, family scale and access land through traditional land allocation systems are referred to as 'landowners'; this is the terminology commonly used in PNG to recognize members of a land-holding group, such as a clan, who exercise resource and use rights over land that is recognized, both customarily and formally, as theirs (see, e.g., Filer and Sekhran 1998). In the context of other countries, PNG landowners would often be described as 'smallholders' or the equivalent.

Papua New Guinea has a dual economy, comprising both formal and informal elements. The formal economy is dominated by large-scale resource projects, particularly in mining, petroleum and logging, and these provide a large proportion of government revenue. The informal economy supports 85% of the people through semi-subsistence agriculture. Most people live and work in the subsistence sector, producing food for consumption, raising animals and building their own housing, as well as producing agricultural commodities for sale in domestic and international markets (McGregor and Bourke 2009). The proportion of people working in the formal sector is small, and they are concentrated in the urban areas and mining towns. Most rural Papua New Guinean receive limited income from agriculture and associated activities such as selling firewood, fish or animals. The estimated cash income to rural households from the sale of agricultural produce for the period 1990 -1995 was about K200 million per year (McGregor and Bourke 2009). A third of this was from the production of Arabica coffee; income from the sale of fresh food

accounted for 22 percent, cocoa 11 percent, betel nut and betel pepper 10 percent, copra 8 percent, oil palm 3 percent, firewood 3 percent and fresh fish and shells 2 percent (McGregor and Bourke 2009). Sales of fresh food provided cash income to more households than any other activity. Income sources for rural households from non-agricultural sources included those from small retail business, particularly retail stores; transport business; the sale of manufactured goods; trading as middle man; paid labour for other villagers, or for businesses such as logging or plantation companies; remittance of money from relatives; royalties from mining and logging activities; and compensation from mining operations (McGregor and Bourke 2009).

1.2.1 The role of forest resources in rural livelihood systems in PNG

PNG has a history of agriculture of about 10,000 years (Bourke 2009). Trees grown or managed for particular purposes are an integral part of PNG farming and land use systems, and the diversity and dynamism of these systems reflect PNG's high level of innovation and adaptation in agriculture (Kanowski *et al*. 2008).

Throughout PNG, plant resources are fundamental for people's livelihoods. Plants provide people with – for example - energy, fibres, food, medicines, poisons, raw material for building shelters and boats, tools and weapons; Powell (1976) recorded 1035 plant species, representing 470 genera of 146 families, with specific uses in PNG. Traditionally, a significant proportion of the total food output in subsistence production systems originated from tree crops (Barrau 1955; Powell 1976). For example, Hanson *et al*. (2001) estimate that some 10 percent of the population of PNG is dependent on sago as the dominant staple. Food from trees originates from wild, semi-domesticated and domesticated sources, some of which are cultivated in gardens and some of which are collected from forested landscapes (Kennedy and Clarke 2004). Powell (1976) listed 251 plant species as source of food; 63 percent of these were gathered from forests, savannahs and grasslands; 20 percent were both cultivated and harvested as wild resources, and 17 percent were cultivated. As well as their use as food and raw materials, some PNG tree species have been adapted and used extensively as part of the fallow cropping to manage soil productivity; a notable example is *Casuarina oligodon* in the highlands fringes of Papua New Guinea (Bourke 1997; Clarke 1993).

There has been limited plantation forestry development in most parts of PNG, notably 6,500 ha of *Araucaria* plantations near Bulolo; 27,800 ha of *Eucalyptus* in Madang, East and West New Britain and Western Highland Provinces; some 12,000 ha of *Acacia* grown for wood pulp near Madang, 4,200 ha of *Tectona grandis* at different locations around the country; and 5,000 ha of balsa plantation in East New Britain Province (Midgley *et al*. 2010). Nucleus estate agriculture with other tree crops, initially with coffee in the Highlands and more recently with oil palm in East and West New Britain and Oro provinces, has been particularly successful; the earlier central role of plantation estates in coffee production has now significantly diminished, and smallholder coffee production on customary-owned land now provides up to 80 percent of PNG's coffee exports (ADB 2007).

A further constraint to future forest-based development is that the history of unsustainable forest harvesting practices means that secondary forests resulting from harvesting since the 1970s are unable to support the levels of yield envisaged in forest management planning (Bird *et al*. 2007). The potential income stream from forest harvesting to both landowners and the national government will diminish substantially as a consequence.
Small-scale 'eco-forestry' projects, based principally around the use of portable sawmills, were initiated largely by non-government organizations in the 1980's as an alternative to the large industrial exploitation model of native forest. However, as Hunt (2000) discusses, eco-forestry enterprises have seldom have proved success without external subsidy. The main constraints here are transport infrastructure and market access (Holzknecht *et al*. 2011).

