Endospermum medullosum (whitewood) value chain analysis and opportunities for value-adding in Vanuatu

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Endospermum medullosum (whitewood) Value Chain Analysis and Opportunities for Value-Adding in Vanuatu

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Thesis submitted to the Graduate Research College, Southern Cross University, Australia, in fulfilment of the requirements for the degree of Master of Environmental Science, Management and Engineering

OCTOBER 2013
Thesis declaration

I certify that the work presented in this thesis is, to the best of my knowledge and belief, original, except as acknowledged in the text, and that the material has not been submitted, either in whole or in part, for a degree at this or any other university.

I acknowledge that I have read and understood the University's rules, requirements, procedures and policy relating to my higher degree research award and to my thesis. I certify that I have complied with the rules, requirements, procedures and policy of the University (as they may be from time to time).

Print Name: **Rexon Viranamangga**

Signature: …

Date: 1st October 2013
Abstract

The native tree species whitewood, *Endospernum medullosum* Euphorbiaceae, is well known as a native forest timber from Vanuatu which can produce large volumes of wood within 15-20 years when managed in plantations. Its domestication is well advanced in the country, where seed can be sourced from first generation seed orchards and where considerable silvicultural expertise has been developed. Although the existing value chain for whitewood is based mainly on trees from native forests, this resource is virtually exhausted and there is an opportunity to develop strong value-added uses for plantation-grown trees.

The objectives of this research were to elucidate the various components of the whitewood value chain, for both domestic and export markets, to identify impediments to the development of a whitewood plantation and processing sector, and further identify opportunities for value adding.

Interviews were conducted in Vanuatu with 115 respondents from the islands of Santo and Efate to understand the existing value chain and identify value-adding opportunities. The respondents were whitewood growers (one of a larger plantation of 270 ha and 60 owners of smaller woodlots), processors (31) including saw-millers, timber yard owners and furniture makers, and consumers (domestic (21) and overseas (3)).

The prices paid for whitewood vary greatly, from as little as $20 per m$^3$ for standing trees to more than $5,393 per m$^3$ for finished furniture and mouldings. In some cases, whitewood trees are harvested and sawn into rough boards with portable Lucas mills and transported to processing centres in the main towns, specifically Luganville, Santo and Port Vila, Efate. Rough sawn green timber is sold in Vanuatu for $380 to $490 per m$^3$ and exported to New Caledonia for processing. The products include dry clear timber envelope-treated for $639 to $659 per m$^3$, dry clear timber envelope treated for domestic interior use for $658 to $2,028 per m$^3$, and finally dry mouldings and furniture at $3,852 to $5,393 per m$^3$.

Specific challenges that growers and processors need to confront along the value-chain are; the need to distinguish domestic whitewood from treated *Pinus radiata* products imported into Vanuatu from New Zealand; the creation of efficient methods of transport from logging sites to processing centres; the need to saw and dry boards quickly after tree harvest; the development of wood treatment (impregnation) techniques, preferably with substances not toxic to humans and wildlife; protecting boards from bluestain, which develops quickly on freshly cut trees; utilising sawing technologies that can be employed in isolated rural conditions to produce boards and small pieces for later value-adding; development of viable products from short, knotty pieces; and economical ways of producing high-value products like mouldings.
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1. INTRODUCTION

1.1 Study background
This study of the value chain and opportunities for value-adding on *Endospermum medullosum* (whitewood) in Vanuatu was sponsored by the ACIAR John Allwright Fellowship under the ACIAR Whitewood Silviculture Project (FST/2005/089). It was a four year project (2007-2011) which aimed to carry out applied research and develop cost effective silvicultural prescriptions for whitewood in monocultures and integrated plantings with other tree species and agricultural crops. The project was managed and implemented by Southern Cross University in partnership with the Vanuatu Department of Forests and Melcoffee Sawmills. Melcoffee Sawmills is the leading private company in both whitewood value-adding and plantation establishment in Vanuatu.

1.2 Statement of the research problem

The present forest utilisation procedures, management, policies, processing and marketing in Vanuatu are structured to serve medium to large-scale natural and plantation forest producers but not small and isolated forestry farmers in the rural areas. The whitewood market appears to be restricted by the low number of timber yards with pressure treatment plants or kiln dryers, and by buyers who offer market prices for untreated whitewood timber below production cost. The other problem faced by the whitewood industry is the flooding of the local timber market by imported softwood (McGregor and McGregor, 2010) making it difficult for whitewood farmers to profitably harvest and process their trees. Many farms with planted whitewood, which is ready to harvest, have trees which remain standing in unmanaged stands with low mean annual increment (MAI) because of high competition for space, light, water and nutrients among the trees.

Russell and Franzel (2004) state that agro-forestry research and development is normally concentrated on tree establishment and management, and often ignores the product, processing and marketing aspects that should be the starting point in tree plantings. This is supported by Price (1998) who said that tree value depends on the processing costs and the end products. Better markets can mean higher value for the products. Scherr (2004) explains that forestry farmers require viable wood markets to effectively venture into business partnerships to supply gaps in the forest products value chain. The Department of
Forests staff only trained and advised whitewood farmers to plant healthy and vigorous trees without training on product development and without providing information on processing and marketing.

The study of value chains describes a business as a chain of activities converting inputs into outputs valued by customers. Pearce and Robinson (2007) provide a good structure for an understanding of how products are processed. The actors in the whitewood value chain need to develop new skills and have support from service providers to effectively engage and have better understanding of markets, whether local or international. That would allow the actors to work in collaboration and be competitive in the marketplace.

1.3 Aim and objectives of the study

The aim of this study is to explore and elucidate the existing value chains and identify value-adding opportunities for whitewood, using value chain analysis. Most importantly this study should contribute to developing ideas to improve the economic efficiency of the whitewood industry and encourage a higher degree of participation by all stakeholders along the value chains. The entire process of whitewood production, from collecting seed, growing trees in the nursery and plantations, to processing and marketing various products to consumers by individuals and companies will be examined.

The main objectives of this research were to:

1. define the existing value chains of whitewood,
2. explore, in detail, options for value-adding of whitewood,
3. identify the various levels of governance in the whitewood value chain and how they are contributing to the whitewood industry, and propose changes and new initiatives required to improve the governing systems.

1.4 Organisational structure of the thesis

- Chapter One provides the study background, problem statement of the study, aim and objectives of the study and presents the background information on Vanuatu.
- Chapter Two presents the overview of the literature that covers the background information of whitewood, the theory of value chain analysis and value-adding.
Chapter Three presents the different types of sampling designs and techniques and the methods of data collection used in the field survey. It also includes a brief introduction of the methods and justifications of the study approach.

Chapter Four presents the components of the field study, their importance and reasons and the anticipated results from each component required to achieve the study objectives.

1.5 Background information

1.5.1 The Country

Vanuatu is a Y-shaped archipelago which lies in the western Pacific Ocean in the middle of a triangle formed by the Solomon Islands, New Caledonia and Fiji. The archipelago stretches approximately 1,400 km from north to south between the latitudes of 13 and 21° S and longitudes of 166 and 172° E and comprises more than 80 islands, 67 of which are inhabited, and 12 of which are considered major in terms of land area. The islands are of volcanic origin along with coral atolls.

Vanuatu is located on the belt of oceanic trenches, island arcs, volcanic mountain ranges and plate movements that encircles the basin of the Pacific Ocean normally known as the Pacific Ring of Fire. The New Hebrides island arc in Vanuatu has been notably modified by collision with several key submarine ridges and plateaux (Mefrel and Crawford, 2001). There are several active volcanoes on some of the islands and earthquakes are common.

The climate varies from tropical in the north to subtropical in the south. The interaction of the general equatorial circulation pattern with the local orographic effect of each island’s topography, are the main influences on the climatic conditions of the south west Pacific (Bellamy, 1993). In the “wet” season (November to April) the moisture content of the atmosphere is so high that any orographic effects on rainfall are minimal and high rainfall is experienced widely on the islands. In contrast during the “dry season”, the easterly trade winds are drier and rainfall is strongly influenced by orographic effects. Normally rainfall is heavier on the south-east facing slopes while the northern and western sections of the islands are relatively dry. The long-term annual average precipitation is 2252mm, measured from Pekoa Airport, which is the only weather station on Espiritu Santo (hereafter known as Santo). Santo has a hotter, wetter season from November to April, with the highest monthly mean precipitation of 299mm falling in February, and a cooler “dry” season with August on average receiving just 83mm (Terry, 2011). Elevations on Santo vary up to the highest point, Mt Santo, at 1704m. Terry (2011) took data recorded from 1974 to 2007 at Pekoa and data collected by the Vanuatu Meteorological
Service from nine sites on Santo for the period 1981-84 and estimated annual average rainfall to range from a low of 2252mm at Pekoa (45m elevation) to 5550mm at Tankara (606m elevation). The average temperature in Vanuatu for February (warmest month) is 26-30 degrees and August (coolest month) is 19-23 degrees (Bellamy, 1993).

Most of the archipelago lies within the cyclone belt and there are roughly two cyclones per year. Between 1970 and 2006 some 84 cyclones affected parts of Vanuatu with strong winds (Terry, 2011). Although cyclones in Vanuatu tend to follow a southern or south easterly course, they are known for their erratic behaviour. The greatest frequency of cyclones is during January and February but they can occur in any of the hotter months, from November to April. Rainfall during these events can be quite substantial, ranging up to the maximum recorded of 267mm in one day during cyclone Sarah in 1994.

Vanuatu’s total land area is about 12,190 km\(^2\) of which 36% has forest cover (>10m tree height), 43% is lower woody and mangrove vegetation and 21% in other land uses. The Exclusive Economic Zone (EEZ) covers an estimated area of 680,000 km\(^2\) and the country shares maritime borders with New Caledonia, the Solomon Islands, and Fiji. Approximately 97% of the land and sea and their resources are under customary tenure (Nari, 2000).

Fernandes de Queirós, a Portuguese explorer, was the first European to visit Vanuatu. He landed on Espiritu Santo in 1605 claiming the archipelago for Spain and naming it Espiritu Santo. Later, in the year 1774, Captain James Cook explored the islands, named most of the main islands and called the group New Hebrides. In the 1880s France and the United Kingdom claimed parts of the country, and in 1906 they agreed on a framework for jointly managing the archipelago as the New Hebrides through a British-French Condominium government. This Condominium governed the New Hebrides until 30\(^{th}\) July 1980 when the country gained its sovereignty and was named Vanuatu.

In Vanuatu, land is constitutionally owned by the indigenous people (Ni-Vanuatu) and Chapter 12 of the Constitution adopted during the Independence of Vanuatu from the British and French Condominium in 1980 specifies the legitimacy of land dealings. The three sections under Chapter 12 ruled that all land, including the natural resources on the land, belong to the indigenous traditional owners and their descendants and custom rulings are the basis of land rights. Only indigenous people have the right to own land in Vanuatu (Tacconi & Bennett, 1994). The association of Ni-Vanuatu and the land is embedded...
within the diverse cultures that have complex access and use rights to the resources. This was not well understood by the early foreign settlers in Vanuatu. The first Minister of Lands, the Honourable Sethy Regenvanu symbolized the relationship between Ni-Vanuatu and their land as a baby being nurtured by a mother. Land is their identity that binds them with their culture. Other people could be allowed to use the land or the resources on the land but the rights of ownership will always remain with the customary owners (Trease, 1987). The Vanuatu land tenure system differs to its Melanesian neighbours, Solomon Islands and Papua New Guinea, where land is held by tribes usually under the commons (Rodman, 1987).

1.5.2 The People

The indigenous people of Vanuatu, called the “Ni-Vanuatu”, are Melanesian in origin. The first people to have settled in the islands of Vanuatu are known as ‘lapita people’ thought to have originated from South East Asia some 2,500 years ago. Lapita people were the explorers of all the Melanesian and Polynesian countries in the Pacific. This was recognised by Patrick Vinton Kirch, an archaeologist at the University of California at Berkeley, who followed their trace of pottery (Dye, 2000). Ni-Vanuatu are culturally heterogeneous which is reflected in the great diversity of languages spoken throughout the country. There are approximately 113 different languages spoken throughout the archipelago (Tryon, 1996). The national language is called Bislama or Pidgin-English and is a language made up of a mixture of mainly English and French words. Bislama began in the early period of European trading and was originally mainly a trading language. Later the language developed into a common language for communication throughout the islands and today it is a first language of second- and third-generation urban dwellers. Today Vanuatu has Bislama, English and French as the official languages.

Vanuatu is a Christian country primarily influenced by the Presbyterian, Anglican and Catholic missionaries who first brought Christianity to the islands. However, in recent years there has been a massive increase of Pentecostal churches in the country. Eriksen (2009) states the breaking way from mainline churches to join and form Pentecostal churches is related to general political development and powerful movement working for social change to safe guard members’ social and economic interests and achievements.

The total population of Vanuatu was 234,023 in the 2009 national population census. From
1999 to 2009 the population growth was recorded at 2.3% per annum. Approximately 98% of the population consist of indigenous Melanesian people. The other segment of the population includes people of different nationalities, such as Australian, New Zealand, European, Asian and other Pacific Islanders. Most of the population (76.6%) live in the rural areas as subsistence farmers and depend entirely on agriculture and fisheries. The population density is 19 people per km$^2$ compared to 15.3 in the 1999 population census (National Statistics Office, 2009).

In between 1999 and 2009, the urban population has increased by 21.5%, an increase of 40 to 57 thousand people with 77% of the urban population living in Port Vila, Efate and 23% in Luganville, Santo. The number of males was 119,000 and 115,000 females (National Statistics Office, 2009).

1.5.3 The Government

The Republic of Vanuatu is a parliamentary democracy government and the constitution provides for a representative parliamentary system. The President as the Head of the State is elected for a five-year term by the Electoral College consisting of the Parliament and the six Provincial Governments’ Presidents. The Prime Minister as the Head of the Government is elected by the party (or a coalition of parties) with the greatest representation in the parliament that forms the government. The President of Malvatu Mauri who advises the government on matters regarding Ni-Vanuatu culture and tradition is elected by the district councils of chiefs.

Vanuatu’s political structure consists of legislative, executive and judiciary branches. Parliament is the legislative branch, which is comprised of 52 Honourable Members of Parliament elected by the people for a four-year term. The executive branch is the Cabinet and is comprised of the Council of Ministers appointed by the Prime Minister. Currently there are thirteen members of the executive branch responsible for overseeing the administration of its thirteen ministries.

The judiciary branch consists of the Supreme Court, a Magistrates Court, Land Tribunal Court, Island and Village Courts. The Chief Justice and three other charges who mind the affairs of the Supreme Court are appointed by the Head of State. Recently Land Tribunal Courts representing the Supreme Court were established on the islands to solve customary land disputes. The judiciary is vested with the responsibility to administer justice in Vanuatu and its basic function is to resolve matters of law.
Vanuatu is divided into six provinces namely: Torba, Sanma, Penama, Malampa, Shefa and Tafea. The six Provincial Councils are under the portfolio of the Ministry of Internal Affairs and are administrated by the Decentralisation and Local Government Act. This act empowers the Provincial Councils to make by-laws with regards to the management of the natural resources. Members of the Provincial Councils are elected for a four-year term by people of the respective provinces. The President is the Head of the Provincial Council and is elected by a party (or a coalition of parties) with the greatest representation in the Council that forms the Provincial Council.

Vanuatu has two Municipal Councils, Port Vila on Efate and Luganville on Santo. Similar to the Provincial Council, the Municipal Councils are under the portfolio of the Ministry of Internal Affairs, and are administered by the Municipalities’ Act of 1980. The Municipalities’ Act provides for the formal establishment of the Municipalities. Members of the Municipal Councils known as Councillors are elected every four years by the municipal residents. The Mayor as Head of the Municipal Council is elected by a party (or a coalition of parties) with the greatest representation in the Council that forms the Municipal Council.

Therefore, there are three levels of government in the entire governing structure of the nation. The National Government headed by the Prime Minister, is responsible for overseeing the affairs of the entire nation and consists of the Parliament and the Council of Minister Cabinet. The Provincial Councils are responsible for the economic and social welfare of their people and finally the Municipal Councils are responsible for the administration of the two Municipalities, Port Vila and Luganville.

1.5.4 The Economy

Economic growth in Vanuatu over the last eight years has been high, averaging 4.3% per annum and is dominated by the service sector (68%); followed by agriculture (22%) and a smaller industry sector (10%) (VNSO, 2011). In 2009, the GDP was estimated at $554 million with an average per capita income of approximately $1500 per year (IMP, 2009). Vanuatu belongs to the group of Least Developed Countries (LDC) and of the 182 countries ranked by UNDP in relation to their development, Vanuatu dropped in the Human Development Index from 119 to position 128 in the 2009 (UNCTAD, 2012).

The economy of Vanuatu is a mixture of traditional and contemporary. The food/cash production activities (agriculture and fisheries) undertaken by the subsistence farmers in
the rural areas either in commercial efforts or more commonly, in self-sufficiency endeavours are not valued in the national income (gross domestic product). Thus the official estimate of around 20% for agriculture’s share in GDP undoubtedly underestimates the sector’s importance to living standards in Vanuatu (VNSO, 2011) albeit subsistence agriculture continues to contribute significantly to both income and food security.

Tourism has been developed since independence and, together with financial services, has become an important source of foreign exchange earnings for the country. The number of tourists arriving in the country between 2006 to 2010 increased by 86% from 68,179 to 126,693 and the number of tourists on cruise ships has almost doubled from 85,570 in 2007 to 140,388 in 2010 (VNSO, 2011). Other areas in the service sector that contribute extensively to the economy are infrastructure development, growth of real estate and increase in project funding by development partners. However, because the service sector activities and employment opportunities are concentrated in the urban centres, this contributed significantly to the high rate of rural-urban drift, particularly in Port Vila, Efate. Vanuatu has so far been largely protected from the impact of the global economic slowdowns, but slowdowns in Australia and New Zealand are likely to have spill-over effects due to the close links with these two countries in tourism and foreign direct investments (IMF, 2009)

Between 1999 and 2009 the agriculture sector grew by an average of 1.6% annually while the overall economy grew 3.3% and the population growth over the same period was 2.3% (VNSO, 2009). The agriculture sector accounts for the bulk of merchandised exports and major commodities are coconut oil, copra, kava, beef and cocoa. Although exports of premium grade spices, coffee, sawn timber, sandalwood oil and marine products to neighbouring Pacific countries can be small, the development of these products can diversify the export base of the agriculture sector (VNSO, 2011).

Agricultural producers in Vanuatu need to consolidate production and improve quality by increasing competitiveness in the higher value markets and thus increase export volumes and prices for these key products. The major constraints for small farmers to compete with imported products are; isolation of farmers on the islands that involve high domestic (intra-island) transport costs, inadequate quantity and inconsistent supply of products, irregularity of quality of products that lead to uncertainties on the market and lack of infrastructure both in rural and urban areas. Information on standard requirements of products already on the market, research information on potential products and market
information are also lacking. Therefore, a value chain analysis on each product is vital to ensure all actors along the value chain need to learn not only how to produce but to identify profitable market opportunities, how to adapt and improve their products and how to work with each other in a market chain to meet consumer demand.

The contribution of forestry in the Vanuatu economy was reduced significantly after the year 2000 when the merchantable volume of timber, especially whitewood, was exhausted from the natural forests. Up until the mid-1990s, the value of forest products exported more than doubled, from $2.8 million in 1994 to $5.8 million in 1999, contributing up to 13% of the GDP in the same year (McGregor and McGregor, 2009). When the Malaysian logging companies ceased operation in 2000 due to the increasing scarcity of whitewood in the natural forests, the forestry contribution to GDP dropped to 7.7% in the same year (ITTO, 2005). Forestry products are now a minor export in the Vanuatu economy and development of both small and large scale forest plantations to supply production and value-adding processing industry for domestic and export markets is the pathway to increase forestry GDP (Viranamangga, et al., 2012).

1.5.5 Forestry Sector

Forestry and the people in rural communities are inseparably linked as forests can be not only a source of cash income but also provide a wide range of locally made products, food, water and environmental services that contribute to the livelihood of the people. In addition, forestry is a source of revenue collection for the government of Vanuatu through various forms of taxes and permits in commercial forestry operations and creating jobs for the people in the rural communities and urban centres in the forestry value chain.

Ownership and management of the forestry resources are primarily under the responsibility of the traditional landowners as specified in Article 7d and 71 of the Vanuatu Constitution on ownership and management of the land and land-based natural resources. However, following the above reasons the Vanuatu government is committed to ensuring that the forest is managed on a sustainable basis. The Forestry Act Cap 147 and 2011-2020 National Forest Policy provides the authority and directions on how the Department of Forests is to assist the traditional landowners to sustainably manage and utilise their forestry resources.

The eight chapters in the Forestry Act provide the provisions for the protection, development and sustainable management of the forests and regulation of the forestry
industry in Vanuatu. The vision of the National Forestry Policy is to manage the forestry resources in a way that provides continuous equity and environmental and social services to all people in Vanuatu (DoF, 2011). The National Forest Policy defines the roles and responsibilities of the major stakeholders such as the National Government, Department of Forests, Provincial Governments, Customary Chiefs, Landowners and Communities, Forest Industry and Non-government Organisations.

1.5.6 General information of study area

The study area is located on two of the main islands of Vanuatu; Espiritu Santo and Efate. The island of Santo is the largest island in the archipelago with a total land area of approximately 4,100 km$^2$ (Figure 1.1) while Efate is the fourth largest island with a total land area of approximately 900 km$^2$.

1.5.6.1 Espiritu Santo

![Map of the island of Espiritu Santo, Vanuatu.](source)

Source: Globe Holidays
Most of the inland and west coast areas of Santo are mountainous and hilly and have been formed by a number of distinctly different geological and geomorphic processes (CSIRO and QDPI, 1993). Santo has the highest mountain in Vanuatu, Mt Tabwemasana, at an elevation of over 1700 m. The vegetation on lower areas of the mountains, hills, gullies and river valleys is generally dominated by forests of moderate heights with a mix of hardwood species, while upper slopes, ridges and hills tops are dominated by low forests, scrubs and grassland. On the eastern side of the island the landforms are relatively flat and the structural surfaces have developed as a result of uplift and subsequent erosion and mass movement (CSIRO and QDPI, 1993). The vegetation is generally open tall forests with *Endospermum medullosum* and *Antiaris toxicaria* (milktree) dominating the canopy.

The coastal areas of the southern and eastern parts of the island are covered with coconut plantations and pastures for cattle grazing while the logged areas farther inland are covered with *Merremia peltata* (big leaf rope) and patches of shifting cultivation, forest plantations and cattle grazing. *Merremia peltata* is a creeping vine from the family Convolvulaceae and is identified as an invasive species in Vanuatu due to its fast-growing behaviour. Smith *et al.* (2012) reported that controlling *M. peltata* in whitewood monoculture is a serious challenge and that wider initial planting spacing requires frequent weed control.

Luganville, the second largest town in Vanuatu and a small industrial centre, is the commercial centre for the island where farmers trade their agricultural products. The rural population of Santo in the 2009 national census was 39,606 with annual growth of 2.5% while Luganville had a population of 13,167 growing at 2.0% (VNSP, 2009). The population of Luganville is quite diverse and the vast majority of indigenous Ni-Vanuatu come from the other islands, with a small population of Chinese and European descendants.

Most villages on Santo are accessible to Luganville by road except for settlements on the west coast. Santo offshore islands must use sea and air transport as their only means of transport to Luganville. Apart from the sealed road from Luganville to Port Olry village infrastructure in rural areas on Santo is poor and lacking proper waterway crossings.
The island of Efate (Figure 1.2) is similar to Santo and has a mountainous and hilly inland that was formed by a great variety of distinctly different geological and geomorphic processes (CSIRO and QDPI, 1993). Mt McDonald is the highest mountain on Efate with an elevation of 647 m. The natural vegetation on the western side of Efate is generally dominated by low forest with a mix of hardwood species in lower lying areas, gullies and river valleys while the vegetation is mainly woody shrubs and grasslands on upper slopes, ridges and hills tops. Landforms are relatively flat on the eastern side of the island as the structural surfaces have developed as a result of uplift and subsequent erosion and mass movement (CSIRO and QDPI, 1993). The vegetation is generally open tall forests up to 35 metres with *Endospermum medullosum* and *Antiaris toxicaria* (milktree) dominating the emergent canopy. The coastal areas of the southern and eastern parts of the island are dominated by cattle grazing, coconut plantations and shifting cultivation.

Port Vila, the capital of Vanuatu, is the commercial centre for Efate and offshore islands where farmers trade their agricultural products. The rural population of Efate in the 2009...
national census was 65,829 with annual growth of 4.5% while Port Vila was 44,040 growing at 4.1% (VNSP, 2009). Port Vila’s population is also quite diverse and the vast majority of indigenous Ni-Vanuatu come from the other islands, with a small population of Asian and European descendants.

Efate is the only island in the archipelago where all villages are accessible by road to the main city, that is, Port Vila. The Efate sealed ring road was built by the USA government in 2010 and has significantly contributed to the economy of Efate and especially benefited the local farmers transporting their agricultural products to be marketed in Port Vila.
2. LITERATURE REVIEW

2.1 Introduction

*Endospermum medullosum* (whitewood) is one of the native and premium timber species in Vanuatu that has traditionally contributed to more than 50% of the country’s annual log production (Vutilolo *et al*., 2005). Whitewood was exploited rapidly because it grows on the most accessible areas of the islands. Following the high demand for whitewood products in both local and export markets, the merchantable volume from the natural forest was nearly exhausted by the early 2000s. The allocation of sawmill timber licenses were political decisions that normally involved rent seeking behaviours by the political leaders. The country’s sustainable yield regulation was derived from the 1993 National Forestry Inventory, but this came too late to reduce the pressure on the natural forests, given that the existing number of sawmill companies far exceeded the acceptable size of sawmill capacity in a small island country such as Vanuatu.

The supply of whitewood timber in the local market was reduced dramatically after natural forest supplies were mostly exhausted. The export of whitewood products as kiln seasoned S4S and S2S planed boards, finger-jointed laminated board and solid laminate ceased in 2008 (McGregor and McGregor, 2010). Whitewood was able to secure a niche market in Japan because it is readily kiln seasoned and treatable with preservatives, stable and not prone to surface checking, of low to medium density and readily stained and easy to machine (Thomson, 2006). McGregor and McGregor (2010) stipulate that the future of whitewood export industry depends on how lucrative it is in the export market to command price premiums and also attract potential investors in forest plantation establishment and processing industry. Nevertheless, the current whitewood industry appears to be severely affected by:

1. The large importation of radiata pine from New Zealand that has flooded the country’s timber market,

2. There are few timber yards with pressure treatment plants and kiln dryers which means that they offer low prices for untreated whitewood timber that are uneconomical for growers,

3. Some of the timber yards with treatment plants and kiln dryers also own whitewood
plantations and sawmills, creating a barrier to farmers through economies of scale.

The aim of this literature review is to examine the concepts and the applications of value chain analysis to address the problems that are currently confronted by the whitewood industry and explore opportunities for value-adding, especially for small forestry farmers. Value chain analysis is a relatively new concept and its definition varies depending on the scholar describing it, but primarily value chain analysis is a representation of various activities that are involved in the production and processing of raw materials to create end products. Value chain analysis is becoming very prominent in the work of the World Bank Group in the areas of business investment and they have embarked in value chain studies in different countries around the world. This type of analysis can be a stand-alone study to improve government policies; for instance, the studies on value chain analysis in various sectors in Indonesia have contributed significantly to government policies and management strategies for development (Subramanian et al., 2007).

This study on the value chain of whitewood should provide a better understanding on how the current problems should be addressed and assist the government of Vanuatu to improve its forest policy and management strategies to better manage the whitewood industry. Subramanian et al. (2007) explain that value chain analysis provides better understanding of the relationships among the firms along the value chain and the key market actors and that is precisely what is required by the whitewood industry. A good understanding of the relationships between the firms along the whitewood value chain is necessary to integrate and be more efficient and competitive in all operations.

This literature review paper covers: (1) background information on whitewood, (2) exploitation of whitewood from the natural forests, (3) production and marketing of whitewood, (4) research and domestication of whitewood, (5) the theory of value chain analysis, (6) applications of value chain analysis in value adding of forest products, (7) opportunities for value-adding.

2.2 Background information on whitewood

2.2.1 Whitewood Taxonomy and Natural Distribution

*Endospermum medullosum* is from the Euphorbiaceae family, and is commonly referred to as whitewood or waetwud in Vanuatu and basswood in Papua New Guinea (Thomson, 2006), while on some islands in Vanuatu whitewood has other names including vingungara.
in West Ambae, kumaro in South Maewo and napasa in Matantas Santo. The local names from the different islands are related either to the traditional uses for parts of the plant, where and how the plant grows or its associations to abiotic and biotic organisms in the ecosystem.

Whitewood is one of the tallest emergent species in Vanuatu’s forests and compares with other major species including *Antiaris toxicaria*, *Agathis macrophylla* and *Callophyllum neoebudicum*. It normally grows to an average height of 40 m, to 60+ m maximum with a 15 m – 30 m clear stem. The average diameter is 60 cm but can reach a maximum diameter above the buttress of more than one metre. Juvenile trees have clear and cylindrical stems, whorled branching and are dominated usually by a single straight stem. Mature trees typically have shallow flattened conical crowns with heavy lateral branching. Whitewood has large simple leaves 10-25 cm long and 5-20 cm wide, cordate to peltate in shape, dark green above and light green below, spirally arranged along the branches with two glands at the base of the mid-ribs and the petiole. It is a dioecious species where male and female flowers are produced by different trees. The flowers are small, greenish white and form in groups at the tip of branches of the panicles. Fruits are born in these panicles and they are light green and turn yellowish green when ripe. They contain the black seed that only opens during germination (Thomson, 2006).

The natural distribution of whitewood stretches throughout the entire chain of Melanesian countries from West Papua and Papua New Guinea covering the Momase Region, Central and Western Provinces, Manus and New Guinea Islands, Bougainville to the Solomon Islands and Vanuatu. Whitewood naturally grows on most of the main islands of Vanuatu excluding all the islands south of Erromango. The species occurs on alluvial and clay loam soils formed over raised limestone (Thomson, 2006).

The whitewood forest that is described by CSIRO & DPI (1990) as “mid-height forest with emergents dominated by *Endospermum medullosum*” occurs on the eastern side of the islands. *Antiaris toxicaria*, *Elaeocarpus sp*, *Dysoxylum sp*, *Terminalia sepicana*, *Pangium edule*, and *Pterocarpus indicus* are the co-dominant species of whitewood. Its natural distribution is mainly influenced by the prevailing south-east trade winds, which create wet weather conditions on the east and dryer conditions on the western side of the islands. Whitewood is also observed on the west particularly in disturbed areas and in the interior. The largest natural stands of whitewood occur on the eastern sides of Efate and Santo, although many of these areas have been deforested and replaced by various land uses, such
as cattle grazing, agricultural farming, shifting cultivation, forest plantations and urban and infrastructure development.

2.2.2 Whitewood Anatomy

Groves and Wood (1998) describe whitewood as a hardwood with a density of class 6 (405-450 kg/m$^3$) sometimes with conspicuous growth rings. The sapwood and heartwood are both white to pale yellowish cream and become lighter when exposed to air with straight to somewhat interlocking grain and even to slightly coarse texture.

Whitewood is found to be very economical because of its working properties, is easily sawn, machines well, with good finish and satisfactory application of glues, paint, screws and nails. There are some tension areas on logs that may cause woolly finish (Groves & Wood, 1998) but that could be reduced significantly in planted forests when proper silvicultural treatments are applied. Whitewood is susceptible to blue stain, pinhole, marine borers and termites. Therefore logs have to be sawn within two days after felling and kiln seasoned or pressure treated quickly with chromate copper arsenate (CCA) or tanalith to the desired hazard level before storage.

2.3 Deforestation of whitewood in the natural forests of Vanuatu

Deforestation of whitewood in native forests began during the arrival of the European settlers in the early 1900s, mainly through slash and burn agriculture to establish cattle grazing and crops such as cotton, coconut and coffee plantations. The pressure on the natural stands of whitewood forest continues to grow as indigenous people redesign their traditional small shifting cultivation patches to meet both their basic food requirements and traditional ceremonial needs, and to be able to survive in the contemporary and commercial society brought in by the settlers.

The British settlers imported timber of pine species from New Zealand and red cedar and various eucalypt species from Australia for construction while the French imported their timber from nearby colonised countries such as New Caledonia and Vietnam until the early 1960s, when a French logging company started to harvest Agathis macrophylla from the island of Erromango. However, with consistent resistance by the indigenous peoples to the settlers and disputes over land and natural resource ownership, logging was operated in an ad hoc basis until after the country’s independence in 1980, after which time the Forestry Act provided a legal basis for logging activities to be carried out in the country. Since then logging companies have been concentrating more on hardwood species, and it was only in
the late 1980s and early 1990s that whitewood was discovered to be an excellent timber species. Three Malaysian logging companies entered the country at this time in competition with five existing logging companies, creating a situation of exploitation where the remaining merchantable volumes of whitewood especially on Santo, Efate and Pentecost, were removed within less than 15 years. The trend of the annual log volumes in cubic metres harvested in the natural forests for the entire country between 1983 and 2010 is shown in Figure 2.1.

![Figure 2-1: Volume (m$^3$) of annual log production in Vanuatu from 1983-2010.](image)

The rapid increase of log production in the early 1990’s is due to the large number of Malaysian logging companies in the country and the cyclical fluctuation generally influenced by the availability of the logging concession areas on the islands. There was a peak of harvesting in 1994, which is a result of the large volume of *Callophyllum neoebudicum* that was harvested at Ipota, Erromango for export. The last peak in the harvesting of whitewood was on Pentecost. The trend after 2005 is mainly due to production by portable mills, with the log volume continuing to decrease due to the reduction of the merchantable volume of timber in the natural stands and also the flooding of the local market by imported pine from New Zealand and Fiji, and also furniture from the Asian countries, especially China.

Following the ban of round log export at the end of 1994 over ten thousand cubic metres of
logs that were harvested at Ipota, Erromango by the Parklane logging company from Malaysia were not exported and were left to rot at the wharf. Nevertheless, during the country’s prime log production during the 1990s and up until 2005 whitewood contributed to more than 50 per cent of the total log production from Vanuatu, especially coming from the Teuma (logging concession title 170 & 168) Efate and on the east coast of Santo. Hardwood species were largely harvested from salvage operations within farms used primarily for cattle grazing, shifting cultivation and other agricultural land. These were on permits provided by the Department of Forests for both large and portable mills which allowed harvest of 10-100 trees,

Selective logging is not practical in whitewood forests because:

1. the logged over areas are usually invaded with pioneer species and vines, especially *Merania peltata* before the regeneration of whitewood and other commercials species;
2. after logging, landowners either authorized portable millers or purchase their own portable mills and harvest the remaining trees,
3. landowners normally convert the logged areas into other land uses such as shifting cultivation, agriculture, livestock and forestry farming,
4. landowners on the islands of Santo and Efate often subdivided the areas and leased them out to commercial developers.

### 2.4 Whitewood production and marketing

Due to the outstanding chemical, physical and working properties of whitewood it is easily accepted in the forest manufacturing industry for both local and export markets without any comprehensive research and development having been done on the products and marketing. Having both soft and hardwood properties, it is used locally in light to medium structural works, furniture and cabinet making, veneer and plywood, interior trim, joinery, carving & turnery, and panelling. Groves & Wood (1998) state that it can also be used in vehicle bodies, sporting goods, musical instruments, vats, wooden toys, pattern making for foundries, laboratory bench top and external cladding.

Treated whitewood structural timber traded at 397 USD/m³ in the local market and increased to 661 USD/m³ when the supply of logs from the natural forest declined significantly and all large logging companies ceased operation. That high price is also influenced by the lower number of treatment plants that exist in Port Vila and Luganville. Several companies are currently buying untreated timber from the portable mills at a
market price from 275 USD/m$^3$ to 328 USD/m$^3$. This timber will trade at an average price of 661 USD/m$^3$ after pressure treatment with CCA or tanalith timber preservatives. The processing of whitewood becomes uneconomical with the high production cost due to high fuel prices, labour costs, sea and land transport costs, especially for the portable sawmills on the outer islands. Consequently, these producers are concentrating purely on harvesting hardwood species. Only a few of the portable sawmills that operate near Luganville and Port Vila continue to harvest whitewood and with that market environment, less supply and high demand enable the portable mill owners to negotiate a higher price with the buyers.

The majority of whitewood that was exported to Japan came from the Melcoffee Sawmills Company at Luganville, primarily as kiln seasoned S4S and S2S A grade sawn boards. These sold at the market free on board (FOB) price of 766 USD/m$^3$ to 1,094 USD/m$^3$ while finger jointed laminated board and solid laminated board sold for 656 USD/m$^3$ to 1,116 USD/m$^3$. The export value of timber to Japan illustrated in Figure 2 (provided by the South Pacific Community (SPC) regional statistics database) is for whitewood; categorised as 44072 with the description of tropical wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6mm.

![Figure 2-2: Value (USD) of Timber Exports from Vanuatu to Japan during 2001-08.](source: Secretariat of the Pacific Community (SPC) Pacific Trade Statistics Database)

### 2.5 Whitewood research and domestication

Leakey and Newton (1994) describe “domestication” as a term more commonly used in
describing farm animals and households pets. It was not often used in relation to trees, until recently, as foresters started to collect seed from wild trees even without selection. It was in the 1960s that the use of provenance collection was introduced and gained recognition internationally. Domestication is defined by Thomson et al. (2006) as the collection of tree species from the wild and cultivated under human management. Libby (1973) highlights the four elements of the domestication of forest trees as: (1) assessment of original genetic variability, (2) selection of trees based on their most desirable characteristics, (3) isolation of the stock to be used, and (4) commercialising the desirable phenotypes and genotypes. Clement and Villachica (1994) describe the several phases of tree domestication as; management of wild populations of the tree, semi-domestication and full domestication of the tree. Thomson et al. (2001) elaborate on the perspective of domestication as primarily depending on the type of species and the anticipated end product/s. Domestication may only involve selection of quality seeds and development of proper propagation techniques for multipurpose tree species, whereas for commercial timber species, full domestication may involve inventory and characterization of genetic variation, development of appropriate propagation and silvicultural prescriptions, tree breeding, use of molecular genetics technologies and production of hybrids.

Formal domestication of whitewood began through the South Pacific Regional Initiative on Forest Genetic Resources (SPRIG) project funded by the Australian Agency for International Development (AusAID) between 1996 and 2001. The original aim of the SPRIG project was to assist the Pacific Island countries, comprising of Fiji, Samoa, Solomon Islands, Tonga and Vanuatu, to conserve, enhance and properly use selected tree genetic resources. In the second phase of the project, the aim was reviewed according to each country’s need. For Vanuatu it included the establishment of local germplasm sources and demonstration of model planting of the priority species including sandalwood.

The process of domesticating whitewood through the SPRIG project involved;

(1) an intensive literature review and eco-geographical survey of the species, documenting its taxonomy, botanical features, natural distribution, uses, protection, variation and breeding,

(2) a survey of local knowledge and uses on the of whitewood in 26 villages on 12 islands which was later used as a guide for seed collection,
(3) a country-wide seed collection from 144 parent trees (except from the Banks Islands because of cyclone damage) with elimination of any seeds infested with larvae of the small wasp *Syceurytoma* sp.,

(4) the establishment of over eight hectares of provenance and family trails from that seed collection at the forestry research station (IFP), Shark Bay Santo during the planting season in December 1998 to January 1999,

(5) determining that clonal hedges and vegetative propagation proved to be risky as the ability to coppice varied with season,

(6) the development of a conservation strategy for whitewood and other local priority species via comprehensive consultation with the communities by Department of Forests (Thomson *et al*., 2001).

Four years later the provenance and family trials were assessed to compare the average height, diameter at breast height (DBH) over bark, volume and survival between the 10 provenances comprising the 97 families as shown in Table 2.1. Individual tree performances were assessed and ranked based on their economic qualities, firstly on average height and secondly on DBH, the two factors that are used to determine volume.

**Table 2.1: Provenance summary of height, survival DBH and wood volume for individual whitewood trees at four years of age.**

*Source: Vutilolo *et al*., 2005*

<table>
<thead>
<tr>
<th>No</th>
<th>Provenance</th>
<th>Height (m)</th>
<th>Survival (%)</th>
<th>DBH</th>
<th>Volume (m³)</th>
</tr>
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<tbody>
<tr>
<td>10</td>
<td>IFP Plantation</td>
<td>9.2</td>
<td>88</td>
<td>16.3</td>
<td>0.12</td>
</tr>
<tr>
<td>3</td>
<td>East Coast Santo</td>
<td>8.9</td>
<td>77</td>
<td>16.1</td>
<td>0.11</td>
</tr>
<tr>
<td>5</td>
<td>Central East Santo</td>
<td>9.0</td>
<td>72</td>
<td>16.8</td>
<td>0.11</td>
</tr>
<tr>
<td>6</td>
<td>South East Santo</td>
<td>8.8</td>
<td>75</td>
<td>16.4</td>
<td>0.11</td>
</tr>
<tr>
<td>7</td>
<td>Teuma, Efate</td>
<td>8.5</td>
<td>70</td>
<td>15.6</td>
<td>0.10</td>
</tr>
<tr>
<td>8</td>
<td>Uri Wiaru, Malekula</td>
<td>8.6</td>
<td>76</td>
<td>15.1</td>
<td>0.10</td>
</tr>
<tr>
<td>9</td>
<td>West Ambae</td>
<td>8.8</td>
<td>82</td>
<td>15.5</td>
<td>0.10</td>
</tr>
<tr>
<td>1</td>
<td>Central Pentecost</td>
<td>8.4</td>
<td>74</td>
<td>15.1</td>
<td>0.09</td>
</tr>
<tr>
<td>2</td>
<td>Forari, Efate</td>
<td>7.8</td>
<td>76</td>
<td>15.3</td>
<td>0.09</td>
</tr>
<tr>
<td>4</td>
<td>Maewo</td>
<td>8.4</td>
<td>70</td>
<td>14.8</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Trees from East Santo and Central East Santo with the family codes of MS2, MS3, MS2, MS44 and MS32 ranked the best five respectively of the best 40 ranked trees. Heights ranged from 7.22 m to 12.98 m and DBH from 20.68 cm to 30.48 cm. The individual trees from islands apart from Santo that fall into the 40 best ranking are from Forari & Teuma on Efate, Maewo and Central Pentecost including West Ambae, and Uri Wiaru, Malekula. The provenances and families demonstrated that considerable genetic variation for height and DBH was present and consequently the best performing trees were selected for a tree improvement program (Vutilolo et al., 2005).

The best results for whitewood were by provenances from eastern parts of Santo, especially from the localised industrial forest plantation, as it would be expected, with an average height of 9.2 m, 16.3 cm DBH, 0.12 m$^3$ volume and 88% survival. The next best performing provenances were East Coast Santo, Central East Santo and South East Santo. However, West Ambae provenance had the best results compared with the provenances from the other islands with an average height of 8.8 m, 15.5 cm DBH, 0.10 m$^3$ of volume and an exceptional survival rate of 82%, outperforming all the provenances including those from Santo, with the exception of the IFP plantation provenance. Vutilolo et al. (2005) point out that the trees in the IFP plantation are progenies of parent trees with significantly superior height growth performance selected from South Santo provenance.