1.2.2 The role of forestry in PNG's development

Some 71 percent (33 million ha) of PNG's total land area of 46 million ha is still forested (Shearman *et al*. 2008). There is an active debate about the extent, rate and causes of deforestation and forest degradation in PNG (e.g., Filer *et al*. 2008; Shearman *et al*. 2008). Filer and Sekhran (1998) reported that some 4 million ha of PNG's forests had been intensively harvested for log exports, with perhaps 0.5 million ha of these subsequently converted to agriculture, around 1 million ha regenerating to forest, and around 1.5 million remaining as degraded secondary forest. Shearman *et al*. (2008) suggest that rates of deforestation and degradation have been higher. However, it is widely agreed that unsustainable forest harvesting levels and practices over more than 30 years, extensively documented elsewhere (e.g., Filer and Sekhran 1998; Hunt 2002; ODI 2006), mean that commercially-accessible natural forest will largely be depleted over the next decade or so. More recently, the use of Special Agricultural and Business Leases and associated Forest Clearing Authorities appears to have offered developers a means to convert large areas of forest to agriculture without the usual constraints applying to forest-based development, and may accelerate the deforestation rate greatly (Ase *et al*. 2011).

The reasons for PNG's poor status in rankings such as the Human Development Index have been extensively discussed elsewhere (e.g., AusAID 2006; Filer and Sekhran 1998). Although analyses and proposed policy responses vary, there is broad agreement on the need for PNG landowners to generate income from land uses that are more sustainable and enduring than industrial-scale logging has proven to be in the PNG context (e.g., AusAID 2006).

1.2.3 Implications for tree growing

The preceding discussion has outlined both the importance of forests to rural Papua New Guineans and the imperative for income generation to enhance their livelihoods. Generally, the income generation options for PNG landowners are very constrained. The area that can be developed as intensive agriculture is limited by inherent environmental constraints, particularly soil (Blaikie and Brookfield 1987) and by lack of infrastructure. Consequently, incorporation of other valuable crops, such as trees, into land use systems is likely to be a good option for landowners in many parts of PNG (e.g., AusAID 2006). Growing commercial timber trees can build on PNG landowners' traditions of innovation in farming systems and capitalize on the improving terms of trade for high-value tropical timber (Kanowski *et al*. 2008). Partly in recognition of these factors, the PNG Forest Authority has developed draft national eco-forestry and reforestation policies; these are indicative of the emerging focus on forms of forestry activity other than industrial-scale logging. However, these policies have yet to be adopted formally and, as many analysts have noted (e.g., Bond 2006; Hunt 2000), policy implementation is severely constrained by capacity and financial limitations, and so little of the good policy intent is able to be realized by government agencies. For these reasons, as Filer and Sekhran (1998) have noted, community-based and non-government organization have played, and continue to play, fundamentally important roles in policy implementation.

It was in recognition of these contexts that the Australian Council for International Agricultural Research (ACIAR) commissioned a project, summarized by Kanowski *et al*. (2008), with the primary objective of conducting research to provide information that would foster the adoption of commercial tree growing by rural Papua New Guineans as a means of enhancing their livelihoods. The ACIAR project was developed from a scoping study that concluded:

> The depletion of Papua New Guinea's natural forests, the skills and innovativeness of many PNG landowners in adaptive farming systems, and the good market prospects for tree species that can be grown in PNG, create new opportunities for PNG customary landowners to benefit from deliberately planting and managing commercially valuable trees.
>
> Research and experience in PNG farming systems and forestry suggest that there are both land use systems and regions in which various forms of high-value tree growing could be developed on a commercial scale. There is already good knowledge of PNG land use systems, candidate species, and institutional and structural

> constraints to adoption, and some knowledge of landowner decision-making processes relevant to tree-growing (Kanowski *et al*. 2008: 127)

This PhD study was situated within that ACIAR project in order to address the limited knowledge of PNG landowner decision-making processes relevant to tree growing for income generation at the household level.

1.3 Research approach, objectives and theoretical frameworks

The research approach and objectives for this study were developed in the context of three theoretical frameworks. Each of these, and the rationale for drawing from each of them, is discussed in Chapter 2. The first of the theoretical frameworks draws largely from human psychology, particularly that developed by Maslow (1954) as the Hierarchical Needs Theory; this is used to explore the different kinds of motivation influencing individuals' land-use decisions. It informs the understanding of the motives, aspirations and needs of landowners and points of articulation between the household and market economies. The second theoretical framework is the Sustainable Livelihood Framework (Chambers and Conway 1992); this is used to explore the relationship between people and their livelihood assets, and examines how these assets are deployed to enhance their livelihoods. It informs the understanding of the interactions between two forms of economy in which PNG landowners operate, and how these influence landowners' decisions and land-use behavior. The third theoretical framework is the Farmer's Land-Use Decision Framework (Pannell *et al*. 2006; Rogers 1995); this is used to examine landowner's land-use decision processes. It informs the understanding of how the interaction of these processes affects decisions about the opportunities for commercial tree growing as a livelihood option for PNG landowners.

Thus, this research takes the household as the unit of analysis and seeks to understand land-use decisions and practices in the context of a household's aspirations, motives and behavior. It therefore necessarily addresses the interface between subsistence food production and cash economy and seeks to elucidate the process by which these two economies, as well as the biophysical and social environments, interact and influence the land-use choices of PNG rural households.
In this context, the specific research objective for this study was to understand how PNG landowners, operating at the interface of the subsistence and cash economies and in particular biophysical and social environments, make land-use choices in the context of their livelihood strategies. A subsidiary objective was to consider how these choices might impact on the opportunities for landowners' adoption of commercial tree growing.

The research was conducted on a case study basis in four regions of PNG. The case study locations and reasons for their choice are discussed further in Chapter 4.

1.4 Research questions

The primary research question on which the study focused was:
On what basis do Papua New Guinea landowners make land-and-resource-use choices?
This primary question was investigated through two subsidiary questions:
1) What are landowner households' livelihood strategies?
This requires assessment of relevant components of households' livelihood assets, household engagement in subsistence and cash income-generating activities, household patterns of consumption and expenditure, and household allocation of labour.

2) How do these strategies influence landowner households' land- and resource-use choices?
This requires assessment of households' decision processes about use of their land and other resources.

The thesis also considers the implications of the answers to these questions for decisions landowners might make about the adoption of commercial tree growing. This requires situating landowners' tree-growing decisions in the context of those about land- and resource-use.

1.5 Outline of thesis

The thesis is organized and presented in four parts:
Part 1 comprises introductory, background and contextual chapters. In Chapter 1, I introduce the research topic with brief descriptions of forests in the context of the livelihood system of the rural people in PNG and as a resource for the country's economic development. From this background, I then develop the research questions guiding this study. Chapter 2 provides a background literature review, the first part of which takes a synoptic overview of theoretical constructs used in these analyses. In the second part, I bring these into the context of PNG landowners and review the household economy (production, consumption, exchange behaviour, labour organization) of rural communities in PNG and assess their land-use choice decisions.

Part 2 covers Research Methodology and comprises Chapters 3 and 4. Chapter 3 presents detailed accounts of research design, ethical considerations and methodological procedures involved in both the work of field data collection and the data analyses processes. Chapter 4 presents study sites and their general characteristics; these are the Upper Ramu Valley, the Upper Markham Valley, Western Province and the Lower Madang region. This chapter is concerned with providing the general socio-economic and environmental context against which landowners' land-use decisions are assessed.

Part 3 of the thesis presents the case study results in each of Chapters 5, 6, 7 and 8. These chapters provide a detailed synthesis of land-use behavior analyses for each of the study sites investigated, and explore the overarching drivers in the land-use choices of PNG landowners.

Part 4 comprises Chapters 9 and 10. In Chapter 9, I consolidate the study findings from the earlier chapters and their relationship to the research questions. In Chapter 10, I explore the implications of the research results for possible strategies for commercial tree growing as a contribution to the livelihoods of the rural people of PNG.

9.7 Conclusions

The study investigated the primary research question: *On what basis do Papua New Guinea landowners make livelihood and land-and resource-use choices*? It found that land-and resource-use choices of landowners were influenced by many interacting factors. The key was their needs and aspirations, the livelihood outcomes they sought, their knowledge and skill base, the institutional systems and processes within which the landowners operated, and their capital assets. It was also evident that while the opportunities for landowners differed between case study regions, thus influencing day to day decisions on the specific nature and scale of land use activities, the motives, behaviour patterns and attitudes to land-use opportunities were consistent across regions and with those of the farmers elsewhere.

Landowner motives and land- and resource-use choices

The research has shown that Papua New Guinea landowners' land-use decisions integrate two economic systems, the subsistence and the cash economies. Throughout Chapters 5 to 8, the study result shows that key land- and resource-use decisions were focused on feeding and clothing households; on meeting the costs of education, health, transport and communication needs; and other needs and social obligations. While the primary goals of landowners were survival, self-sufficiency, minimising risk, maximisation of household income and fulfilment of social obligations, there were also longer-term foci on longer-term prosperity and enhancement of social values, whilst maintaining the stability of family units and the community at large.