Following recommendations by Vutilolo et al. (2005) on whitewood tree improvement and the full process of domestication described by Thomson et al. (2001) from the Australian Centre for International Agricultural Research (ACIAR), further development of whitewood domestication continues in two projects. The ACIAR whitewood silviculture project (FST/2005/089) aimed to carry out applied research and develop the best silvicultural prescriptions for whitewood in both monocultures and integrated plantings with other tree species and agricultural crops. The ACIAR sandalwood and whitewood deployment project (FST/2008/010) aims to genetically improve both species through establishment of a seed orchard, creation of advanced progeny trials, establishment of gene resources populations and development of demonstration plots on the selected islands in Vanuatu.

2.6 Whitewood planting program

Forest plantings or forest plantations are defined by Evans (1992) as manmade forests artificially raised by sowing or planting. The forest plantings are normally referred to as
afforestation, reforestation or forestation depending on the status of the area before it was planted. Their descriptions might vary according to countries and scholars, however Evans (1992) describes afforestation as planting of areas that have been cleared and with no forest for the last 50 years, while reforestation is planting of areas that have been with forest for the last 50 years and forestation is used for both plantings. Most of the forest plantings in Vanuatu fall into the category of reforestation and only a few are in the afforestation category, in particular the grassland and savanna areas on ridges and mountaintops at the dry western side of the islands.

The first two scales of forest plantings introduced in Vanuatu during the early 1970s were known as local supply plantations (LSPs) and the industrial forest plantations (IFPs). The LSPs were intended to supply the future local demand of timber and the IFPs were to provide future timber for export, but were discontinued when the introduced species failed to survive the weather conditions, pests and diseases that existed in the country. The LSPs were funded by the New Zealand government, and the British government funded the IFPs. All the planting areas were returned to the landowners as failed forest plantations except for the partially successful radiata pine plantings, which were a combination of LSPs and land degradation programs on the island of Aneityum.

The shift from introduced species to native species also instigated a new arrangement in forest planting similar to that used with agricultural crops whereby plantings are established by the landowners. Whitewood was the first native species to be introduced to the landowners as a forestry species. The Department of Forests only provided technical advice on tree plantings and genetically improved planting materials to the forestry farmers through its applied research findings and tree improvement programs. This is because in Vanuatu land is constitutionally owned by the indigenous people. Chapter 12 of the Constitution adopted during the Vanuatu Independence from the British and French Condominium in 1980 specifies the legitimacy of land dealings. Three sections under Chapter 12 ruled that; all land including the land-based natural resources belong to the indigenous traditional owners and their descendants, custom rulings are the basis of land rights and uses of the resources, and only indigenous people have the right to own land in Vanuatu (de Vletter et. al., 2004).

Landowners and leaseholders have been involved at various scales of planting; the line plantings, agroforestry, integrated plantings and woodlots are commonly known as small-
scale farm forestry whereas large-scale plantations are often referred to as industrial. Most of the woodlot establishment was associated with shifting cultivation practices and therefore, they can be very small. According to Aru et al. (2012), the 139 whitewood farmers surveyed on Santo only planted 63 hectares of whitewood while 270 hectares were planted by Melcoffee Sawmills in 1993. The minimum size of small-farm forestry in Vanuatu is less than 1-5 hectares compared to 10 -20 hectares in Australia as described by Herbohn and Harrison (2004).

Timber plantations are a long-term investment and the process is normally divided into three management phases: seed collection and handling, nursery techniques, planting and management practices but the narrative of the tree planting is incomplete when the production and the marketing aspects are excluded. Russell and Franzel (2004) argue that agroforestry research and development is normally concentrated on tree establishment and management, and ignores the product, processing and marketing aspects that should be the starting point in tree plantings. This is supported by Price (1998) who stated that the value of the tree depends on the processing costs and the end products and a better market means higher value for the products.

Forestry farmers should consider the following questions to decide which species to plant:

(a) Does the species have market demand and what are the market characteristics?
(b) Is the species able to provide sustainable supply of raw materials required by the market?
(c) How can the farmer improve their operations to adapt to evolving markets?
(d) Does the farm require mixed species to meet market demand?
(e) Do mixed species on farms meet the range of livelihood of the households?
(f) What is the genetic makeup of the species? (Anyonge & Roshetko, 2003).

The current whitewood farmers of Vanuatu are faced with the problems of not having good forest plantation planning, management and projections of potential end products and markets (Price, 1998; Russell & Franzel, 2004). Many farms have ready to harvest whitewood trees that are still standing in unmanaged stands. These trees have a low mean annual increment (MAI) because of high competition for space, light, water and nutrients. Additional reasons are a lack of processing facilities to process the juvenile trees and
isolation of farms from processing centres, similar to problems faced by the forestry farmers in the far north coast of New South Wales (NSW), Australia as specified by Leys and Vanclay (2010). Nevertheless, because of low opportunity costs for land and labour, whitewood farmers have the competitive advantage to economically harvest and process their trees provided they have access to appropriate processing technologies and market strategies. Streed et al. (2006) specify that it can be more economical for small forestry farms to process their trees and trade as structural timber, rather than sell as stumpage.

2.7 Theory of Value Chain Analysis

2.7.1 Introduction

Value chain analysis (VCA) is commonly studied in the context of the new age of globalization in which individuals, firms and countries seek prosperity and comparative advantage in the global economy. In the last several decades the global economy has changed in many ways but the two most important new characteristics are the globalisation of production and trade (which influenced the industrial growth of developing nations) and the restructuring of transnational companies which targeted high value-added segmented products. Therefore, a 'global value chain' study provides an understanding on how governance is structured in sectors that produce for the global market (Gereffi et al., 2005). Kaplinsky (2000) also pointed out that the principles of value chain analysis could be used to analyse and compare the connection between the growing inequality and global integration of production and marketing.

However, the responsibilities of forest management have been diversified, with more emphasis on criteria other than those related to wood production. Forest managers are facing an increasing demand for more adaptability, with emphasis on biodiversity, carbon and ecosystem services as well as commercial timber. They must base their decisions on consumers’ preferences and market demand for the forest products, rather than on a statistical framework derived from general development of multi-objective planning which is usually controlled by the forestry technicians (Leskinen et al., 2009). The focus on forest management and conservation has shifted from highly technical production forestry to a more socially-oriented forestry (Harrison et al., 2002) with increasing interests in contributions to small farm forestry and trading of minor forest products to encourage sustainable development and combat poverty (Singh, 2008). The principal idea in much of recent forestry activity is that by encouraging landowners and communities to replant the
degraded forests with local species, the benefits would be improved standards of living for local communities and environmental benefits to the global ecosystem (Streed et al., 2006). Nevertheless, there is limited understanding on the distribution structures of these forest product markets (Ribot, 2006). Thus, it is important to investigate the functions and structures of value chains for the whitewood forest products that are produced and marketed in both domestic and the export markets. The supply of whitewood and other local timber species from the natural forests has been reduced significantly and future of Vanuatu timber depends on plantation establishment.

2.7.2 Definitions and Concepts of Value Chain Analysis

Kaplinsky (2000) defines value chain as the entire process whereby products or services are developed from their origin as raw materials, through various levels of production, to delivery of the final products to the consumers and eventually disposal of the products after use. The activities within a value chain can be performed by a company or a number of companies in a particular location or various locations (Herr & Muzira, 2009). Wood (2001) conceptualises value chain as the convention centre for all societies that deal with the production and trade of goods and services including the vital aspect of globalisation and how countries are integrated into the global economy. The value chain provides a clear definition of value since it is a functional analytical model that explores the entire process of delivering consumer fulfilment (Gattorna & Walters (1996). Herr and Muzira, (2009) describe ‘value chain’ as increasing the value of the primary products along the value chain via combination with other resources, for instance equipment, human resources and other raw materials. Rayport and Sviokla (1995) describe the value chain as a representation of various activities in the value-adding process, linking firms via the aspect of supply and demand that involves logistics, production, marketing and distribution of products to the consumers. Due to the complexity that exists in the linkages and intra-linkages of value chains, Kaplinsky and Morris (2002) defined and illustrated four further levels of applications (Figure 2.3).

According to Irawati et al. (2009) the activities along the value chain in furniture production include: harvesting of logs from the forests, sawmilling of logs to timber, processing of timber to furniture by furniture makers, and sale of the furniture, either directly to the consumers, or to the consumers through domestic wholesalers/retailers or foreign wholesalers/retailers.
1. ‘The simple value chain’: has the same definition as Kaplinsky (2002) but is modified to include two-way scenery linkages among the various sectors along the chain (Figure 2.3). These are indirectly connected, for instance the designer who has influences on the market and the consumers.

1. ‘The extended value chain’: the linkages of the value chain in real life are composite as there are many more linkages relating to production of a furniture industry. Production not only begins with the design of the furniture, but the establishment and management of the forest plantation until the trees are harvested and the logs are processed into timber before being transported to the furniture factories, as indicated in Figure 2.4. In this value chain the furniture is designed and manufactured according to the consumers’ preferences.
3. ‘One or many value chains’: This model is based on multi-linkages in the value chain between the manufacturers, such as the sawmillers, mining, and pulp and paper industries as shown in Figure 2.5, and are connected to various customers or firms along the value chain. This may have many uncertainties as the market is controlled by the suppliers.
Figure 2-5: One or many value chains
Source: Kaplinsky and Morris (2002).

4 ‘One or many labels’: The concept of the value chain crosses boundaries with other similar concepts and can create confusion. A good example is the inter-link which Porter (1980) refers to as the value chain which is a single link connecting to other links as shown in Figure 2.4. A single link forms from forestry to multi-links from sawmills and other sectors and Porter (1980) again refers to multi-links as value systems concluding that both concepts become the ‘modern value chain’.

2.8 Importance of value chain analysis in the global economy
Kaplinsky and Morris (2002) described three important issues of value chain analysis as it relates to the modern trend of globalisation:

(1) increasing labour specialization enables high rivalry in the production at the global scale,
(2) participating in the global trade requires efficiency in production,
(3) the entire value chain analysis provides adequate knowledge of how the global economy is enabling a steady increase of income.

Bolwig et al. (2008) point out that recent published reports and articles on value chain analysis have advanced the understanding on how companies and farms in the developing nations are accessing international markets. This can significantly contribute to the development of better policies and management guidelines to combat poverty. The studies of global value chain analysis present clear scenarios on how the producers in the developing nations could be provided with advice, technologies and functions to upgrade
their trading capacities.

Value chain analysis has become very important and widely used in the natural resources sectors to investigate, analyse and understand how natural resources are managed through a range of complex dynamics, with diverse results in aspects of environment, social and economics. Singer and Donoso (2008) categorise value chains of natural resources into ‘upstream’ and ‘downstream’ activities. ‘Upstream’ involves activities that produce raw materials and ‘downstream’ involves activities that convert the raw materials to finished products to supply final markets. The decision of which category firms, countries or individuals are involved in should be determined by the theory of comparative advantage related to the abundance of the natural resources and low cost of production (Keuschingg, 1999). For instance, there is a comparative advantage for forestry plantations that have a lower rotation age in countries in the tropical regions compared to the countries in the northern hemisphere. However, companies who pursued ‘downstream’ activities have empirically proven to develop faster than the companies who are involved in ‘upstream’ activities (Singer & Donoso, 2008). Nonetheless, the theory of comparative advantage could be minimal when compared to the challenges normally encountered by small and isolated rural forestry farmers accessing local or the export markets. Bolwig et al. (2008) refers to them as the ‘weak chain actors’. Therefore, ‘action research’ is required in the areas of management and planning guidelines and political support to assist rural farmers in their production strategies and market access (Bolwig et al., 2008). Fitter and Kaplinsky (2001) affirmed that producers in the least and developing countries should move out from raw material production to value adding and become exporters of manufactured goods.

2.8.1 Growing Importance of Systemic Competitiveness

The importance of systemic competitiveness in the value chain was first described by Porter (1980) via five main activities including; the ‘inbound logistics’, ‘operation’ (production), ‘outbound logistics’, ‘marketing & sales’ and ‘service’ and these activities are supported by; administrative infrastructure management, human resource management, technology (R&D) and procurement. The success of these activities depends on the human resource and management. Kaplinsky and Morris (2002) imply that the initial ideology of the ‘division labour’ by Adam Smith is embedded within the concept of economic growth, and is basically used to dismantle the large activities into smaller and more numerous components where employers are developing expertise in one job to increase efficiency. While concentrating only on one job, the employees are able to
develop their skills and become experts on the job, resulting in high production and turnover rate for companies (Kaplinsky & Morris, 2002). Furthermore, Clegg et al. (2005) imply that the four principles of Taylor’s theory in ‘scientific management’ provide in-depth narratives on how the division of labour could be improved. These are:

1. improved effectiveness at each workstation by timing the employers with stop watches and using appropriate tools to maximize daily outputs and set payments according to outputs
2. trained employees effectively perform their duties,
3. trained employees could share new ideas with managers and receive higher wages,
4. maintenance of good boundaries between supervisors and managers and sharing of good work ethics.

Clegg et al. (2005) also point out that after Taylor there are other management and administration philosophers such as Braveman who critically describe Taylor’s theory to be labour exploitative and unfriendly, displaying the norms of capitalism similar to Marxists, where employees are exploited for high turnover capitalists. Henri Fayol, who is regarded by the European scholars as the founder of contemporary management, proposed orderly training for employees and surpassed Taylor’s four principles by fourteen principles provided in a manual for effective management, competent institutes and enthusiastic workers (Clegg et al., 2005).

However, in the early 1900s Henry Ford transformed Taylorism into a more competitive production system via a new approach for labour management. The three unique aspects of Fordism are:

- the movement of the vehicle parts between the workers along the assembly line
- all employees were paid equally (five American dollars a day)
- employees were offered higher wages compared to other employers in the region (control of labour was extended outside the factory).

As a result, between 1903 and 1906 Ford alone produced the same number of vehicles as all other automotive companies combined, therefore the initial view of Fordism was perceived as the introduction of ‘mass production’ (Dassabach, 1991). Murray (1998) had a similar view describing Fordism as the age of industrialisation and the origin of mass production, which was determined by the four fundamental principles of Fordism:

1. activities in each workstation along the chain of production were standardised
distinctive to craft production,

(2) activities were mechanised for mass production and there were some activities that were unable to be mechanised,

(3) those activities that were addressed through Taylorism involved scientific R&D, redesigning and training the employees on the new activities,

(4) the flow of vehicle parts along the chain of production instead of workers moving between working stations.

The mass production of the Ford Model T enabled Henry Ford to sell his vehicles for half the price of the craft-built car in the US in 1916, therefore accommodating fifty percent of the entire car market. This new groundbreaking production system was widely adopted in the twentieth century by other processing industries such as the furniture, textile, processed food and even shipping industry after World War II. In such an industry, the establishment cost is normally high but cheaper to operate and maintain and the economies come from the mass production. According to Henry Ford himself, mass advertisement is essential for mass consumer willingness to buy standardised products.

2.8.2 Efficient Production

The next important aspect of value chain analysis is that it helps us to understand the advantages and disadvantages of companies specialising in certain products and their connection to final markets. Effective cooperation and coordination of companies along the value chain will enable them to be more competitive in their production. It will also create difficulties for their competitors to copy not only the product but also the entire product processing system. It is a matter of continuous learning and innovation within the value chain producing to obtain product differentiation and large companies have to recognize the significance of sharing information with small companies along the value chain (Herr and Muzira, 2009). More companies and nations continue to improve their productions in the post-war period for instance the fundamental driver for the Japanese’s rapid industrial growth is the philosophy of ‘just in time’ (JIT) which is flexible and allows teamwork between large and small companies to be more responsive to just in time processing through ‘lean production’ (Womack et al., 1990). Wood (1993) and Krafcik (1998) describe JIT as the Japanese improvement of Fordism and Taylorism that addressed the problem of waste in manufacturing industries. Fordism and Taylorism were concentrated on improving the workstations along the assembly chain to obtain mass
production but they do not effectively deal with the problem of overproduction and underproduction which is a cost to the companies according to Wood (1993).

2.8.3 Just in Time

Duncan (1998) describes JIT as concept with the main purpose being to deal with the problem of waste in any manufacturing industries including social services (such as banks, hospitals etc.). On the perspective of small manufacturing, the Australian Department of Industry, Technology and Commerce (ADITC) (1997) describes JIT as well defined plan that enables manufacturing to prosper by entirely eradicating waste and these are tasks or manufacturing process that do not bring value to the product but costs to the companies. Similar Turnbull et al. (1989) referred to the waste as any activities that added cost and not value to the product. Wastes in manufacturing industries could be in any form, such as over stocking, damage or unnecessary materials, imperfect timing, human error, delay in transportation, breaking down of machinery and many more and therefore with the idea of JIT these areas are adequately identified and addressed (Duncan, 1998) & (ADITC, 1997).

Manufacturing is basically value-adding of raw materials and it can be in a form of finished products delivered directly to the customers or consumers, components or semi-finished products required by other manufacturing industries. Numerous studies on time spent within the different divisions of manufacturing concluded that usually only five percent of the time is spent on value-adding while the remaining ninety five percent is spent on the acquiring materials, work in progress, inventory management and transportation including the various forms of wastes mentioned previously. Therefore by implementing JIT, Australian small manufactures with improved technology are able to reduce the wastes by seventy five percent through manufacturing lead time within five months (ADITC, 1997). According to Duncan (1998) the proportion of the time spent on value adding is less than two percent and this is because most of the processing designers, engineers and scholars concentrated their research on how to reduce the time spent on value adding while the work in progress was normally done by employees with little formal training and experience. Most of their effort is on survival and retaining their jobs rather than minimizing or solving the problem of wastes.

2.8.4 Lean Production

‘Lean productions’ as a neo-Fordism developed by Eilija Toyoda (Toyota family) with his engineer specialist Taiichi Ohno after spending three months at the Ford’s Rouge plant in
Detroit during the spring of 1950 studying the concept of mass production along assembly lines. The modifications of the die from hand beaten by craftsman to pressure die in massive stamping by Porsche and General Motors then to dies changes specialist by Detroit (Ford), Wolfsburg (VW), Flins (Renault) and Mirafiori (Fiat) that normally takes three months to change the dies is banished by Ohno in late 1950’s. Ohno modify the change of dies from every three months to every three minutes by using rollers to move the dies in and out of their positions using simple adjustments. In the process of modifying, the change of dies Ohno also found out that it would be more efficient and cheaper to have small batches of stamping than massive lots. The associated benefits for small batches of stamping are that mistakes are discovered early and fixed, and huge inventories are eliminated. To effectively implement these modifications of the manufacturing process Ohno decided to organise the employers in team work with team leaders. This compares to Fordism where there are supervisors that supervise various sections along the assembly lines without doing the work themselves. Ohno empowered the workers in decision making to make sure mistakes within their workstations are addressed on time, enabling Toyota to eliminate rework at the end of the assembly lines (Womack et al., 1990). Lean production plants are more capable and have high levels of productivity, quality and mix complexity driven by policies that emphasise employer’s capacity building, empowerment and discipline. These factors greatly neutralise the risks along the production lines (Krafcik, 1998).

Skorstad (1994) implies that the economic foundation of lean production is the focus upon cost reduction through the elimination of waste (muda) which in the manufacturing industries is commonly between 2-20 percent for value adding and 80-89 percent in lead-time such as buffers, transportations, handlings and waiting. The target areas to focus on in order to minimize the effect of lead time are; proper layout of equipment and machineries, better production plans and control base ‘pull effect’ and adequately skilled and empowered employees to deliver expected outcomes. Goods are delivered according to actual demands and not according to anticipated demands, traditionally known as ‘push effect’ (Skorstad, 1994).

Construction companies in Europe are now working for quality and cost reasons, or using lean production in a process-based way, following the introduction of the building code by European Union to enhance rivalry in the construction industry. Certain innovative policy has significantly increased the volume of timber produced by the sawmilling industry. By
adopting the lean and JIT manufacturing system from the automotive industries, many construction companies are fabricating building elements in factories using the lean manufacturing systems and assembling at the construction sites instead of the usual site construction. Furthermore, since wood is a renewable resource compared to concrete or steel, and regarded as environmentally friendly, it becomes very competitive in the construction industry (Tykkä et al., 2009).

In the furniture manufacturing industry, Hunter et al. (2007) describe lean production as efficient and practical as it uses less of everything compared to other manufacturing systems. According to their case study research, lean production has been proven to be flexible, lucrative, deliver quality goods and ‘ergonomically’ suitable for the furniture manufacturing industry. Likewise, the assessment of the Oregon forest products industry by Reeb et al. (2009) has ranked the forest product companies employing 20 to 100 people as ‘Competitive Position and Lean Manufacturing’ 1 and 2.

The Australian furniture industry encountered enormous rivalry in the late 2000 from international suppliers. The role of information technology in response to this competition was researched by Mo (2009) who pointed out that lean and agile production requires integration of information technology. Albeit, the information technology provides extensive change to lean production but there are also non-information technology aspects of lean production that should always be addressed, such as continuous capacity building for the employers, better machinery layout to maximize production and minimize machinery setups, quality control and many more. The information technology involves computer programming, especially spreadsheets that enable furniture companies to visualize and control due dates for each workstation along the assembly line to perfectly meet the customers demand. The proper arrangement of the employees into small workstations enable the companies to achieve the ‘pull effect’ compared to previous practices where schedules of finishing products are left to the employers and not the customer orders. The establishment of better management procedures also enhance the coordination, communication and supervision roles normally performed by the managers, team leaders and workers.

2.8.5 Agile Production

The idea of agile production was developed by the Lehigh University in 1991 to describe the constant economic growth both locally and globally creating a diverse and complex
market with rapid and unpredictable changes. Agile production encompasses the philosophies of Fordism and Ohnoism, but is defined as production that can resist and adapt and become successful by focusing on the customers’ preferences in a market environment that has enormous rivalry and uncertainties. The primary elements of agile productions are; (1) providing real value to customers, (2) always anticipating change, (3) acknowledging employees’ skills and knowledge and (4) having effective business cooperation (Gunasekaran, 1998). Sharifi and Zhang (2001) imply that agile production is developed in response to the diversity and unpredictable changes in the new world market which vital for manufacturing companies to maintain their competitive advantage to survive. They view agile production as reactive to change and opportunities to discover and take advantage of the changes. According to Hallgren and Olhager (2009) the main contrast in performance outcomes between lean production and ‘agile production’ are that ‘lean production’ has a significant impact on cost performance while ‘agile production’ has a stronger relationship with volume and a product mix flexibility compared to lean production.

2.8.6 Total Quality Control

‘Total quality control’ (TQM) is another manufacturing philosophy developed by Deming Edward in the 1950’s for educating Japanese companies in quality control to boost their industrial development. These companies later become the model of production techniques for all other countries (Boje & Winsor, 1993). The improvement of manufacturing management by focusing on customer preferences is defined by Oakes and Westcott (2001) as ‘a customer driver’. Likewise, Juran (1995) describes TQM as an amalgamation of management theory where manufacturing techniques and tools for establishment focus on the customers meaning of quality, continued improvement of production & development and control of techniques via statistical analyses. TQM was widely used in the early 1980s by the manufacturing industry in the USA and was labelled as the ‘battle cry’ for competitive advantage. Boje and Winsor (1993) described TQM as ‘neo-modern Taylorism’ when comparing the modern principles of TQM with the four principles of scientific management. It has been accepted globally because it was adaptable to contemporary devices of production.

Companies require constant improvement in their operation to be more competitive as the increased level of competition locally and globally forces improvement in their operational performances and their strategic positioning (Hallgren & Olhager, 2009). Value chain
analysis plays a vital role in understanding and distinguishing the capacity and systematic competitiveness of each company along the value chain through mapping the flow of inputs and outputs. The companies can be more effective and competitive to secure niche markets for their products locally and abroad. The manufacturing processes that are adequately done by certain companies are outsourced to the most appropriate companies along the value chain. The competition is growing intensely as companies in developing countries such as Mexico, Brazil, Hong Kong, Malaysia, Singapore and Thailand improve their capabilities and expand abroad (Kaplinsky, 2000). Gerefii (1991) claims that it is globalisation that drives the competitive dynamics of countries, companies and industries as indicated clearly by the trend of industrialisation moving to developing and least developing countries for example the ‘East Asian miracle’ referring to the enormous high-performing Asian economies.

2.9 Market Analysis

Kotler et al. (2010) describe marketing as rewarding the customers with the value they prefer. The simplest definition of marketing is ‘managing profitable customers relationship’ since the overall goal of marketing is to lure and increase customers by providing the best value in products they purchase. Contemporary marketing is fulfilling customers’ needs and interacting with them and no longer is simply the ‘telling and selling’ through media advertisement in the old sense. Therefore, value chain analysis plays a vital role in understanding the entire marketing system, including all companies that operate within the industry from suppliers to customers, supporting markets and financial services in the industry and the business environment of the industry. The importance of having a wide scope of industry analysis is because the ‘principal constraints to competitiveness’ may exist within or outside the market system. These can only be properly addressed if they are identified (Campbell, 2008). The analysis needs a significant understanding of a country’s local and export markets and how the country is performing in the international economy (Subramanian et al., 2007) to be able to carry out a better market analysis and obtain good knowledge of the industry performance. This can be achieved through understanding the country’s level of production, imports and exports, economic performances and GDP, trade policies and agreements and so on. Nevertheless, the components of ‘marketing process’ are; understanding the customer needs and wants, designing plans of actions for marketing, developing market organisation to build profitable customer relationships, creating value for target customers and market
innovations to operate within the dynamic of globalisation (Kotler, et al., 2010).

2.9.1 Market competitive strategies

The three basic ‘competitive strategies’ described by Porter, (1985) are;

- ‘Overall cost leadership’; where firms take leadership roles over their products and through hard work they obtain lower cost of production and distribution, offer lower prices compared to their competitors and become major market suppliers,
- ‘Differentiation’; this is where firms concentrate on producing unique products with high demand nationwide. These could branded goods with competitive prices,
- ‘Focus’; this is where firms focus their effort on a few segmented markets, targeting particular consumers and offering competitive prices and quantity and quality of goods.

Campbell (2008) implies that end markets offer opportunities and set frameworks for firms or countries to obtain economic growth. The end markets requirement varies depending on whether the products are traded internally, regionally or globally. Thus, it is vital to ‘segment the market’ to ensure the products are competitively marketed. Similarly Dann and Dann (2007) point out that ‘market segmentation’ is the key to market development for the reason that there are always challenges in introducing new products into existing markets and ‘market segmentation’ usually goes through the entire process of market development strategies. Dann and Dann (2007) also indicated that Porter’s ‘overall cost leadership’ competitive strategy does not only lower price due to low production cost but in addition; increases unit price, having the opportunities to alter pricing as a barrier to competitors, and improve market shares and economic performances. However, the threats to ‘overall cost leadership’ are that scares and high value resources are traded at a lower price, the firms are vulnerable to market and technology shift due to lack of R & D because of low production cost and it is not a global solution to improve profit.

The cost of productions and the quality of the products are the driving forces of competition between firms along the value chains (Herr & Muzira, 2009). Contemporary markets are highly competitive and shift rapidly and firms need to take regular appropriate actions to meet the market requirements and demand conditions the consumers deserve. This creates great challenges to the rural small forestry farmers in the developing countries to secure niche markets for their forest product. These challenges are described by Kaplinsky and Morris (2000) as entry barriers. Scherr (2004) argue that the majority of
existing forest product markets developed specifically for large-scale forest operations even though it was estimated that there are 500,000 to 1 billion small forestry farmers globally. The majority of agroforestry research from the 1970s up to the 1980s was focused on the agroforestry systems and it was only in the 1990s that some agroforestry projects began to embark on production and marketing at the local level (Scherr, 2004).

Likewise, Anyonge and Roshetko (2003) specify that most of the small-scale forestry farmers have limited access to market information, limited knowledge on market requirements, and weak linkages to buyers. The efforts to improve small-scale forestry farming have focused on farm establishment and management with little attention on marketing of the products. It is important that a ‘marketing chain analysis’ is conducted before planting to identify market opportunities for the anticipated products. ‘Marketing chain analysis’ is a series of processes where products are developed and marketed. It is divided into ‘functions, participations, linkages and channels’ and can be conducted with the producers (farmers) involvement to obtain knowledge on the various aspects of marketing (Anyonge & Roshetko, 2003). It is a similar concept to value chain analysis as it provides better understanding of the associations and linkages between producers and consumers and the various key market actors. For instance a ‘coffee value chain’ would connect the coffee farmers to the manufacturers and the transnational customers at one end, and suppliers of inputs such as (fertilizer producers) at the other end. Numerous value chain analyses also include how products are shifted along the value chain and where firms get financial support (Subramanian et al., 2007).

The activities that will enhance small-scale forestry farmers to improve timber production are; having access to markets and marketing information, genetically improved planting materials and knowledge of species selection, tree management and product development. At the community level, the activities include; marketing analysis of current and future demands and identifying trees that may have comparative advantages, organise farmers in associations and cooperatives to facilitate production and marketing and to improve economies of scale, and close collaboration with government agencies and advocacy groups to develop appropriate extension materials and policies (Anyonge & Roshetko, 2003). Wilson (2006) also argues that, although timber production has long value chains and many linkages: from land acquisition, log production, sawmilling and value adding to retailers, there is evidence that cooperative marketing along the entire chain can add value to the raw materials. Furthermore, having formal business relationships between private
enterprise small farm producers can be beneficial to both parties. Private enterprise can access timber with competitive cost, forest asset production, local environmental expertise and social branding opportunities while local farm producers will benefit from genetically improved planting materials, technical assistance, product design and monitoring of products and having access to business and marketing expertise (Scherr, 2004).

### 2.9.2 Certified wood

Forest certification to promote sustainable management of the tropical rain forests was launched by the United National Conference on Environment and Development (UNCED) in 1992 at Rio de Janeiro, Brazil. Like organically grown products, it is meant to notify the consumers that the forest products are from a well-managed forest. Therefore increasing consumer demand for the certified products creates incentive for the producers to market their products at higher market prices. However, Scherr (2004) explains that certificate schemes are not practical for small–farm producers and unless there are changes made in the certification processes, only a few small-farmers will be directly involved in the certified market. The restrictions includes very high economies of scale, major buyers exclude chain of custody, dependence on international experts, difficult to identify potential buyers and lower price paid for premium products. Small-farmer producers will participate effectively in certified wood market only if the costs of obtaining certification are low, the location, cost of access and quality meet market criteria, and there are direct links to buyers. They also need partners who are willing to underwrite certification costs and facilitate the process (Scherr, 2004). However, with the increasing concern over the depletion of the land-based natural resources, the global timber market is evolving to meet new market conditions, and forest certification is increasingly becoming a market requirement with consumers in Europe and the USA who are willing to pay more for certified forest products (Nor Suryani et al., 2011).

### 2.10 Key elements of value chain analysis

#### 2.10.1 Barriers to Entry and Rent

The various firms who participate in the value chain from farming, manufacturing, marketing, coordination and recycling normally position themselves against their competitors. This may involve the concept of ‘rent’ from owning exclusive resources that enable ‘barriers to entry’. Therefore, value chain analysis provides clear understanding on the distribution of funds required by each firm to be competitive in their sectors. There are
various forms of ‘rent’ but ‘economic rent’ has been the focus on the literature and widely used by government policy makers and entrepreneurs (Kaplinsky & Morris, 2001). Tietenberg (2007) implies that in most natural resource sectors, rents are increased to avoid reduction of producer’s surplus and the producer’s surplus that continue to pursue success in competitive equilibrium, is called ‘scarcity rent’. The ‘scarcity rent’ concept was introduced by David Ricardo, who suggested that due to scarcity of land, the price of land will be determined by least fertile and marginal land. This will ensure infertile and marginal lands are purchased for production with total revenue equal the production cost and no surplus or profit while fertile land obtain higher return due to low cost of land. Therefore, ‘scarcity rent’ is an opportunity cost and its main purpose is to protect future consumers. By setting price control on natural resources governments will provide under allocation of resources for the current generation and over allocation for the future generation. The interference of government through lobbying, and allocation of quotas on natural resource use to increase profit is called ‘rent seeking’ (Tietenberg, 2007).

Barriers to entry are situations created by industries to disadvantage other new competitors to enter existing markets. The six main sources of barriers to entry described by Porter (1980) are;

- ‘Economies of scale’; where decrease in production cost per unit enables mass production that forces competitors to take the risk of producing high volume for entry or produce less and be disadvantage by the existing companies. This could be in any function along the value chain from farming to production, marketing and distribution. The ‘economy of scale’ is the source of barriers to many multinational companies where individual firms are specializing in segmented products for instance an electric motor could be used in fans, blenders, hairdryers and cooling system for electronic equipment,
- ‘Product differentiation’; is where existing companies with branded products, have gained consumers’ confidence and loyalties due their past promotions. This creates difficulties for new entrants and forces them to invest heavily to distort the consumers’ confidence and loyalties,
- ‘Capital requirements’; a barrier to entry is created when large establishment costs are required to start a business. Upfront costs such as promotions, R&D, environmental impact assessment (EIA) and inventories are unrecoverable, for instance extractions of timber from the natural forests and minerals,
• ‘Switching costs’; is where the barrier to entry is created by ‘switching costs’ as consumers change from one supplier to another,
• ‘Access to distribution channels’; is where the barrier to entry is masterminded by the new competitor by accessing existing markets through offering low prices either via government support or cooperative supporting schemes. Sometimes new distribution channels are created, if the existing channels are hard to enter,
• ‘Cost disadvantages independent of scale’; is where existing companies are in an advanced economic situation that it is impossible for new entrants and these involve; product patents, secure and lockup access to most desirable raw materials, favorable locations and access to government subsidies,
• ‘Government policy’; governments create barriers to new entrants though protective policies, regulations and legislations especially for natural resources.

The effects of these sources of barriers extend beyond the boundary of value chain and become barriers to development, especially in the least and developing countries where the governments are heavily burdened with loan repayments, reduction of exports due to falling prices and economic flight. Tietenberg (2007) explains that agriculture policies in the developed and industrial countries are undermining the normal function of pricing system of agricultural products to be responsive to changes in price and substitution. These involve; subsiding of pesticides, fertilizers, equipment and materials used on the farm, minimizing price fluctuations for outputs and protecting the farmers from import rivalries through ‘trade barriers’ such as import tax and quarantine laws. These prospective measures permit economy of scale for the developed and industrial countries and creating a barrier for least and developing countries exports.

In the forestry sector, many of the developed and industrialised countries are removing policy barriers that have been put in place to encourage and control commercial processing and subsidies are now allowing normal market pricing system. Nevertheless, the existing regulations are still not favourable for small farm producers to participate in the industry but favour large-scale forestry operations. In most circumstances, the forest product markets are distorted by the dominancy of the large-scale operators and government policies. For the small-scale operators to participate effectively in the industry, governments are beginning to undertake participatory and comprehensive forest policy reforms to remove extreme regulations, allow open and fair trade and involve farmers in policy development (Scherr, 2004). Streed et al. (2006) also specified that ‘economy of
"scale" is the main barrier to efficient small forestry farmers in the tropical countries.

2.10.2 Governance

Value chains involve monotony of connections and interactions between firms along the value chains and governance ensures that these interactions are well organised and managed by the firms, since the quality and efficiency of the products, process and logistics depends on each firm. Governance is different to firm coordination and is a function performed by key actors along the value chain normally referred to as ‘power asymmetry’ (Kaplinsky & Morris, 2001). It specifies which firms along the value chain are being accepted by other firms in the chains to establish and implement guidelines on their behalf, and is associated with benefit sharing, relationships and power dynamics. For instance, market changes and increases in product competition will force the sellers and buyers to enter into another level of relationship to adjust themselves to the market changes and remain competitive (Campbell, 2008).

Gereffi et al. (2005) proposed a more complete typology of value chain governance and they are:

a) Markets. Market linkages are not entirely temporary, they could be continuous but the fundamental point is the costs of switching to new partners are low to both parties,

b) Modular value chains. Producers make specific products for customer’s requirements and producers take full responsibility to produce the products,

c) Relational value chains. Complex interactions between suppliers and buyers and it may involve family and ethnic bonding,

d) Captive value chain. A network where small suppliers are dependent on large buyers and suppliers are captive in switching costs. Such networks are normally controlled by lead firms,

e) Hierarchy. The governance is normally in vertical integration, either from manager to subordinates or headquarters to subsidiaries.

These types are the basis for deciding the operational theory of value chain governance and under which circumstances the market is expected. The key determinants of value chain governance patterns are: ‘complex of transactions’; ‘codifiability of information’; and ‘capability of suppliers’. They provide understanding of the problem of asset and the cost of coordinating activities along the value chains (Gereffi et al., 2005).
Irawati et al. (2009) found that small furniture makers in Indonesia are not maximizing the benefits from their products because the furniture industry is controlled by the buyers, which is a perfect paradigm of ‘captive value chain’ described by Gereffi et al. (2005). Lead firms also can increase the complexity of the value chain when demanding ‘just-in-time’ supply and increased product differentiation (Gereffi et al., 2005). However, the three types of value chain governance identified by Irawati et al. (2009) are ‘market based’, ‘directed network’ and ‘balanced network.’ Their recommendations for improving the small-scale furniture producers are; establishment of small-scale furniture associations, collaborations among producers along the value chain to produce new products or services, and moving up the value chain and venturing into furniture brokering by working with finishing companies and or exporters.

2.10.3 Types of value chain

Gereffi (1999) describes the types of value chains as ‘buyer-driven chains’ and ‘producer-driven’. The governance of ‘buyer-driven chains’ is controlled by the buyers and the industries, are labour intensive such as textile, footwear, furniture and toys (Gereffi, 1999). Barriers to entry in production are normally low therefore the producers are supplemented to key designers and marketing agents, especially the control of brand names and retailing (Raikes et al., 2000). ‘Producer-driver chains’ are where key producers determine the essential technologies (Gereffi, 1999), such as automotive and aircraft industries. Barriers to entry are high and manufacturers are the main agents (Raikes et al., 2000).

2.10.4 Value Chain Mapping

Value chain mapping provides a comprehensive understanding of all the activities, key actors and their relationships and interactions along the value chain. Mapping combines the information from the ‘market analysis’ with detailed information about the firms along the value chain to understand how products are profitably produced and supplied to the consumers. This involves understanding: how firms or farms are linked to their industries either locally or abroad, the strength of each firm along the value chain and the key firms, service providers and their interactions (Subramanian et al., 2007). Kaplinsky and Morris (2001) strongly emphasise that value chain mapping is a very important exercise as it provides the ability to analyse and understand the earnings by different firms and individuals in the value chains and should not be underrated. Similarly, Ribot (1998) described mapping of commodity chains as a commanding instrument for identifying gaps
in policies and understanding the political, social and economic structures that exist within the charcoal extraction and production in Senegal. In addition, it maps out the property rights and accessibility and the bundles of power over the resources (Ribot, 1998). Meinzen-Dick et al. (2004) explain that property rights can be quite complex. They are better understood as overlapping bundles of rights such as: ‘user rights’, the rights to access and exploit the resources for economic benefits and ‘control or decision-making rights’ the rights to manage, exclusion and alienation. In general, they are embedded with ‘legal pluralism’ (Meinzen-Dick et al., 2004). However, the parameters used to map the charcoal production in Senegal consist of; discovering the main actors along the value chain, assessing the income and profit for each actor and assessing the distribution of income and profit of each actor (Ribot, 1998). This is similar to the study of Uganda’s charcoal value chain, in which the producers, agents, transporters, traders and retailers were identified as the key actors (Shively et al., 2010).

2.11 Value-Adding

2.11.1 Process Based Value-Adding

Lantz (2005) explains that value-adding is a strategic goal for the contemporary forest products industries and is defined as the ‘economic value of products earned by the processing company’, and it is the difference between ‘physical inputs’ and ‘outputs’ required to manufacture the products. Sathre and Gustavsson (2009) emphasised that in industrial processing, value-adding is basically adding exchange value to primary resources, creating final products with higher exchange value than the total inputs that can be sold profitably in the market. It does so not only by adding value to the products but also contributes to creating jobs, government revenue and capitalist incentives.

2.11.2 Inputs and outputs values

In production ‘inputs’ are received in the form of raw materials, human resources, funds, utilities, and information and when the ‘inputs’ are changed in the ‘conversion subsystem’ into consumable products and services, they become the ‘outputs’. A fraction of the ‘output’ is observed in the ‘control subsystem’ to qualify the product in terms of quality,

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1 Sets laws, local/customary, family state, religious and international operates in both formal and informal way.
2 Subsystem of a larger production system in which inputs are converted into outputs.
3 Subsystem of a larger production system in which a portion of the outputs is monitored for feedback signals to provide corrective action if required.
quantity and cost. If the ‘output’ is acceptable then it is introduced into the market but if it is not accepted, it is reassessed by the firm (Gaither & Frazier, 2002). The assessment of how much value is added to the products can be difficult and depends on how accurately the costs of both ‘input materials’ and ‘output products’ are estimated. Thus, the ‘inputs’ and the ‘outputs’ are normally valued through the recognition of three market prices which are ‘basic’, ‘producer’ and ‘purchase’.

Inputs should be evaluated based on the ‘current purchase price’ which includes the basic price, packaging and delivery costs, insurance and all taxes paid by the industry to obtain the input goods. It is important to recognize the ‘economic value’ and the ‘potential utility value’ of the different types of forest raw materials. For instance, input such as sawn logs can be used in various levels of processing along the value chain while others such as pulpwood, polewood and firewood can be processed only to certain levels (Sathre & Gustavsson, 2009).

Nevertheless, value-adding can be influenced by many factors such as the operational level of a company, the level of value chain of the industry, methods of production, and the prices of the pertinent merchandise. The impacts of these factors on value-adding in the forestry industry can be systematically addressed through modelling, taking into consideration all the input materials and capital required (Lantz, 2005). Sathre and Gustavsson (2009) also explain that the changes on market prices for the forest products, whether raw materials, semi-finished or finished, usually create difficulties in determining specific prices to calculate the value added thus, many value-added forest products are purchased on ‘contract prices’ instead of ‘spot price’. Contract prices may be higher than the spot price but the advantages are that the buyers are protected from sudden increases in prices and the resources are always available in the future.

Lantz (2005) emphasises that output is elastic because the value-added can be altered through the changes in the inputs of the individual firms and along the value chain of the industry. For instance, if a firm’s output increases the collective outputs also increase, including the value of transportation, the use of materials and supplies and energy, but if the cost of transportation, materials, supplies and energy increases the difference between the market value and the cost of production also increases. Sathre and Gustavsson (2009) also pointed out that the determination of the added value through the difference between

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4 The amount receivable by the producer from the purchasers per unit including subsidies and excluding tax and transport costs
5 Basic price plus tax on the output invoiced purchasers less the subsidies from the government
6 The amount paid by the buyer per unit of output less tax but included transport costs and trade margin on products invoiced separately
the ‘input prices’ and ‘output prices’ not only depends on the internal production components but also on the ‘elasticity of demand’ creating changes in the output prices and value added either way. However, the values of the manufactured goods amplify as they progress along the ‘value chain’ from primary resources to harvesting and use by the consumers. Various forms of value are added to the products along the value chain. The initial value-adding normally involves tangible physical or chemical changes of materials input while towards the end of the value chain it normally involves non-tangible activities such as logistics and administration to ensure consumer preferences are well accommodated (Sathre & Gustavsson, 2009).