Livelihood outcomes

Despite substantial cultural and regional differences, land-and resources-use choices of the landowners were consistent across regions. The results presented in Chapters 5 to 8 show that the principal outcomes landowners sought from their land management activities were subsistence food production, cash income generation, risk management, fulfilment of social obligations, and pursuit of entrepreneurial opportunities. Each of these is pursued with varying degree of

commitment of labour and land, depending on the opportunities and personal preferences and values. Landowner behaviour generally followed the underlying assumptions postulated in the Maslow's Hierarchical Needs Theory.

Assets and alignment of land-use strategies with household needs

The study found that key assets of the landowners were land, labour and financial resources. Labour was found to be the most limiting factor constraining landowners' adoption decisions, and their production systems and levels. The key issue for landowners in their land- and resource-use choices is how to align assets and production strategies with the different needs of the household. In response to these aspirations and livelihood necessities, landowners plan and strategise their land-use activities over three different time horizons: the immediate future, principally in terms of food production; annual or similar cycles, principally in relation to recurring cash requirements; and the much longer-term, which is associated with both intermittent cash requirements and legacies for future generations. Commercial tree growing options fit well with the second and third of these time horizons, particularly when labour requirements can be integrated with other work.

Knowledge and skills base

The study also found that levels of education and skill were very critical factors in the land-and resource-use choices of the landowners. The knowledge and skill base of the landowners influenced land- and resource-use decisions of the landowners in two ways. The first is related to the level of education of the decision-maker. This had an effect on the opportunity for off-farm employment, particularly for the jobs that required specialised, formally trained skills. Secondly, the ability of the landowners to make informed choices about given opportunities, particularly in relation to adoption and production related choices was influenced greatly by the level of the education of the decision-maker. This was found to be major constraint on the land-and resources-use choices of the landowners, and is likely to be a constraint to commercial tree growing as a livelihood option for the landowners.

Institutional systems and processes

This study found that the institutional processes were critically important in facilitating agriculture and forestry interventions. The key issues were appropriate policies, supported by responsive organisational structures and effective service delivery mechanisms. The study found that successful adoption and production of introduced cash crops were attributed to the effective extension and communication strategies, and that private sector partnership models proved very successful in in adoption and production systems. The study also noted that, while PNG's customary tenure system may appear unattractive to some private sector investors in terms of resource security, approaches based on the development of Incorporated Land Groups and use of 'lease, lease-back' arrangements have proven successful in facilitating agricultural development. However, the study also noted number of issues with institutional processes and capacity that need to be resolved in order to facilitate commercial tree growing activities as a livelihood option for landowners in Papua New Guinea. These are discussed further in Chapter 10.

10.6.1 Recommendations for research and policy

The study findings provide an adequate understanding of the relationship between landowners' motives, livelihood assets and strategies, desired outcomes and land-and resource-use decisions. The study findings also suggest that commercial tree growing activities can be conceived and designed so as not to compete with food and other cash income-earning activities, or with the important livelihood assets of land and labour. However, there are needs for further research in the areas of knowledge and skills, and institutional systems and processes, and in policy development.*243*

ISSUE 1 Technical knowledge and skills relevant to commercial tree growing

As this study noted, whilst subsistence-based agroforestry is well established within the production system of the landowners, its application for commercial timber growing is very limited due to lack of technical knowledge and skills about commercial and lack of business and marketing skills. To address these issues, it is recommended that programs be developed to communicate to interested growers:

1) Basic knowledge about commercial tree species nursery production, establishment and management;

2) Basic knowledge about commercial decisions related to tree growing within the context of landowners' livelihood systems, and about markets for tree products.

ISSUE 2 Institutional Systems and Process

These vary in scope, scale and urgency. Those of most immediate importance the lack of appropriate policies, the lack of extension and service delivery mechanisms, the lack of physical and market infrastructure, and strategies for best accessing and using the traditional land tenure system. To address these, it is recommended that the relevant agencies of government, particularly the Papua New Guinea Forest Authority:

1) Complete and have promulgated the Reforestation Policy that is currently in draft form, and that policy be informed by the results of this study;

2) Create a forest extension division headed by social scientist within the National Forest Service within the PNGFA, to provide forest extension and communication delivery services;

3) Explore options for funding the activities proposed above, including the use of the reforestation levy or other public funds or levies, or from externally funded assistance; and

4) Explore options and strategies for strengthening and fostering tree growing through various incentives schemes.

Addressing these institutional issues will provide a stronger foundation from which the potential for commercial tree growing by PNG landowners can be realised and in ways that enhance livelihoods and contribute to realising their aspirations.

11.4 Appendix 4. Financial performance measures

This appendix provides definitions for each of the financial performance measures used in the discounted cash flow analyses of alternative planted tree production systems.

Net Present Value

Net present value (NPV) is the sum of the flow of annual net returns, each of which is expressed as a present value. It is calculated by subtracting the present value of costs from the present value of revenues associated with an investment. A present value is the equivalent value today of a cost or revenue incurred or generated in a future period. For this study all present values are in 2010 prices which is the year for which most of the data were collected. Discount rates are used to calculate present values of costs and revenues that occur at different times and a real discount rate is used when benefits and costs are defined in constant value terms. The following formula is used to derive NPV:

$$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

where B_t is the value of benefits in year t, C_t is the value of costs in year t and r is the discount rate.

Discount rate

The discount rate allows all costs and returns incurred in future periods to be expressed in equivalent present-value terms. The discount rate is equivalent to the rate of time preference, which is the rate at which the future is discounted to establish an equivalent present value.

The choice of discount rate is important as small variations can result in significant changes to NPV. For example, a high rate favours investments that have a short-term pay-off over those that take many years before they mature. The rate selected can be the rate required by an investor, the rate of return from an alternative investment (opportunity cost of capital) or it can be a target rate of return. Choice of rate also depends on whether the project or investment is a private decision or a public decision. A private rate of discount is appropriate for evaluating tree production systems. The chosen discount rate could be the interest rate on borrowed funds or the opportunity cost of using own funds such as a long-term deposit rate from a financial institution or the rate on long–term government bonds. All costs and revenues used in the analyses are in constant 2010 values and a real discount rate is used.

Poor households tend to have a relatively short time preference and therefore they have a high discount rate or a high minimal acceptable rate of return. Therefore, for the analyses a range of discount rates were used: 7.5% which is a moderate risk adjusted discount rate, 10%, which is high risk adjusted discount rate and 20% which is very high risk adjusted rate.

Internal rate of return

The internal rate of return (IRR) is the discount rate that equates the present value of the revenues with the present value of the costs of an investment. It is the rate at which the net present value of an investment equals zero. If the IRR exceeds the discount rate, then

the project or investment is considered to be profitable. The IRR is obtained by applying the following formula:

$$\sum_{t=0}^{n} \frac{B_t}{(1+IRR)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+IRR)^t} = 0$$

where B_t is the value of benefits in period t, C_t is the value of costs in period t and IRR is the discount rate that equates the present value of benefits with the present value of costs.

Annual equivalent value

The annual equivalent value (AEV) is the annual equivalent of the NPV. It is a useful measure for comparing net returns from a land use activity that spans several years such as forestry, with annual land use activities such as cereal or vegetable crops or other perennial crops that are productive over several years. It is a practical measure to use in this study as the different timber production systems involve different time periods. The AEV allows comparison of investments that have unequal lives, implicitly assigning a common life of infinity to all investments being considered. This measure is also referred to as the equivalent annual annuity (EAA. An annuity is a series of equal annual payments. In selecting between projects or investments the preferred choice is the one with the highest AEV. The formula for determining the AEV is:

$$AEV = r\left(\frac{NPV\,(1+r)^t}{(1+r)^t - 1}\right)$$

where r is the discount rate, NPV is the net present value and t is the term of the investment or the rotation length in the case of a forestry investment.

Benefit-Cost Ratio

The Benefit-Cost Ration (BCR) is the ratio of discounted stream of benefits to the discounted stream of costs. If the ratio is greater than one, then the investment yields more benefits than costs and is considered viable. The BCR is computed using the following formula:

$$B/C = \left(\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}\right) \Big/ \left(\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}\right)$$

where Bt is the value of benefits in period t, Ct is the value of costs in period t and r is the discount rate.

Return to labour

Return to labour is the wage rate that sets the NPV equal to zero, which is also referred to as the breakeven wage rate. It is the highest rate that can be paid for an additional unit of labour before the NPV becomes negative. Where the return to labour exceeds the minimum daily wage rate or the off-farm wage rate, individual land owners are better-off financially applying their own labour to growing trees for timber products rather than working for wages. Return to labour is a useful primary indicator of profitability for smallholders where labour may be a limiting or critical resource. More knowledge intensive timber production systems, such as sawlog production, place increased demands on labour and so it is valuable to explore returns to labour as a performance measure.

11.5 Appendix 5. “Making money from trees” – Costs & Returns Calculator

Excel spreadsheet available separately from ACIAR.