2.11.3 System boundaries

An industrial structure is not a standalone entity with a single value chain, but it is complex and comprised of various linkages, both horizontal and vertical, with the main actors performing specific tasks along the value chains. Therefore value added analysis defines the boundary of the value chain. The main actors each constitute a distinctive part of the value chain, from primary materials, harvesting, processing, packaging and delivery to the market as finished products. It is not easy to determine the value-adding boundaries because some industries begin their value-adding from outputs of other firms (Sathre & Gustavsson, 2009). A United Nations report (2003) indicates that all production is regarded as economic activity and included in the production boundary except the domestic services\(^7\) that produce and consume within the same households are excluded.

In a concept similar to the ‘simple value chain’ specified by Kaplinsky and Morris (2002), Juurma and Põlder (2011) describe ‘life cycle assessment’ (LCA) as the transition of products from primary material, harvesting through processing, use and disposal. One of methods of LCA is to define the ‘system boundaries’ and that is to decide what to consider in the LCA as indicated in Figure 6. However, how the definition of ‘system boundaries’ depends on the purpose of the analysis and the understanding of the inputs in each links. In a ‘bottom-up approach’, the analysis can be concentrated on several links in the chain of value-adding. Vertical integration of firms on the value chain can affect the calculation of the value added. This is because the measure on how value is added depends on the accuracy of data and information obtained on the integrations, transition and transfer of costs between the divisions or firms along the value chain. Also vertical integrations may

\(^7\) Such as cooking, cleaning, decoration, maintenance and repair, household transportation, taking care of children and sick people etc.
boost material flows to value-adding or may limit material flows, especially when firms are only producing single products and are less responsive to market opportunities (Sathre & Gustavsson, 2009). Lantz (2005) explains that the variations on the prices of materials/supplies and energy will affect value-added production including the changes in stumpage fees, which is a major effect on materials costs and is often unclear. Nevertheless, there are opportunities for both upstream and downstream firms forming partnerships to target product or market opportunities (Sathre & Gustavsson, 2009).

Figure 2.1: Defining goal and scope in wood supply chain

Source: Juurma and Põlder, 2011

2.12 Value-adding of wood products

Value-adding of wood products is the processing of primary wood products such as logs and boards into higher valued products such as furniture, joinery, mouldings and engineered wood products, most of which are normally associated with housing construction activities. The engineered wood products include; glued beams and posts from sawn woods, veneer lumbers and veneer sheets re-sawn into required shapes and sizes (United Nations, 2010). Traditionally in the forestry industry, ‘value-adding’ is referred to as ‘secondary wood processing’ where primary outputs such as timbers are down processed to finished products (Sathre & Gustavsson, 2009). In Canada ‘value-adding’ is usually defined as the expenses of raw materials inputs minus the shipment value of a product sold in the market (‘value adding = value of output – cost of materials supplies – cost of purchased energy’) (Lantz, 2005). Sathre and Gustavsson (2009) clarify that previous value-adding analysis in forestry normally has focused on solid wood products rather than on identifying a wider range of technologies to produce high value products in a form of composite products, liquid fuel, electricity, heat or paper products.
Now the federal and provincial governments in Canada, British Columbia and other countries are promoting value-adding in the forestry industry through various policy approaches such as capacity building in production and marketing, modernisation of value-adding equipment and technologies. Some governments even provide soft loans to the forestry value-adding companies. These policy directions help to boost the value-adding industries to allow sustainable and economic utilization of the forestry resources (Lantz, 2005). Promotion of value-adding in the forestry industry has the potential to raise the level of production, advance the technologies and increase profit margins to the industry (Cohen, 1990).

Many forestry policy makers believe that investing in advanced technologies in value-adding of forest products will allow the forestry industry to be competitive in the international market. Already U.S. forestry researchers are documenting the significant contribution of the value-adding investments and responses to market changes. In areas where forestry resources are limited, the high costs of raw materials enable the value-adding industries to invest in advanced technologies. These include European furniture makers in Italy and Germany who are shifting to automated computer technologies (Hoff et al., 1997). The rivals of the USA in value-adding such as Taiwan and Korea are investing heavily in advanced technologies. Lantz (2005) also specified that efficient improvement of value-adding in the forestry industry through technological innovation will reduce cost of production. According to Kant and Nautiyal (1997), the production structure and the technology in the Canadian logging industry must change so that total production costs don’t become uneconomical due to conservation activities combined with long transport distances and difficult terrain to access forest resources. The forest-based industry, forestry and environment authorities, ministries and conservation activities should put more effort on technology development rather than putting pressure on logging companies through environmental awareness and technical changes that will reduce the scale of harvesting (Kant & Nautiyal, 1997). Lantz (2005) explains that forest companies with low levels of value-adding will experience a decline in production over time while there will be productivity gains for the companies with high levels of value-adding. Therefore, the decision on technology innovation depends on the company’s levels of value-adding and the outputs required by the market.

ITTO (2002) specifies that traditionally many of its timber-producing member countries are limited, as the producing member countries export primary forest products such as
logs, slabs and panels that maximise the benefits consuming countries gain from value-
adding. The limitations for producing countries to value-add locally are the lack of
infrastructure and technologies, capital investment and less purchasing power from the
local consumers. Nonetheless, with the strong economic growth experienced by producing
countries, many are committed to value-adding locally before export. Malaysia, Thailand,
Indonesia and the Philippines from the Asia-Pacific region are becoming world-leading
exporters in the furniture market. Brazil has also developed a large value-adding industry.
The African region appears to behind the rest of the world but has made considerable effort
towards value-adding, for example by banning of round log export by Ghana (ITTO,
2002).

Australia adopted ‘value-adding’ as one of the main objectives in its timber industry in the
early 1990s. Through intensive research on wood technology and value-adding
technologies by CSIRO Forestry, Forest Products in Victoria and Queensland government
agencies, processing standards for each hardwood species are specified for various value-
adding products. In recent years forestry farmers from various parts of Australia have been
involved in forestry farming, targeting high value products from value-adding. The
species included in the research are; ‘Eucalyptus grandis (rose gum), Eucalyptus
sideroxylon (red ironbark), Eucalyptus camaldulensis (river red gum), Eucalyptus
maculata (spotted gum), Eucalyptus globulus (southern blue gum), Eucalyptus saligna
(Sydney blue gum) and Eucalyptus cladocalyx (sugar gum)’. Previously many of these
species were only used for domestic construction, decking and fencing because they are
susceptible to visual and mechanical stress albeit having properties suitable for high value
products (Ozarska, 1998).

One of the primary visions of the Vanuatu Department of Forests under its National Forest
Policy is to work cooperatively with the forestry farmers and the forestry industry to
develop and encourage value-adding to contribute to the country’s economy and provide
employment for current and the future generations. In order to achieve this, the
government implemented a ban on round log exports, allocated ‘green timber licenses’ (10
year timber license) to major sawmill companies, provided government subsidies through
exemption from import tax and value-added tax on fuel and importation of value-adding
machinery. They also limited the number of operator licenses for scarce and high value
resources such as sandalwood and burls and reserved the small sawmills to be owned and
operated only by indigenous Ni-Vanuatu (Department of Forests, 1997). This policy
direction contributed significantly to the development of the whitewood industry and consequently whitewood producers were able to secure niche markets in Japan and other countries. Likewise, by allowing only two sandalwood license holders in the country, these companies are able to produce sandalwood oil and pre-grind for incense sticks.

However, the shift of whitewood supply from natural forests to planted forests has brought about a new era in the country’s forestry sector. Thus, the Department of Forests has to review its National Forest Policy and regulations to accommodate the shift, particularly how the small farmers in the rural areas are able to economically harvest and trade their whitewood farms. Scherr (2004) explains that small farmers are more competitive in open and well-defined niche markets for small producers with no ‘economies of scale’ and low cost of ‘barriers of entry’ through government policies and regulatory supports. For instance, the smallholders of rubber (*Hevea brasiliensis*) plantations in Malaysia and Thailand are becoming competitive in the local, regional and global markets in both latex and wood products through government subsidies supporting replanting of old farms, processing and marketing. Because of strict control on the harvesting of natural forests, both countries explore and promote value-adding of lesser known timber species such as rubber tree. The export of rubber wood products in Malaysia increased from 26% to 35% between 1998 and 2007 while in the same period Thailand rubber wood export increased from 40% to 70%. The highest proportions of these exports are in furniture, 80% in Malaysia and 90% in Thailand (Shigematsu *et al*., 2011).

Van Herk (2001) explains that often the timber industry views itself as a processor of logs while it refuses to acknowledge the significant profits that are available through the value-added chain. Value chain is a complex process that involves; raw materials, ecological issues, timber seasoning, processing, manufacturing, and design and marketing. In general, it can be divided into two main areas: ‘*higher capital, low labour, high output*’ (e.g. flooring and major pine processing plants), and ‘*lower capital, higher labour, low output*’ (e.g. furniture manufacture, handcrafted furniture and crafts, boutique timber supply). The further the product is up the value-adding chain, the greater the risk and accountability to the customers. Therefore, with a planned operation, it is important to identify how higher returns can be achieved from the least amount of work (Van Herk, 2001). According to a case study by Land and Reed (2004) on the difference between selling trees as standing firewood and processing the trees then selling as value-added products, the net return from the value-added products is ten times more than that from
standing trees sold for firewood.

At present mass production has been shifted to more flexible production and heavy and large companies are becoming smaller. Small and medium-size enterprises are becoming competitive and contributing significantly to economic development. The roles of small and medium-size enterprises in social structures are gaining importance and can be supported by the development of relevant policies to guide their influence in the societies (Erdem, et al., 2010). By far domestic consumers are the main customers for small-scale producers but as forest resource scarcity increases, the high demand for forest products may provide incentive for export markets (Scherr, 2004).
3. RESEARCH METHODS

3.1 Introduction
This chapter presents the research methodology for the study, outlines the sampling methods and research instruments and includes the literature related to the sampling procedures. Additionally the various steps used to systematically map the actors participating in the production are described, including the approaches to studying processing, marketing and consumption of whitewood products. The distribution of benefits to the various actors is identified, along with the potential role of upgrading within the value chain.

3.2 Justification of the research approach
Research involves using the scientific method to assess ideas and facts to obtain objective conclusions about the real world, whether in the social sciences, business or physical sciences (Zikmund et al., 2010). Creswell (2009) describes research design as plans and procedures for research that transform broad ideas to specific methods of data collection and analysis. Design and methods are the second major element of research. It is desirable to have a clear research rationale to adequately design the study and select specific methods, to demonstrate the feasibility of the study (Marshall & Rossman, 2011). Creswell (2009) states the three types of designs are qualitative, quantitative and mixed methods. Qualitative usually applies in social science by means of exploring and understanding social or human problems by direct contact with the participants while, quantitative usually applies in science by means of testing objective theories through investigating the relationship among variables. The mixed methods research is a combination of quantitative and qualitative (Creswell, 2009). Often qualitative researchers assume the variables of social and cultural structures may be overlooked without quantitative research, and it is not wrong but it will be wrong if they fail to acknowledge that survey questions also make meaningful measurements of such entities (Silverman, 2000).

Leskinen et al. (2009) explains that responsibilities of forest management have become diversified, having more emphasis on criteria other than those related to wood production. Forest managers are facing an increasing demand for more adaptability and need to base decisions on consumer’s preferences and market demand for the forest products. Often the statistical framework is derived from general development of multi-objective and
participatory planning methods which are usually controlled by forestry technicians (Leskinen et al., 2009). Harrison et al. (2002) also specify that recently the focus on forest management and conservation has shifted from highly technical forestry to a more socio-economic oriented forestry. Similarly, the goal of this study is to generate analyses that support the creation of a whitewood industry that is economical, efficient and more participatory for all individuals and firms along the value chain.

The study used the mixed methods research approach which includes both qualitative and quantitative research methods. Cresswell (2009) explains the strength of this type of study is greater than either one alone. Hackley (2003) also pointed out that qualitative and quantitative methods are not exclusive, and most research studies in marketing and consumer affairs are a mixture of both. There are a number of customary qualitative methods used to obtain satisfactory information from a target population however the most common methods are focus groups and interviews. Both methods allow the researchers and the target population to interact and have deeper deliberations and therefore understanding of the research topic (Ayala & Elder, 2011).

### 3.3 Site selection

The research on whitewood value chain analysis and opportunities for value adding was carried out on the islands of Santo and Efate. These are the two main islands of Vanuatu where virtually all government, commercial and business activities exist. The capital of the country, Port Vila, is on Efate and Luganville on Santo is the industrial area of the entire country (Figure 3.1). Selection of both islands for the research did not involve using a criteria matrix as all the whitewood major activities starting from production, processing to marketing consumption exclusively occur on both islands, but not on the other islands in the country. Noumea, New Caledonia was visited during the second phase of the data collection to extend investigation of the whitewood value chain to include export consumers. As mentioned in the introduction, the largest natural stands of whitewood occurred on the northern and eastern sides on both islands but large fractions of the forest have been logged and replaced in accessible areas by cattle, coconut plantations, gardens and settlements.
Figure 3-1: Map of Vanuatu including the islands of Efate and Santo where study sites are located.

3.3 Sampling design and techniques

3.3.1 Sampling selection

Defining how sampling will be done is part of developing a research design (Malhotra, 2004) and is a measurement or a study of some components of a population in order to understand the entire population. It should ideally be cost effective, accurate and precise. Good sample design is judged by how well it represents the characteristics of the population (Emory & Cooper, 1991). Generally, sampling is an estimate of unknown parameters of a population (Sampth, 2005). The sampling selection in this study included the determination of the target population to be interviewed, along with the identification of all types of participants in the whitewood value chain on the two islands chosen for the
3.3.2 Target population

The target population is a set of elements or items that have the information required for the investigation by the researcher. Defining the target population is the beginning of the sampling design (Malhotra, 2004). The target population in this study were; whitewood farmers or producers, processors (including saw-millers, timber yard owners, and value-adding processors) and consumers. Consumers are individuals and companies that only use and do not trade whitewood products. For instance, construction companies may be involved in value-adding, such as producing engineered products or furniture making but as it is part of their construction agreement with the building owner these companies are categorised as consumers. However, if they are involved in trading of value-added whitewood products outside housing construction then they are categorised as value-adding processors. Farmers or producers include all individuals or companies that are involved in whitewood farming and plantation establishment. Likewise, processors are all individuals and companies who are involved in value-adding and marketing of whitewood forest products. There are individuals and companies involved in more than one category and they were surveyed according to each level of operation.

3.3.3 Sampling frame

The sampling frame is intimately related to the nature of the population and defined as the list of elements from which the sample is actually drawn (Emory & Copper 1991). It specifies the directions for identifying the target population, similar to a telephone book, with all the contact information for individuals, companies and industries (Malhotra, 2004). In this study the list of farmers and details of their information and locations were obtained from the forestry farmer survey completed by the Department of Forests and the whitewood silviculture project and by Forestry Extension officers. The list and all the information and locations of stakeholders in the processing category were obtained from the operator license database from the Department of Forests and from Forestry Extension Officers working for the Department of Forests. The list of consumers was obtained from the Department of Forests offices, Forestry Extension officers and through interviewing the whitewood producers and processors.
### 3.3.4 Sample Size

The sample size necessary to address the research questions was obtained from the sample frame. However, due to the reduction in the whitewood industry following the exhaustion of whitewood supply from natural forests, the number of stakeholders interviewed in the processing and consuming categories by and large was determined by the number of people still processing and consuming whitewood. Consequently, the sampling intensity in the processing category was exceptionally high compared to the producers and the consumers, that is, almost all processors were surveyed whereas not all producers or consumers were.

Emory and Cooper (1991) specify that the best sample size is the one that provides the required information accurately and precisely and that the sampling should be cost effective. Probability sampling is the fundamental formula for calculating sample size by assuming the population is countless. For instance, the accuracy estimation of sampling of 100 out of 5,000 could be the same as 100 out of 200 million. A major problem is that large scale sampling is difficult and costly. Therefore, variance is the most important factor in determining population size. Sample size increases according to the increase of variance to provide accuracy estimation of the population (Emory and Cooper, 1991). Malhotra (2004) explains that determining the sampling size is complex and in qualitative studies the sample size is normally small for exploratory research and large for a conclusive survey such as a descriptive survey.

However, Zikmund (2000) explains sample size can be either proportional\(^8\) or disproportional\(^9\). This study adopted the disproportional sample since the sample size of the different stakeholders along the whitewood value chain on Santo and Efate varied and did not correspond with population size as indicated in Table 3.1. Zikmund (2000) suggested that if the objective of the research is to analyse some aspect of the stratum separately and assess differences among strata, then disproportional sampling is appropriate.

### 3.3.5 Sampling units

Sampling units are designed to answer the research questions (Zikmund, 2000) and in this study the units selected were major whitewood stakeholders as listed in Table 3.1. The

\(^{8}\) Sampling size of each stratum corresponds with population size

\(^{9}\) Sampling size of each stratum may vary and not correspond with population size
units include individuals and companies who own whitewood farms/plantations, processing facilities and domestic and foreign consumers who purchase whitewood forest products.
Table 3.1: Sampling units and locations for study

<table>
<thead>
<tr>
<th>Island</th>
<th>Whitewood Major Stakeholders</th>
<th>Locations</th>
<th>Type of Sawmill/Types of consumers</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santo</td>
<td>Farmers/Producers</td>
<td>East Santo</td>
<td>Chainsaw mini-mill</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Central Santo</td>
<td>Portable sawmill</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South Santo</td>
<td>Forest Mill</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South West Santo</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Processors</td>
<td>Lugarville &amp; other parts of Santo</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saw-millers</td>
<td>Lugarville and other parts of Santo</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Timber Yards</td>
<td>Lugarville and other parts of Santo</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Furniture Makers</td>
<td>Lugarville and other parts of Santo</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Domestic Consumers</td>
<td>Lugarville and other parts of Santo</td>
<td>Construction companies</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individuals</td>
<td>1</td>
</tr>
<tr>
<td>Efate</td>
<td>Farmers/Producers</td>
<td>South West Efate</td>
<td>Chainsaw mini-mill</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>North West Efate</td>
<td>Portable sawmill</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>North East Efate</td>
<td>Forest Mill</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South East Efate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Processors</td>
<td>Port Vila and other parts of Efate</td>
<td>Chainsaw mini-mill</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Saw-millers</td>
<td>Port Vila and other parts of Efate</td>
<td>Portable sawmill</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Timber Yards</td>
<td>Port Vila and other parts of Efate</td>
<td>Forest Mill</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Furniture Makers</td>
<td>Port Vila and other parts of Efate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Domestic Consumers</td>
<td>Port Vila and other parts of Efate</td>
<td>Construction companies</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individuals</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Foreign Consumers</td>
<td>Noumea, New Caledonia</td>
<td>Companies</td>
<td>3</td>
</tr>
</tbody>
</table>

**Subtotal samples 69**

<table>
<thead>
<tr>
<th>Island</th>
<th>Farmers/Producers</th>
<th>Locations</th>
<th>Type of Sawmill/Types of consumers</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efate</td>
<td>Farmers/Producers</td>
<td>South West Efate</td>
<td>Chainsaw mini-mill</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>North West Efate</td>
<td>Portable sawmill</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>North East Efate</td>
<td>Forest Mill</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South East Efate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Processors</td>
<td>Port Vila and other parts of Efate</td>
<td>Chainsaw mini-mill</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Saw-millers</td>
<td>Port Vila and other parts of Efate</td>
<td>Portable sawmill</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Timber Yards</td>
<td>Port Vila and other parts of Efate</td>
<td>Forest Mill</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Furniture Makers</td>
<td>Port Vila and other parts of Efate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Domestic Consumers</td>
<td>Port Vila and other parts of Efate</td>
<td>Construction companies</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Individuals</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Foreign Consumers</td>
<td>Noumea, New Caledonia</td>
<td>Companies</td>
<td>3</td>
</tr>
</tbody>
</table>

**Subtotal samples 46**

**Total Samples 115**

### 3.3.6 Sampling techniques

The population is divided into subpopulations (strata) and random samples are taken of each stratum. The two broadly classified sampling techniques are probability and non-probability. In probability sampling, the sampling units are selected by chance and the sampling techniques include: random sampling\(^{10}\), systematic sampling\(^{11}\), stratified

---

\(^{10}\) Sample in which every element in the population has an equal chance of being selected

\(^{11}\) Statistical method of sampling involving the selection of element from ordered sampling frame
sampling\textsuperscript{12} and cluster sampling\textsuperscript{13}. Non-probability sampling depends on the researcher’s judgements. The researcher decides which units should be included in the sampling. These techniques include; convenience sampling\textsuperscript{14}, judgemental sampling\textsuperscript{15}, quota sampling\textsuperscript{16} and snowball sampling\textsuperscript{17} (Malhotra. 2004).

Several sampling techniques from both the probability and non-probability types were used in this study to address the research questions. In the whitewood farmer survey, the islands were stratified into localised areas as indicated in Table 3.1 to ensure the variables were homogenous within a stratum and heterogeneous in different strata. The method used for selecting farmers for an interview addressed both random and judgemental sampling techniques questioning the expertise and understanding of the farmers by the researcher and research intermediaries from both islands. The survey of sawmillers was stratified into those who used chainsaw mini-mills, portable mills, forest mills (stationary sawmills), the sampling involved random, judgemental, and snowball sampling. Malhotra (2004) verifies that snowball sampling is commonly used in business and marketing research to discover the sellers and buyers of any particular product. It has been widely used in recent years especially when respondents are hard to identify and are best located by referral networks (Emory & Cooper, 1991). Accordingly, the sampling of the timber yards, furniture makers and consumers also used the random, judgemental and snowballing sampling techniques.

3.4 Data collection methods

3.4.1 Survey design

Surveys involve questioning people and recording their responses for analysis. The strength of the questioning as a main data collecting technique is that it is flexible and in this manner, we are able to gather large amounts of data in short period of time. Standardization of questionnaires can be administered by more than one person and interviews can be done through telephone and mail with less cost and covering large sampling areas (Emory & Cooper, 1991). Marshall and Rossman (2011) explain that face-

\begin{itemize}
  \item \textsuperscript{12} Sampling method where the population is divided into subpopulation (strata) and random samples are taken of each stratum
  \item \textsuperscript{13} Dividing the population into groups before randomly selection
  \item \textsuperscript{14} Sampling of people because they volunteer, available or easy to access
  \item \textsuperscript{15} The researcher uses his/her experience to select the population to be sampled based on experience and knowledge
  \item \textsuperscript{16} Representative individuals are chosen out of a specific subgroup
  \item \textsuperscript{17} Chain sampling, where key people along the chain provide information on who to sample
\end{itemize}
to-face surveys enable researchers to focus on the problems, obtain accurate information and avoid ethical or political interference in the research process. Further, they outlined that this type of survey is open to statistical analysis, easy to organize and manage, and the researcher is able to obtain cooperation from the respondents. Researchers can assess the legitimacy of the information provided by the respondents during the survey. The face-to-face survey approach was considered most appropriate given that the information needed in this research is about examining the attitudes, perceptions and behaviour of individuals in the whitewood value chain in a diverse social and business environment.

### 3.4.2 Question design

A questionnaire is a well-defined set of questions formulated to acquire information from the respondents through written or verbal interviews. The three objectives of questionnaires according to Malhotra, (2004) are:

1. To ensure the information is translated into simple and clear questions that can be easily understood by the respondents,
2. To boost the morale and encourage the respondents effectively to participate in the interview,
3. Questionnaires are designed to minimize respondents’ error.

A researcher has to ensure the questionnaires are relevant and accurate to achieve the purpose of the study. Accuracy means the information collected is dependable and appropriate and relevancy means the information efficiently addressed the research questions (Zikmund et al., 2010).

Malhotra (2004) explains that the process of questionnaire design involves;

1. Specifying the information required to address the research problems,
2. Specifying the method of interview whilst avoiding long and complex questions,
3. Revising question content for each respondent, some questions might not be necessary for some respondents,
4. Designing questions that uplift respondent’s morale,
5. Deciding on the question structure either ‘multiple-choices, dichotomous and scales’,
6. Using question wordings,
7. Structuring the questions in order,
8. Determining the format and layout of the questions,
making copies of the questionnaire on quality paper to avoid respondents thinking that the research is not important,

pre-testing of questionnaire on small sample to identify problems and revise questions

The two types of questions used in questionnaire design are closed and open-ended. Closed questions offer the respondents choices that are easily converted into numerical formats for statistical analysis. Open-ended questions offer the respondents the freedom to express their opinions. The results are then summarised into different categories and entered into Statistical Package for the Social Sciences (SPSS). Combinations of closed and open-ended questions at times provide better opportunity for the respondents to select their answers from the list of choices or list their answers on the additional category (other) if not on the list. Combinations of closed and open-ended questions can be very useful during the questionnaire trailing stage to ensure all the response categories are covered (Pallent, 2011). In this study both closed and open-ended type questions were used and were designed and structured according to the processes described by Malhotra (2004).

3.4.3 Pilot testing

Pilot testing or pretesting is the last process in the questionnaire design described by Malhotra (2004). The main purpose is to test the questionnaire on a small sample of respondents and to enable the researchers to test the comprehensiveness of the research problem and the clarity of the questions. A general rule is that all questionnaires have to be pre-tested before engaging in the field surveys (Malhotra, 2004). Pre-testing also provides a means for testing the interviewers to judge whether their presentations are adequate and the sampling procedures are efficient (Zikmund et al., 2010).

Five representatives of each whitewood stakeholder type (farmers, processors and consumers) were sampled to pre-test the questionnaires. This was to make sure the interview was conducted in a situation as close to real interviews as possible to allow the researcher to rethink and rephrase questions that seemed unclear or ambiguous, to reflect on the manner of asking questions, personal presentation, and how to improve on the interview design. The researcher was able to discover certain weaknesses in the interview process from the respondents’ replies during the pilot testing, especially, not understanding the questions, and the respondents temperaments and how to address such situations through rephrasing the questions. Additionally, pilot test sessions assisted the researcher to
assess the resources required to budget for the interview process.

3.4.4 Gaining access

The whitewood primary and secondary processors and consumers were informed about the research by phone or office appointments and interviews were scheduled according to their time. Getting access to farmers was difficult because of limited communications in the rural areas and poor road infrastructures. However, the local knowledge of the Forestry Extension Officers facilitated access to farmers so that interviewers were able to visit farmers at their house or in their woodlots. Early morning and late in the afternoon are the best times to get access to the farmers. Those farmers who live on the small offshore islands and do gardening on the mainland were contacted at the boat landing sites.

3.4.5 The interview

Interviewing is a collaborative conversation between interviewers and respondents. Normally respondents are strangers and interviewers control the deliberations. The interviewer requests information from the respondents and successful interviews can offer excellent results although the benefits may appear to be minimal for the respondents (Emory & Cooper, 1991). The fundamental value of interviewing is the depth and detail of information that can be obtained from the respondents. In-depth interviews carried out on a one-on-one basis are also known as individual in-depth interviews (IDIs) (Malhotra, 2004). The advantages of IDIs are: (1) interviewers have more control enabling them to make sure respondents are responding appropriately, (2) interviewers are able to obtain additional information from extra questions, and (3) interviewers are able to adjust their style of presentation if they see that the respondents are uncomfortable. The disadvantages of in-depth interviews are: (1) the expense, (2) respondents may be unwilling to participate, especially with strangers, (3) interviewers may be unwilling to meet strangers alone, especially in evening interviews, and (4) altering the questions by the interviewers can affect the interview results (Emory & Cooper, 1991). The three in-depth-interviewing techniques that are widely used in marketing research are laddering\textsuperscript{18}, hidden issue questioning\textsuperscript{19} and symbolic analysis\textsuperscript{20} (Malhotra, 2004). The in-depth-interview is the

\textsuperscript{18} Question is pushed by the interviewer, the first question is simple and the following question is asked about the response

\textsuperscript{19} Interviewers concentrate on deeply felt concern and complaints

\textsuperscript{20} Interviewers use symbolic meanings when asking the questions
only method that was used in this study thus the three in depth-interviewing techniques were adopted to ensure the respondents adequately responded to the questions. The interview lasted between 60 to 90 minutes and at the close of the interview, the researcher thanked the respondent for participating.

After the interview, the researcher requested from the respondents a quick observation of their operations. This enabled the researcher to confirm and understand the weaknesses and strengths of the respondents’ operations, in particular the primary and secondary processors. The researcher managed to visit most of the woodlots and conducted some of the interviews at woodlots, despite limitation of study time, scattered locations of woodlots and poor road conditions in the rural areas. The observations of the respondents’ operations increased the reliability and validity of the results.

3.5 Data processing procedures
The raw data collected from the study areas was heterogeneous and had to be categorised into useful formats for analysis. The process of preliminary analysis of the raw data is to ensure the data is accurate and simple for the next stage of analysis (Emory & Cooper, 1991).

3.5.1 Editing
The field data were edited by the researcher in the field and in the office while the information was still fresh in his memory. However, further scrutiny for abnormality in the data was done in the office. Zikmund (2000) refers to data editing as a process of checking data collection sheets for omissions, legibility or consistency.

3.5.2 Coding
Two coding systems were used in this study; pre-coding, which involved prior assignment of categories with numbers before the field work, and post co-coding, which involved coding or recording after data was collected. The later was necessary especially for open-ended questions, while the former was used for the close-ended questions. Many replies could be reduced to a few categories containing vital information by assigning categorical responses with numerical codes or scores to make analysis easier.

3.5.3 Analytic techniques
Various statistical techniques were used to analyse the data collected from the interview and the sawmill study. As described by Zikmund, (2000), raw data collected from the field
can only be transformed into useful information for decision making through data analysis. The raw data was analysed using the Statistical Package for Social Scientists (SPSS) Version 11 (Pallant, 2001) and Microsoft Excel. This level of analysis provides better interpretation and understanding of data and helps to determine the pattern and key details of the research study.

Inferential statistics were computed using an independent sample t-test to explore the differences between the whitewood stakeholders on the island of Efate and Santo in regards to their operations. Descriptive and inferential statistics were also used to answer the research objectives.

3.5.4 Descriptive statistics

The interviewer collected descriptive data on each of the respondents’ land tenure, planting area, planting space, methods of site preparation and weed control. Data on the cost of production and value-adding processing, market price for whitewood products, gender employment, wages and salaries and alternative source of income other than forestry were also collected. The descriptive demographic data were transformed to nominal and ordinal data for analysis and interpretation. The treatment of the data included frequency distribution, means and range.

3.5.5 Cross tabulation

The importance of cross tabulation is to describe the relationships and differences between two populations (Zikmund, 2000). The interpretation of the cross tabulation was simplified by adopting a percentage calculation of relative variables and identifying the frequency of each dependant variable factor with each independent variable. Percentage was calculated to compare the variables between Santo and Efate.

3.5.6 Inferential Tests

An independent sample Students t-test was used to test for significant differences between the various activities of the main actors along the whitewood value chain on the islands of Santo and Efate. T-tests were computed for the size of the whitewood mean planted area in five years intervals, the number and average income of females and males engaged in farming, sawmilling, timber yard and value-adding on each island, methods of woodlot maintenance, and holding capacity of timber yards.
3.6  Sawmill study

This section presents the research methodology for the sawmill study conducted to examine the sawn timber recovery by grade class, to investigate mechanical properties of plantation materials, and to test the penetration of preservative into whitewood heartwood. The viability of the whitewood plantation industry depends in part on the ability of sawmillers to secure adequate recovery from smaller plantation materials.

3.6.1 Selection and harvesting of trees

Six whitewood trees were selected from a 16-year-old plantation established by Melcoffee Sawmill Company at Lorum on the east coast of Santo Island. The plantation was established at wider spacing (10m x 4 m) and pruned to 6 m. The trees were selected to represent the range in diameter at breast height of the stand. Melcoffee Sawmill Company logging crew felled and cross cut the trees in the plantation to maximize yield straight logs and transported them to Melcoffee Sawmill at Luganville. The average small end diameter of the logs was 29.0 cm (range 19.2 – 42.8 cm).

3.6.2 Processing of Logs

The logs were processed with a band primary saw and a circular secondary rib saw for docking between knots. The outer clear wood sections of the logs were sawn to produce 25mm boards. The centres of the logs were sawn into 50mm thick random width boards that included knotty and pith wood (Figure 3.2).

Figure 3.1: Typical saw pattern for recovering 25 mm thick boards free of defect in random widths and 50 mm thick boards where defect is likely.
3.6.3 Drying and grading of timber

The timber was strip stacked and air seasoned at the Melcoffee Sawmills timber yard. After air-drying, the timber was visually graded under supervision by a student of the Vanuatu Agriculture College at Luganville on Santo Island, Vanuatu. The timber was graded into one of four appearance grades; (1) clear wood, (2) clear on one face and edges, (3) knotty wood excluding pith and (4) pith included. The dimensions of each board were measured using a cloth tape (length) and ruler (thickness and width). Each board was then marked to define clear sections between any defects, simulating cross cutting. The length of clear sections was measured and collated to form a total clear wood volume.

3.6.4 Timber testing

A random sub sample of 30 boards, nominally 100mm X 50mm was selected from the sawn timber and tested for strength and stiffness in bending. Sample selection and tests were conducted according to specifications in Australian and New Zealand standard AS/NZS 4063:1992 Timber - Stress-graded - In-grade strength and stiffness evaluation. The data derived from these tests was used to calculate basic working stress \( (R_{\text{basic}}) \) and characteristic stiffness \( (E_k) \) in bending, and compared to current structural grade specifications used in Australia. In addition to these tests, each board was visually sorted into four structural grades. These grades were defined as (1) clear wood, (2) boards with only small diameter (<50mm) knots, (3) boards with some larger diameter (>50mm) knots and (4) pith included boards.

3.6.5 Pressure vacuum treatment of timber

A sample of sawn (four pieces 100mm X 100mm) and round (two pieces 100mm diameter) whitewood were selected and transported to Australia where it was pressure vacuum treated with Koppers Tanalith E in the research facility at Southern Cross University (Lloyd et al., 2011). Each sample was end coated with a sealant prior to treatment. Penetration of preservative was qualitatively assessed on cross cut sections after treatment.
4. RESULTS AND DISCUSSION

4.1 Whitewood value chain entry point

The first necessary step in value chain analysis is to identify the entry point along the value chain to ensure adequate investigation of all relevant linkages in the chain. Value chain analysis is reasonably flexible and the value chain can be analysed from the perspective of any of the dominant actors in order to achieve desired development outcomes.

In this study, the whitewood farmers/producers were identified as the entry point of the whitewood value chain as they are the main producers supplying the processors with raw materials in the form of logs and boards. However, the study involved the entire process from collecting whitewood seed, growing seedlings and managing trees in plantations, to processing, marketing various products to consumers by individuals and companies (Figure 4.1). The farming practices involve various agro-forestry systems, determined by the ecological, social and economic factors of specific sites. One of the major outcomes of this research was to reveal how farmers are functioning in the current value chain, and how their roles can be improved to increase benefits in relation to other actors along the value chain.

4.2 Mapping the core actors of whitewood value chain

A map of the core actors in the whitewood value chain is shown in Figure 4.1 while the numbers in each category of actor who were sampled and interviewed is indicated in Table 3.1. The first actor group in the whitewood value chain is the forest owner, whether they manage planted trees or natural forest. The Vanuatu forest owner group consists of traditional landowners and land leaseholders who own both individual and private companies.

Downstream, the second group is the saw milling industry, which is made up of stationary sawmills, semi-stationary sawmills and portable sawmills. These sawmills are owned by companies, private and forest owners, trustees or associations. The third group is the timber yard managers that further process and refine the sawn timber to customer needs, and wholesalers stocking and distributing saw timber products for further use. Pressure treatment, kiln drying, air seasoning, docking to and dressing of timber are the main activities taking place in timber yards.
The fourth group consists of all companies using sawn timber to manufacture a finished wood base product e.g. mouldings and furniture manufacturers. They produce semi-finished products like glulam beams, building components and construction joinery as well as finished products (Vinnova, 2001).

The fifth group, called distributors, is made up of retailers and hardware stores (not included in the study due to little involvement in the whitewood industry) selling to private consumers, especially mouldings and furniture. Hardware stores are one-stop-shop for
professional consumers as they offer large number and variety of products.

The sixth actor group are the end-users, which includes private and professional consumers. Professional consumers are very important because they are the ones who can drive the fashion changes of the entire whitewood production and processing industry with their purchasing.

A final actor group are the import agents (briefly involved in the research due to minor export of whitewood products). This group plays the facilitating role between the local supplier and foreign private and professional consumers.

4.3 Mapping the activities of whitewood farmers

4.3.1 Mapping the specific activities of whitewood farmers in plantation establishment and management

![Figure 4-2: Specific activities and main actors in whitewood establishment and management](image)
Table 4.1: Specific activities undertaken by the farmers in whitewood plantation establishment and management

<table>
<thead>
<tr>
<th>Actors</th>
<th>Department of Forests &amp; private nursery owners</th>
<th>Whitewood farmers</th>
<th>Whitewood Farmers/Saw Millers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities</td>
<td>- Whitewood seed collection,</td>
<td>- Site preparation,</td>
<td>- Harvesting of whitewood</td>
</tr>
<tr>
<td></td>
<td>- Raising of whitewood seedlings in nurseries,</td>
<td>- Planting of</td>
<td>(thinning/final harvesting)</td>
</tr>
<tr>
<td></td>
<td>- Supplying of seedlings to farmers,</td>
<td>- Management and</td>
<td>- Trees harvested and</td>
</tr>
<tr>
<td></td>
<td>- Department of Forest advise</td>
<td>- maintenance of</td>
<td>processed by the farmers,</td>
</tr>
<tr>
<td></td>
<td>farmers on whitewood establishment and</td>
<td>trees,</td>
<td>- Farmers hire saw millers to</td>
</tr>
<tr>
<td></td>
<td>management,</td>
<td>- Applications of</td>
<td>harvest and process the trees,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>silvicultural</td>
<td>- Farmers sell standing trees</td>
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<td></td>
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<td>prescriptions</td>
<td>to saw millers,</td>
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4.3.2 Whitewood seed collection and nursery production

Whitewood seed collection is not generally from seed orchards. The main seed sources on Efate are fast growing trees with good form and good branching characteristics selected from plantations. On Santo, selection is mostly from parent trees with well-performing offspring from the provenance/progeny trials at the Shark Bay Field Research Station, established in December 1998 to January 1999 (Vutilolo et al., 2005). However, proper methods to record seed collection and tracing the seedlings in the field to monitor and record performances are lacking. The Whitewood and Sandalwood Deployment Project is currently funded to establish whitewood seed orchards on various islands in the country. The project is funded by ACIAR FST/2008/010 and is implemented by the Vanuatu Department of Forests and James Cook University, Queensland, Australia.

Seedlings for woodlot establishment were sourced from both private and government nurseries (Figure 4.3). The Department of Forests was the main supplier of whitewood seedlings between 1993 and 2012 with 84% of the distribution on Santo and 95% on Efate.
Private nurseries supplied 16% of the seedlings on Santo and 5% on Efate. Of the 60 respondents, it is estimated that 40 farmers on Santo planted 27,074 seedlings and 20 farmers on Efate planted 17,842 seedlings. Melcoffee Sawmills Nursery was the main private supplier of seedlings from the mid-1990s to the mid-2000s on Santo. The nursery also produced the highest number of whitewood seedlings in the same period compared to the government nurseries on Santo, not only to supply the woodlot farmers but also to establish its own 270 ha whitewood plantation at Lorum. This plantation was established between 1994 and 1998.

Government nurseries such as Tagabe Nursery on Efate, Sapui Nursery and Shark Bay Field Research Station nursery on Santo provided most of the seedlings to the farmers. The Shark Bay Field Research Station nursery ceased operation in 2003 when the government subleased the research station to a private company. The loss of the Shark Bay nursery likely contributed to the reduction of whitewood planting on East Santo.

4.3.3 Whitewood Plantation Establishment and Management

The most common forms of land ownership in Vanuatu are customary and leasehold land. Of the 60 farmers interviewed, 97% of the whitewood plantings are on land managed under customary land and 3% on leasehold land. Table 4.2 shows the estimated total land area planted with whitewood from 1993 until 2012 on the two studied islands.
Table 4.2: The estimated total area (ha) of whitewood planting by 40 farmers on Santo and 20 farmers on Efate by five year planting period

<table>
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<tbody>
<tr>
<td>Santo</td>
<td>17.7 ha</td>
<td>30.4 ha</td>
<td>11.9 ha</td>
<td>0 ha</td>
<td>59.8 ha</td>
</tr>
<tr>
<td>Efate</td>
<td>8.7 ha</td>
<td>6.0 ha</td>
<td>5.2 ha</td>
<td>5.2 ha</td>
<td>30.9 ha</td>
</tr>
</tbody>
</table>

The mean size of woodlots was calculated for the sixty farmers interviewed. Woodlot mean size varied between islands and five yearly periods between 1993 and 2012 (Figure 4.4).

![Figure 4-4: Mean size (ha) of whitewood woodlots established by 40 farmers on Santo and 20 farmers on Efate between 1993 and 2012 (error bars show standard error). None of the 40 farmers on Santo established plantings in the period 2008-2012.](image)

On the island of Santo, the greatest number of woodlots were established in 1998-2002 (n=24, SE=0.16, average area 1.3 ha), with 1993-1997 having the next highest number of woodlots planted (n=14, SE=0.26, average area 1.3 ha) followed by 2003-2007 (n=11, SE=0.14, average area 1.1 ha). None of the 60 farmers interviewed had plantings during the period 2008-2012.

Woodlots on Efate which were planted in 1998-2002 (n=5, SE=0.66), and 2008-2012 (n=3, SE=0.29) were the largest of study with a mean area of 1.7 ha. During the 2003-2007 period they averaged 1.1 ha (n=10, SE=0.23) and the smallest woodlots were established between 1998-2002 with an average area of 0.6 ha (n=10, SE=0.09). These results do not
include the Melcoffee Sawmills Ltd 270 ha whitewood plantation on Santo or the Jean Pie Tranut 25 ha whitewood plantation on Efate. These plantations were excluded from the analysis to avoid misrepresentations of the measure of dispersions from the mean at the 95% confidence interval for the woodlots. If the Melcoffee Sawmills Ltd and Jean Pie Tranut plantations were to be included in the results; the 1993-1997 period would have highest whitewood plantings on Santo and 1998-2002 for Efate.

There was no significant difference between the mean size of woodlots on Santo and Efate, or between the mean size at 5 year intervals on Santo alone (p>0.05). However when comparing the total area planted at the 5 year intervals between the two islands, there was a significant difference between Santo and Efate during the years 1998-2000 (n=30, t=2.48, p=0.0096).

Comparing the mean areas of woodlots in 5 year intervals on Efate alone with a paired-sample t test, there was a fairly significant difference between sizes of woodlots established during 1993-1997 and 1998-2002 (t = 2.15, p = 0.05). There was also a significant difference in mean woodlot size between 2008-2012 and 1998-2002 (t =5.54, p=0.0004). The overall mean size of whitewood woodlot for both Efate and Santo was 1.25 ha.

The relatively high mean area of planting in 1993-1997 on both islands, and in 1998-2002 on Santo are possibly due to a number of factors. Whitewood was the only tree species promoted in the early years of planting and a free seedlings policy was adopted by the Department of Forests in the early 1990s. This aimed to promote whitewood planting in the rural communities and each year between 2000 and 2002 approximately 18,529 seedlings were distributed to farmers in Vanuatu. Ten-year green timber licenses\(^{21}\) were given to Melcoffee Sawmills and Santo Veneer in 1995 to promote the replanting program. Both companies were allocated with an annual allowable cut of 30,000 m\(^3\) each, and exempted from forest management charges by the Department of Forests to raise and supply free seedlings to interested farmers. The year 2001 was declared as a year of reforestation by the Vanuatu government, who supplied farmers with free seedlings and nursery materials; especially boxes of planter bags (total of 7000 bags).

The increase of mean planting areas in 2008-2012 was driven by the nursery and woodlot establishment and management projects of the Department of Forests development.

\(^{21}\) Green timber license is renewed every ten years instead of one year compared to normal timber license.
partners including Food and Agricultural Organisation (FAO), New Zealand Aid and the SPC-Venezuela Project. This increase in plantings is not restricted to whitewood but also includes other priority species. The Department of Forests continues to empower communities and individual farmers to establish nurseries on a number of other islands.

4.3.4 Whitewood plantation site preparation

Farmers used various methods and labour types to prepare sites for the establishment of whitewood lots (Figure 4.5).

The most common method of site preparation was slash and burn with 92% using this method, 3% used line cutting, none were documented using roll over and clear felling by bulldozer and 5% used other methods. The methods of site preparation included in ‘others’ were cattle clearing and integrated plantings in existing coconut plantations.

Among the sixty whitewood farmers interviewed, 65% responded that woodlot site preparation was completed by themselves (along with families and friends), 25% employed casual workers and 10% hired social groups such as women’s groups, youth groups, sport clubs and associations. The average income generated through casual labour
from site preparation in one hectare on both Santo and Efate was $126 (n=15, SE=11.3) for males, $110 (n=9, SE=3.11) for females and $117 (n=6, SE=8.8) for hired social group. The average income for the three workgroup types was $118/ha and there was no significant difference in income between groups.

Selection of an appropriate method of site preparation for forestry plantation establishment and spacing is considered one of the most important forest management decisions. Establishment is usually the most costly expenditure in a rotation and constraints on landowner capital investment must be considered. The anticipated products, crop uniformity, required number of thinnings, age of final crops and projected stumpage prices must all be considered in the establishment phase (Dickens et al., 2012). Lane et al. (2012) and Dickens et al. (2012) explained that forestry plantation site preparation normally involves mechanical and chemical methods or combinations of both; with herbaceous weed control (HWC) to control competitive vegetation and increase timber production (Lane et al., 2011).

Designing a forestry plantation to achieve projected growth rates and wood quality is a major silvicultural management challenge of the last 15 years. There has been increasing research on soil and plant morphology and related effects on tree growth, wood quality and non-wood values to address this (Gonçalves et al., 2004). Practices include weed control before and after planting, soil preparation and fertiliser application (Gladstone & Ledig, 1990). Soil preparation before planting reduces soil bulk density and breaking up impermeable barriers improves soil drainage and aeration, allowing the young roots to establish after transplanting to the field (Gonçalves et al., 2008).

Small scale forestry often adopted these practices from large commercial forestry plantations (Gladstone & Ledig 1990) assuming that these site preparation and management techniques will improve the survival of plantings (Closs & David 2003). Graham et al. (2009) reviewed plant survival against these site preparation practices from forty-four studies and concluded that the optimal plant survival may be obtained through applications of one or two of these practices. The greatest improvements in early plant survival and growth can be obtained by combining the use of soil preparation and controlling of weeds before planting.

---

22 Approximately 40 person hours of work
In contrast, the whitewood farmers on Santo and Efate adopted their methods of site preparation from shifting cultivation slash and burn technique; and not employing mechanical or chemical methods but controlling secondary growth by hand. The planting areas were slashed and burnt during the dry season between August and November and the plantings were done during the wet season from December to March.

All the whitewood plantings on Santo and Efate involved agro-forestry farming except for large scale plantations. The first step of site preparation is the trimming and weeding of the undergrowth with bush knives (machetes) and spades (yam spade). The plants and vines with tubers are dug from the soil and burnt with the rest of the debris to avoid sprouting after the crops are planted. Burning and removing of all debris from the planting sites prevents pest and disease colonisation and damage to the crops. Rodents and snails are a major problem for food crops such as *Archis hypogea* (peanuts), *Citrullus lanatus* (watermelon) and leafy vegetables such as *Abelmoschus manihot* (island cabbage). Once the undergrowth is cleared and burnt the large trees are felled, trimmed and used either for timber, poles, firewood or stakes for climbing crops such yam, cucumber, beans and others.

Decaying logs and branches from trees that have a lot of sap in their cambium layer and sapwood such as *Ficus spp*, *Artocarpus altillis*, *Delonix regia*, *Erythrina spp* and other rainforest species were observed around the plant sites to have created excellent growing environments for *Phellinus noxius* (Corner) G. Cunn. (brown root rot) and other types of fungi that destroy food crops. *Phellinus noxius* was reported throughout tropical countries in the Southeast Asia, Oceania, Central America and Africa (Wu *et al.*, 2011) causing decline in numbers and mortality in approximately 216 tree and plant species (Fu *et al.*, 2012). Even in areas with low soil moisture content *P. noxius* is able to survive at rates of 80% to 92% for more than 2 years and in woody debris in the soil, *P. noxius* is able to survive up to 10 years after the host plant was killed (Chang, 2012).

Whitewood is reported to be resistant to *P. noxius* (Ivory & Darubi 1993), an important characteristic for selection for planting in Vanuatu. Otherwise to date only insignificant events of defoliation of young trees by *Urapterioides astueniata* a skeletonising moth larvae, and minor attacks of *Phaeoseptoria spp*, a leaf fungus, have been recorded (Leslie, 1994), although larger stands of planted whitewood may lead to outbreaks of these or other pests.
The majority of whitewood plantings are carried out by family members as part of their normal shifting cultivation practices. Farmers who hired casual workers and social groups to carry out site preparation were regular income earners from urban centres and rural farmers who operate other businesses. The majority of the farmers only paid the hired workers to trim back the vegetation and leave it to dry while the final steps of site preparation and plantings were normally done by the farmers themselves. The average cost of $118/ha for site preparation for initial planting from this study is comparable to the cost of line cutting at $165/ha provided by Grant et al. (2012). The cost of site preparation is influenced by several factors such as the status of the existing vegetation, whether it is a secondary or primary forest, a logged area, old garden area or an integrated planting with existing crops. In addition, the rate of hiring casual workers or social groups is reduced in communities further away from urban centres.

Weed control in forestry plantations and woodlots is very important in the early plantings to avoid competition for water, nutrients and light that can lead to slow growth and mortality if not controlled on time. In woodlots where whitewood is inter-cropped with agricultural crops, weeds are effectively controlled by the farmers, as the agricultural crops require regular weeding. Furthermore, whitewood is a fast growing species, which together with the agricultural crops, are able to dominate sites and provide their own measure of weed control. Only in planting areas dominated by M. peltata, does it require continuous weed control along the woodlot boundary. Generally, farmers continue to farm around whitewood woodlots making sure M. peltata is not a threat to the trees.

In large forestry plantations, M. peltata can be controlled manually however it requires burning because roots and stem fragments readily re-sprout. Chemical control has been advocated using glyphosate or 2, 4-D. Mechanical control methods include using tractors to slash among the trees, and use of cattle as they will readily graze on M. peltata. The problem with cattle is they can chew on the bark of whitewood, therefore it is important that the correct number of cattle is introduced at any given time to make sure there is enough feed to stop them from chewing the bark. Cattle should only be introduced during the wet season when there is plenty of water and only older cattle should by introduced into young whitewood trees (5 years or more). Young cattle are observed to be more likely to chew the whitewood bark because they feed in a more aggressive manner and tend to graze on any plants, and any part of the plants.
The cheapest and most effective method of establishing a large whitewood plantation in areas covered with *M. peltata*, is to fence the area and introduce cattle before the area is manually or mechanically cleared for planting. This is because *M. peltata* does not have the chance to survive under cattle grazing. By completely eradicating the *M. peltata* during the site preparation stage the cost of weeding is reduced and seedlings have an opportunity to grow with minimal competition. Using bulldozers for site preparation alone will not solve the problem of *M. peltata* as was observed at the Kalsei whitewood silviculture trials at Sara, Santo (Smith *et al.* 2012). Apart from these issues, fencing also stops feral and domesticated animals such as cattle and pigs and goats from damaging the seedlings.

### 4.3.5 Whitewood planting spacings

![Diagram showing planting space distributions](image)

*Figure 4-6: Planting space distributions (% of total plots) for whitewood plantings between 1993 and 2012 on Santo and Efate.*

The most commonly used plant spacing was 5m x 5m, with 54% of the total woodlots on the two islands using this spacing. Most of these spaced woodlots were established during 1993 to 2007. Planting spaces of 6m x 6m (15%) and 8m x 6m (11%) started to increase from 2002 onwards. The implementation of the wide spacing of 10m x 5m (1%) only
occurred during 1998-2001, while 10m x10m (8%) distribution is fairly even throughout the period from 1993 to 2007. Woodlots of 8m x 6m were the only type established from 2008-2012.

A comparison of the distribution of spacing between Santo and Efate, regardless of the planting years, shows the spacing of 5m x 5m is still the most common on both islands followed by 6m x 6m and 8m x 6m particularly on Efate. The frequency of spacing of 5m x 5m (60%) found in this study is similar to Aru et al. (2012) who recorded 57% of the 139 farmers interviewed from 40 villages on Santo to have used 5m x 5m spacing for their whitewood woodlots. The spacing of 5m x 5m is the original spacing that was recommended to the whitewood farmers in early plantings by the Department of Forests following the agro-forestry trails at Shark Bay Field Research Station in Santo.

The agro-forestry trails were established by Harry Bule (Forestry Extension Officer) between 1995 and 1997 with a wide range of vegetables, root crops and *Fleugeea flexuosa* as the durable round wood for traditional house construction especially on the northern islands of Vanuatu. The production outcomes of all crops from the agro-forestry trails were outstanding but unfortunately, the results have never been formally analysed,
reported or published, although many are summarized in Leslie (1994). In the course of monitoring and observing the whitewood performance of Bule’s trials with the spacing of 5m x 5m and 6m x 5m, two initial planting spacing were recommended. These were 6m x 3m (556 stems/ha) and 8m x 2m (625 stems/ha) which were later thinned to a final spacing of 6m or 8m between rows to obtain crop stocking of 208-278 stems/ha (Thomson, 2006).

The technical and financial concept of uncommercial thinning was not familiar to the farmers and they generally would not allow uncommercial thinning but only commercial thinning, otherwise the trees remained. The farmers would not accept the advice that without thinning their trees are competing among themselves for space, light, water and nutrients and that consequently the mean annual increment (MAI) for their woodlots are low. There is also a lack of facilities to process the juvenile trees from thinnings. Consequently, trees with poor form have often been retained and little pruning has been done to procure clear wood in the lower part of trees.

To overcome this problem, two wider final spacings (6m x 6m & 8m x 6m) were adopted by the Department of Forests and recommended to farmers to avoid poor tree performance in un-thinned plantings and to provide wider spacing for agro-forestry and integrated plantings. The final spacing also accommodates portable sawmill operations and heavy harvesting machines especially in large plantations (Thomson, 2006). Farmers have observed and acknowledged the high yield production from agro-forestry crops and integrated plantings of other forestry species such as Fleuggea flexuosa and the rapid growth of whitewood trees in wider spacings. Therefore, from the 139 farmers interviewed by Aru et al. (2012) 59% preferred to adopt 8m x 6m in their future whitewood spacing.

Grant et al. (2012) advised the wider spacing has to be investigated as the trees only moderately exhibit ample growth and the ‘net mean annual increment’ is still reduced for the value produced. It may have been offset by the benefits from the agricultural short rotation crops, other forestry species and animals raised among the trees. Likewise, Glencross et al. (2012) also specified that wider spacing might offset maximum growth and low establishment and management costs. The trees grow large and possess long-lived branches lower on the stem compared to the restricted small branches on more densely established stands. Wider spaced trees have greater growth, and ultimately can produce more quality trees for pruning and thinning selections than in closer initial spacing.
Grant et al. (2012) modelled the existing woodlots on Santo and advised that possibly the best silviculture of whitewood is: (a) to have 635 stems/ha as the initial stocking level and for the stands to be thinned at age 20 and 26, clear felled at age 36 with 133 trees as final crops with mean DBHOB of 55 cm, and (b) to have 400 stems/ha, only one thinning at age 24, clear fell at age 34 with mean DBHOB of 54 cm. The last option is based on the scenario in which thinning is considered to be uneconomical. According to Viranamangga et al. (2012), knotty wood from thinned plantation trees has the potential to be processed into large sections and pressure treated for structural timber. Also knotty stems can be processed by docking between knots to produce clear short lengths of timber for general furniture manufacture.

The thinned logs used in the study for Viranamangga et al. (2012) were transported to the Melcoffee Sawmills in Luganville, hydraulically rotated and processed by the bandsaws and docked between knots with circular saw to maximise recovery of the logs. This does not provide a clear solution for remote farmers who will be processing their trees at stump sites with portable sawmills or chainsaw mini-mills. Further research is required to investigate the most suitable brand(s) of portable sawmill that will be able to process the juvenile and small size trees at stump sites with maximum recovery rates.

4.3.6 Whitewood management and maintenance

Maintenance of whitewood plantations requires labour for the management of weeds and silvicultural practices to maximise woodlot outputs. The knowledge and experience of farmers in whitewood silvicultural management can influence the outcomes. The methods used by the respondents and division of tasks for woodlot maintenance is outlined in Figure 4.8.
The most commonly used method of whitewood woodlot maintenance is use of cover crops with 92% of farmers employing this technique, 5% used ring weeding, 3% used strip line weeding while none of the surveyed farmers used herbicide or other methods of weed control. The other methods of site preparation recorded in the islands were using cattle for clearing and integrated plantings in existing coconut plantations.

According to the applications of silvicultural treatment, 78% of the farmers reported to have pruned their trees while only 3% thinned their woodlots, so the majority of the woodlots are not thinned. Most woodlot maintenance was done by the farmers themselves, and their families and friends, without any direct monetary cost involved (85%), while 10% was done by hired working groups and 5% by contracted casual labour. In contracted casual labour, 12% was male and 3% was female. There was no significant difference on the amount of income earned ($) by female (mean=$113, n=3, SE=7.08) and male (mean=$159, n=7, SE=14.46), (P>0.05). The woodlot maintenance activities are usually done in less than a month and among the 303 individuals involved in the maintenance activities; 64% were male and 36% were female. The average cost of maintenance was $215 per ha.
The level of knowledge and experience among the farmers was recorded as; excellent on site preparation at 87%, average on selection of healthy and fast growing seedlings (73%), average on appropriate planting stock per hectare as monocultural plantings or wider spacing to accommodate agro-forestry and integrated plantings (88%) and poor on fertiliser application to seedlings (97%) as expected. The level of knowledge and skills regarding weed control was distributed between good (47%) and average (43%). Similarly, knowledge and skills related to pruning were distributed between average (42%), and good (37%), and poor (43%), to very poor (42%) for thinning.

Overall, the knowledge and experience related to whitewood silvicultural management indicated by the respondents was average (34%), followed by good (27%), poor (21%) excellent (11%) and very poor (5%).

The first maintenance activity for a successful woodlot is protection of the planted areas from fire, domestic and feral animal damage and human trespass. This was not observed to be an issue as all woodlot establishment involved agro-forestry and these farmers are well aware of the level of planning, and management required avoiding damage to crops. In most circumstances, farmers select planting sites where there is less chance of plants being damaged by domestic and feral animals. Also village or community laws on compensating damage to crops by domestic animals are well established and enforced by
the village chiefs, thus domestic animals such as pigs, cattle and goats are kept fenced.

The second maintenance activity is weeding and the most common method of weed control used by the farmers was cover crops combined with regular hand weeding during pre- and post-planting. Food crops in the form of vines such as *Ipomoea batatas* (sweet potato), *Cucurbita spp* (pumpkin) and watermelon are very efficient cover crops as they capture planting sites before weed establishment and are less competitive to the trees for nutrients, space and sunlight. It was observed that in wider spacings such as 8m x 6m and 10m x 10m food crops such as island cabbage, *Musa spp* (banana), *Manihot esculenta* (cassava) and *Piper methysticum* (kava) are not only important for weed control, but also in creating competitive interactions amongst the whitewood trees to maximise their growth.

Hand weeding with bush knives is the most common method of removing weeds in agro-forestry to avoid regrowth from plants with lignotubers. *Merremia peltata* is one of the most challenging weeds for whitewood farmers on Santo and Efate. Hand-weeding control starting from site preparation to maintenance helps to overcome *M. peltata*. Control can be most effective if the lignotubers in the soil are removed to avoid sprouting.

Du Toit *et al.* (2012) specify that improved wood productivity can be gained by limiting the competition between weeds and trees for space, light and nutrients in the early stage of the forestry plantation establishment. Tropical weeds such as *M. peltata* can be catastrophic if not properly managed and controlled. Lowery *et al.* (1993) report that early effective management of weeds in tropical forestry plantations results in an increased survival rate of up to 90% and an increase in wood volume of up to 50% while reducing rotation age by 2 years. A review of 60 long-term studies in North America, South Africa, South America and New Zealand/Australia indicated an increase in wood volume of 500% at harvest age of 30 because of effective weed management (Wagner *et al.*, 2006). Furthermore, weed competition can also influence wood properties (Du Toit *et al.*, 2010).

The use of cover crops by the farmers in woodlots is the best management system for weed control as it not only optimises survival and whitewood growth but it is a cheap method of weed control and the agricultural food and cash crops provide food and subsistence level income for the farmers. The agricultural crops also provide understory microclimate conditions that are similar to those in the natural forests. Whitewood seedlings planted in areas with only bare soil and no crops between the seedlings were observed to be
struggling in the first few months after planting compared to seedlings being transplanted to a garden area where the understory microclimatic conditions for plant growth have been established by the agricultural crops.

The medium and large-scale whitewood plantations could adopt the same establishment and management system but it requires applied research to make sure the cost and methods of establishment and maintenance are properly researched. The agricultural crops can be lucrative in the local and export market but should be selected to match the site.

Viranamangga (2002) projected the average value of the following agricultural root crops when intercropped with whitewood: *Colocasia esculenta* (Fijian taro) $6986/ha @ $0.44/kg, *Colocasia antiquorum* (dryland taro) $6550/ha @ $0.33/kg and cassava $7860/ha @ $0.55/kg. The planting space for these agricultural crops is 1m by 1m and the value is estimated according to the Jubilee Farm purchasing prices. Kava is the crop that may be most suited within medium to large whitewood plantations. Kava is more lucrative in the local and export markets and it is not labour intensive compared to the root crops valued by Viranamangga, (2002). The estimated value of kava is $35038/ha @ $2.00/kg, if planted at 2m by 2m spacing with one kava plant weight of 4 kg. Additionally, if cattle are introduced after the first thinning the estimated value is $1533/ha at a cattle stocking of 2.5/ha, average weight of cattle 280kg/head and market price of $2.00/kg.

Such development in the rural areas will provide jobs for the rural people, control rural and urban drift and improve the living standards for the rural communities. The income earned could also be used by the farmers to increase and improve their level of whitewood woodlot farming. This level of knowledge spill-over and economic growth has been observed in the timber processing industry where workers gained knowledge and experience and established their own timber processing businesses. This has not been the case in forestry farming probably due to the small number of commercial forestry farms in the country.
4.4 Mapping the specific activities of agro-forestry under whitewood plantings

Figure 4-10: Mapping of the specific activities and main actors in agro-forestry under whitewood plantations

Table 4.3: Specific activities undertaken by the farmers in agro-forestry under whitewood plantations

<table>
<thead>
<tr>
<th>Actors</th>
<th>Whitewood farmers</th>
<th>Whitewood farmers</th>
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<tbody>
<tr>
<td><strong>Activities</strong></td>
<td>-Business such as retail shops, food stalls, land/sea transport, property rental,</td>
<td>-Farming and fishing - Harvesting products - Sorting products for market, - Processing products, - Storing of products, - Packing products, - Transporting products to consumers and retailers,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Selling products at the Luganville and Port Vila market, -Selling products to consumers, retailers, hardware and abattoir in Luganville and Port Vila - Lower grade products are sold at a local/village market or consumed by the farmers</td>
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</table>
Figure 4-11: Percentage of respondents participating in the production and marketing of food crops and agricultural cash crops under whitewood woodlots on Santo

Agro-forestry food crops produced under whitewood plantings is a more commonly used system on Santo Central with 100% of the farmers indicated having planted all the crops in the crop categories specified in Figure 4.11. Santo South was second with 90% for all crop categories, and followed by Santo Southwest with 60%. Santo East had 50% each for root crops and bananas and 40% for vegetables.

One hundred percent of the whitewood farmers on Santo South planted agricultural cash crops with the whitewood plantings, followed by Santo Central and Santo Southwest, both with 90% each and 20% on Santo East.
Figure 4-12: Percentages of respondents who marketed short rotation agricultural crops on Efate

Agro-forestry food crops under whitewood plantings are more common on Efate Northeast where 100% of the farmers have planted all food crop categories, followed by Efate Northwest with 80% and Efate Southeast with 60% for each food crops category. In Efate Southwest, 60% of whitewood farmers grew root crops and 20% grew bananas and vegetables. Establishment of agricultural cash crops under whitewood was only recorded on Efate Northeast with 60% of the farmers having planted agricultural cash crops within whitewood plantings.

The distribution of food crops and agricultural cash crops indicated by the respondents in each study site represents the usual farming systems, and the particular crops normally produced by the farmers. Over time, the level of agro-forestry farming systems and particular food crops and agricultural cash crops produced by the farmers are influenced by combinations of environmental, economic and socio-cultural factors. In recent years, income generation from agriculture has become the main socio-economic indicator, and the agriculture farming practices have moved from need-based to market-based. This enormously enhanced the socio-economic circumstances for the farmers and positively
contributed to the social structures of the societies at large (Dahal et al., 2009). Simple agriculture farming practices are now transformed into complex agro-forestry with agriculture crops, livestock, forest tree crops, fruit trees and vegetable crops as the five key components (Dhakal et al., 2012).

Patterns of agriculture on the islands are influenced by abiotic conditions such as climate and soil. The south-easterly prevailing wind, which brings significant rainfall on the eastern side of the islands compared to the west, is one of the main causes of the climatic patterns on the islands. The orographic lift of air masses by the mountains causes precipitation on the east and only dry air moving to the west. Additionally, soils are more fertile and deeper on the east compared to the west side of the islands, which generally has shallow and rocky soils commonly dominated by igneous and consolidated sedimentary rocks (CSIRO & QDPI, 1991).

Accessing rural areas on Santo by means of land transport is difficult and expensive due to the high cost of fuel and spare parts, poor road conditions and lack of infrastructure for watercourse crossings. The majority of the watercourses along the roads connecting Santo South and Santo Southwest to Luganville do not have proper water crossing infrastructure. During heavy rain, farmers are unable to get access to Luganville and other parts of Santo by land transport and the situation can last for a number of days or even weeks. Lacking proper infrastructure for watercourse crossing makes it difficult for farmers on Santo South and Southwest to effectively and economically produce and trade food crops for the Luganville markets.

The farmers within the vicinity of Fanafo and Butmas at Santo Central, Nabauk and Narango in the interior of Santo South are the main producers and suppliers of food crops and agricultural cash crops such as kava and vanilla for the Luganville and Port Vila markets. Transport costs are lower for the villages that are closer to Luganville and the climatic and soil conditions in the interior are more favourable to food production compared to the coastal areas. Farmers along the coastal areas on Santo East and South are the main producers of agricultural cash crops and livestock, especially copra and cattle. Food crops are by and large produced for household consumption.

On Efate the distribution of food crops and agricultural cash crops are significantly influenced by the annual rainfall of >2500mm on the east and southeast, and <2000mm on the west and northwest (CSIRO & QDPI, 1991). In addition the high rate of conversion of
traditional farm land to land leases (50 – 75 year) for real estate, commercial developments and farming was observed to not only have an influence on crop production distribution but also on the decline of the quantity and quality of the crops produced by the farmers. As more prime agricultural land is converted to other commercial development, the fallow period will continue to be reduced and farmers will move to marginalised areas where the environmental conditions are not as favourable to growing food crops. It was observed that prices of food crops at the Port Vila markets are increasing each year while the quantity and quality are reduced and high value crops such as yam and taro sold at the Port Vila Markets are produced on the other islands.

The highest proportion of leased land in the country is the rural land on Efate (43.6%) followed by Santo rural which is 9.7% (Scott et al., 2012). The majority of the Efate land leases are on the southern part of the island, extending from Mangaliliu village on the west coast and across the island to the east coast between Epau and Pangpang villages. There are patches of areas that are not under land lease within the land boundaries of Pangpan, Eton, Erantapao, Eratap and Mele village, however most of the areas are under land leases connected to the Port Vila urban land leases. Port Vila is located on prime agricultural land on Efate and already 8.2 km$^2$ of the agricultural land around the Port Vila CBD has been transformed into commercial and residential leases. This is combined with 418 km$^2$ of agricultural land in the Efate rural area that has been transformed into cattle grazing and commercial land leases.

Human activities have been recognised as a major force in reshaping the biosphere and land transformation is one of the activities that are recorded back to antiquity (Turner & Meyer, 1994). The universal demand for land-based natural resources will continue to grow while maintaining land capacity to sustain the demand will always be a challenge to natural resource managers (Fazal, 2000) as land transformation to a certain level always constitutes land degradation (Blaikie & Brookfield, 1987). Globally the loss of agricultural land to urban areas was estimated to be 16,000 km$^2$ per year (FAO, 2006). India alone is estimated to have lost 1.5 million ha of mostly agricultural land to urban settlements between 1955 and 1985 (Fazal, 2000), and Fuzhou City in South China has lost 232.6 km$^2$ of agricultural land to urban settlement between 1989 and 2009.
4.5 Mapping the specific activities of other income generation for the whitewood farmers

The activities performed by the different actors in the value chain are mapped in Figure 4.13 and specified in Table 4.4 while detailed operations by each actor are presented and discussed under respective sections.

![Figure 4-13: Map of the specific activities of other income generation for the whitewood farmers](image)

<table>
<thead>
<tr>
<th>Actors</th>
<th>Whitewood farmers</th>
<th>Whitewood farmers</th>
<th>Whitewood farmers</th>
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</thead>
<tbody>
<tr>
<td>Whitewood Farmers</td>
<td>-Business such as retail shops, food stalls, land/sea transport, property rental, etc</td>
<td>-Farming and fishing</td>
<td>-Selling of products at the Luganville and Port Vila market, -Selling of products to consumers, retailers, hardware and abattoir in Luganville and Port Vila -Lower grade products are sold at a local/village market or consumed by the farmers</td>
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<tr>
<td>Other businesses</td>
<td></td>
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<td></td>
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<tr>
<td>Other products</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Other products (Firewood, Carving etc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Cash Crops (Kava, Vanilla, Fruits, Nuts etc)</td>
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<td></td>
<td></td>
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<tr>
<td>Short Rotation Agricultural Crops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Livestock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fisheries and Aquaculture</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Laganville/Port Vila Consumers</td>
<td></td>
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<tr>
<td>Local/Village Consumers</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Household consumption</td>
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<td></td>
<td></td>
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<tr>
<td>Domestic hardware, abattoir &amp; retailers</td>
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</tbody>
</table>

Table 4.4: Specific activities undertaken by whitewood farmers for additional income generation
Figure 4-14: Means of income generation on Santo from natural resources and other businesses apart from forestry.

On Santo 100% of the respondents from all four study sites are producing agricultural cash crops and trading at the Luganville and Port Vila markets. Short rotation agricultural crops are mostly produced at Santo Central (100%), followed by Santo South at 90% and 60% of respondents at Santo East and South West respectively. Cattle production is most common on Santo East (90%), followed by Santo Southwest (60%), and 10% for both Santo South and Santo Central. There were no respondents involved in fisheries and other natural resources products on Santo except for other business on Santo East (40%).

4.6 Mapping the specific activities of the whitewood producers and value-adding processors

Mapping the specific activities of the whitewood producers and value-adding processors provides understanding on the activities and products produced by the actors in the value chain. Farmers source whitewood logs from natural or planted forests and sell to sawmill companies who process them and sell to timber yards, value-adding processors or directly to consumers. Timber yards and value-adding processors treat and value-add the timber to finished products and sell to the consumers (Figure 4.15).
Figure 4-15: Map of the specific activities of the whitewood producers and value-adding processors

Table 4.5: Specific activities undertaken by the whitewood producers and value-adding processors

<table>
<thead>
<tr>
<th>Actors</th>
<th>Landowners (Planted whitewood and whitewood from natural stand)</th>
<th>Saw millers and Department of Forests (DoF)</th>
<th>Timber yards and value-adding processors</th>
<th>Domestic consumers (Builders and individual consumers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities</td>
<td>Negotiating log price with saw millers and demarcating harvesting areas,</td>
<td>-Saw millers obtain permits from the DoF to harvest the trees,</td>
<td>-Timber grading</td>
<td>-Timber for construction,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Log scaling</td>
<td>-Timber treatments</td>
<td>-Household consumption of value-adding products</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Processing of timbers</td>
<td>-Dressing of timbers,</td>
<td>from whitewood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Timber grading</td>
<td>-Processing of timbers into value-added products,</td>
<td></td>
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<td></td>
<td></td>
<td>-Transporting of timbers to customers,</td>
<td>-Selling timbers (different customers)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>-Selling value-added products to customers</td>
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</table>
4.6.1 Sawmill Operations

Figure 4-16: Various activities undertaken by saw-millers on Santo and Efate

Ninety percent of Santo sawmills are located in the urban areas compared to 80% of sawmills located in the rural areas on Efate. The majority of these sawmills are portable and dominated by Lucas mills comprising 70% of the Santo sawmills and 100% of Efate sawmills. Stationary bandsaws and a semi-stationary Mahoe Sawmill only exist on Santo and process logs at sawmill sites and log landing sites.

Ninety percent of the saw-miller respondents on Santo harvest their whitewood trees from the natural forests and 10% from forest plantations. On Efate, 80% of the saw-millers harvest their whitewood logs from natural forests and 20% from forest plantations. Regarding log processing, 80% of the saw-millers on Santo processed the whitewood logs at stump sites, and while on Efate, all the saw-millers processed their whitewood logs at stump sites. The recovery rate of 40 to 49% of processing whitewood logs to timber by the saw-millers was most common on both islands.

Sawmill operators on both Santo and Efate have been assessed to have good and excellent
knowledge and skills in timber grading and most of the sawmill owners are also involved in farming and other businesses.

The majority of Santo sawmills located in Luganville are owned by Luganville residents unlike Efate where sawmills are owned by local villagers and located in the rural areas. In the 1990s there were five stationary sawmills for the entire nation and this total was reduced to one on Santo (Melcoffee Sawmills Company) due to the reduction of the merchantable volume of whitewood in the natural forests (Viranamangga et al., 2012). Currently most whitewood processing is done by portable sawmills (also known as Walkabout sawmills) that can be taken to the forest or to the stump to process the trees.

In early 1990s The Foundation of the People of the South Pacific (FSP) Vanuatu, an NGO, introduced portable sawmills with the aim of providing income opportunities to landowners through processing their own resources and avoiding environmental degradation at operation sites. Portable sawmill operations started throughout the country and gained popularity in only a few years among the landowners milling their own timber and entrepreneurs establishing portable sawmill businesses. There were approximately 100 portable sawmills with the capacity to harvest up 300 m$^3$ of timber annually.

In 1997 the Department of Forests regulated the portable sawmills due to environmental, social and economic issues from operations in rural communities. This included land disputes, unsettled royalty payments, harvesting of fruit trees around the villages, operations in riparian zones and cultural sites and many more destabilising issues. Under the Vanuatu Department of Forests Act, Cap 147 all sawmills operating as business must be licensed with the Department of Forests.

In the 1997 National Forests Policy one-third of the country’s sustainable yield was allocated to portable sawmills and controlled by the 1998 Small Sawmill Order. By allowing quotas, the Department of Forests hoped to control sawmills and monitor the quota that each sawmill harvests. Monitoring portable sawmills is always a challenge for the Department of Forests as sawmills moved to and from operation sites and between islands within the same province. In 2012 only 33 portable sawmills were registered and licensed with the Department of Forests. Many portable sawmills, including some that participated in this study, were not registered and operating without licenses.

However, the major challenges to portable sawmills operations are the lack of infrastructure in rural areas, such as access roads and watercourse crossings to operation
sites, and prolonged wet weather periods. These challenges are in addition to the usual waste in processing described by Duncan (1998) & ADITC (1997) such as over stocking, damage or unnecessary materials, imperfect timing, human error, delay in transportation, breakdown of machinery, and many more problems. The most common difficulties observed in portable sawmills processing involve negotiations to purchase trees from owners, land disputes, movement of portable sawmills between operation sites and breakdown of machinery.

Many portable sawmills in Vanuatu are unable to survive the challenges of lack of infrastructure, prolonged wet weather seasons and inefficiency in portable sawmill processing. However, successful ones provide significant economic benefit to many families and also offer higher stumpage price compared to stationary sawmills. Natural forests and planted forests are the main sources of raw materials for the portable sawmillers and they either purchased trees from other farmers or processed their own trees. The majority of Santo portable sawmills only purchased trees from farmers in the rural areas and their operations involved work crews camping in the villages or forests to process the trees, while on Efate portable saw-millers harvest both their own trees and purchase trees from other farmers. The Efate portable sawmill operators normally live in the villages and travel to operation sites daily to process the trees.

Transporting timber from operational sites to consumers depends on the arrangements between the portable sawmill owners and consumers. Normally timber is transported to consumers by portable sawmill owners but occasionally during shortage of timber supply or higher timber demand in the market, consumers, especially timber yards and value-adding processors, transported owned timbers from sawmill processing sites. River Side Timber Yard, Luganville, Santo is the only consumer that subsidised transport cost for all timbers purchased from portable saw-millers ($100 for a truckload of timber, approximately 2 m$^3$).

The low recovery rate of timber from logs (40-49%) indicated by the sawmillers is an ongoing inefficiency as only the clear, knot-free timber is sold and lower grade material is discarded. The lower grade timber is either left at the processing site or scavenged by local people for fuel wood and temporary structures. Traditional sawing practices are still used by portable sawmills therefore lower conversion efficiency makes it difficult to survive in the highly competitive marketplace compared to large sawmills which have adopted the latest sawing techniques and technologies to improve recovery rate and who
also supply imported radiata pine products from New Zealand (Lin et al., 2009).

The recovery rate of whitewood can be improved by using proper sawing techniques, machinery and optimum technologies. Viranamangga et al. (2012) have demonstrated that recovery of 83% of timber from 16-year old thinned whitewood trees is possible using a primary break-down bandsaw and a secondary circular ripsaw.

Portable sawmill operators normally grade timber before delivery to consumers but then consumers such as timber yards and value-adding processors re-graded the timber before buying. First grade timber with blue-stain fungi and pinhole borers is downgraded to second or third grade and lower grades are rejected. Therefore, it is important that whitewood is processed during the dry weather season or on sunny days and delivered to consumers within two days to avoid infestation of blue-stain fungi, pinhole borers, marine borers and termites (Viranamangga et al., 2012). The portable sawmill operators on both Santo and Efate obtained knowledge and skills on timber grading mostly from work experience and from the few timber grading training sessions offered by the Department of Forests.

Large sawmill companies on Santo such as Melcoffee Sawmills Company and Santo Veneer also operate timber yards and value-adding processing to maximise the return from their products. For portable sawmills, the majority of the owners are farmers who, apart from their portable sawmills operations, grow food crops for family consumption and agricultural cash crops to earn money. However, in recent years five portable sawmill owners on Santo and three on Efate have extended their operations to timber yards and value-adding processing to maximise returns from their products.

The impact of poor road infrastructure will continue to be the main obstacle to the portable saw-millers to transport their mills to the processing sites and transport timber to the markets on time. Additionally, processing and handling for the portable saw-millers is difficult with whitewood being prone to biodegradation.

The only option for the portable saw-millers to avoid these situations is to camp out in the village and forest and manually move sawmills to the processing sites, and only work with whitewood logs on dry and sunny days to limit biodegradation. However, the unavoidable disadvantage to these options is the high transaction costs in getting the timber processed and transported to the market. Transport costs for timber in the rural areas are extremely high ($50-70/m³) due to the poor local-level transport systems and poor roads where
driving is difficult during dry seasons and they become inaccessible during rainy seasons. Portable saw-millers are able to overcome these high costs of operation by processing hardwood species, which can be processed during wet seasons, timber species which are not prone to biodegradation and which have high market prices compared to whitewood. Harvesting of woodlots will be more economical to portable saw-millers when trees are closer together to enable fast and easy movement of the portable mill between standing trees. Logs can also be moved to sawmill processing sites by being manually rolled, winched with a hydraulic winch and pulled by vehicles or four-wheel motorbike. Nonetheless, handling of whitewood timber to limit biodegradation will be a continuing challenge to the portable saw-millers and the idea of establishing a central timber treatment for timber to be air seasoned or kiln seasoned before wood is transported to the market will be an option for the farmers to consider.

Another option will be for the farmers to market their woodlots as logs to stationary sawmills to limit the problem of biodegradation, which is contradictory to the views of the whitewood farmers. A majority of the whitewood farmers preferred to process their own woodlot-grown trees, either by purchasing their own portable sawmill or by hiring portable saw-millers to process their trees. Furthermore, woodlot sizes are small and scattered throughout the rural areas making it difficult for saw-millers to assemble the logs and transported to the milling sites. This level of operation can only be done in medium to large whitewood plantations where resource stock is big enough to transport logs to the sawmilling sites.
4.6.2 Timber Yards Operations

Figure 4-17: Various activities undertaken by timber yards on Santo and Efate

The majority of the timber yards on Santo and Efate are located in urban centres and all the timber yard owners operate other businesses apart from a timber yard. The owners of all timber yards on Efate purchased timber from portable saw-millers operating on Efate and on other islands in Vanuatu, and imported timber from other countries. On Santo the majority of owners also owned sawmills where they processed their own timber and purchased timber from portable saw-millers, though unlike Efate, they did not import timber from other countries. The mean holding capacity of the timber yards for Santo was 75 m$^3$ ($n=3$, SE 15), and 85 m$^3$ ($n=4$, SE 19) for Efate and there was no significant difference between the mean holding capacity on Santo and Efate ($P>0.05$).

The three timber yards on Santo employed a total of eight females who earned an average monthly income of $432.38$ ($n=3$, SE 156.10) while in four timber yards on Efate there were a total of four female workers with a slightly higher monthly income of $446$ ($n=4$, SE 44.30). In the three timber yards on Santo the total number of males employed was twenty five with an average monthly income of $478.90$ ($n=3$ SE 1.30) while in the four timber yards on Efate there were a total of twenty six males with an average monthly income of $454.90$ ($n=4$, SE 32.30). There was no significant difference between Santo and Efate ($P>0.05$) in the number of females and the number of males working in timber.
yards. However, there was a significant difference between the total number of females and total number of males working in timber yards from a paired-samples t test with the number of female (n=2, SD=1.17) and male (n=9, SD=3.58) conditions; t(11)=4.76, p = 0.001, although this is a very small sample size. There was no significant difference between the mean monthly income for both female and male on and between islands (P>0.05). The knowledge and skills of timber grading was recorded as excellent on Santo compared to Efate where only 50% were assessed to have this level of skill and knowledge with the reminder equally distributed between good and average. In family owned timber yards, wives and daughters are usually employed as secretaries and cashiers for timber sales, while other female staff were employed to sort and stack timbers to sell to consumers.

Timber yards purchase green, rough-sawn timber from portable sawmills. These boards are then air seasoned, kiln seasoned, vacuum/pressure treated and dressed before sale to consumers. Timber yards and timber suppliers may carry out different wood treatments, while hardware stores purchase either local or imported timbers and sell to consumers without further timber treatment. Three pressure treatment plants operate on Santo while the one plant on Efate operates sporadically, once or twice a month, due to limited supply of whitewood timber (Viranamangga, et al., 2012). One kiln dryer on Santo has not been operational since 2006 since Melcoffee sawmills company ceased whitewood exports to Japan.
4.6.3 Value-Adding Processing Operations

All the value-adding processors on Efate are located in urban areas compared to Santo where 57% are located in rural areas and 43% in urban areas. The high percentage of value-adding processors on Santo and located in rural areas on Efate reflects the increasing prices to lease or rent commercial properties in urban centres. Local investors have limited capital investment and often the best economical options are using their back yards, or leasing rural land purposely to operate businesses. Rural areas are generally adjacent to urban centres with access to power and water supplies to operate machines, and to operate other businesses.

All value-adding processors on Santo operate other businesses; while on Efate, 75% operate other businesses while value-adding processing is the only means of livelihood for the remaining 25%. Operating a value-adding processing operation alone appears to be uneconomical to local investors with no ability to compete with larger value-adding processors. There is less local demand for value-added whitewood products due to cheap imported value-added products. Thus, value-adding processors also venture into other
business such as timber yards, building construction and retail to be competitive.

Saw-millers are the main timber suppliers for the value-adding processors on both islands with 50% on Santo and 42% on Efate. The value-adding processors purchased green timbers direct from portable sawmills at reduced prices ranging from $244/m³ to $340/m³ compared to purchasing air seasoned timber from timber yards that ranged from $658/m³ to $822/m³ on both the island of Efate and Santo. The timber is air seasoned and either sold directly to consumers or used in value-adding processing and building construction. The most common value-adding products produced from whitewood are general furniture (67% of processors on Santo and 78% on Efate). Moulding is more commonly produced on Santo with 33% of processors making this product compared to 22% on Efate. Demand for these products is driven by building construction activities.

The employers are multi-skilled and able to perform all activities in timber yards, value-adding processing and building construction. Fifty percent of the value-adding processors on Santo and Efate were assessed to have excellent knowledge and skills on timber grading, while the knowledge and skills on pressured timber treatments was almost evenly distributed from poor to excellent on Santo and poor to good on Efate. Most owners of value-adding processing on Santo and Efate were former employers of larger sawmills with experience in sawmilling, timber yard management and value-adding processing. This knowledge and experience enabled them to set up companies and pass on knowledge, and experience to employees. Most of the value-adding processing operations are family businesses and wives and daughters are employed as secretaries and cashiers, in a similar situation to sawmills and timber yards.

The average number of females employed in value-adding processing on Santo was 2 \((n=7, \text{ SE } 0.5)\) with an average monthly income of $297 \((n=7, \text{ SE } 7.90)\), while on Efate the average number of females was 2 \((n=4, \text{ SE } 0.3)\) with an average monthly income of $311 \((n=4, \text{ SE } 10.70)\). The average number of males employed on Santo was 6 \((n=7, \text{ SE } 1.7)\) with a monthly income $386 \((n=7 \text{ SE } 31.10)\), and on Efate the average number of males was 7 \((n=4, \text{ SE } 1.8)\) with monthly income of $470 \((n=4, \text{ SE } 33.80)\).

There was no significant difference between the number of female and males working in the value-adding processing on Santo and Efate \((p>0.05)\). However, from a paired-samples t-test there was a significant difference \((t = 4.19, p = 0.002)\) between the total number of females \((n=2, \text{ SD}=1.5)\) and males \((n=6, \text{ SD}=4.0)\). Conversely there was no
significant difference between the mean monthly income for female and male on both islands (P>0.05).

Small value-adding processors in Vanuatu face many processing and market barriers. The high cost of production is the main obstacle but they also have little access to market information concerning demand and price of value-added products, little knowledge of market specifications; and weak linkages with market agents. As a result, they have little knowledge to assess the competitive advantages of their competitors, differentiate their products and become competitive in the market. In addition, modernisation of value-adding equipment and technologies is very important to create the ability to compete with imported products and small value-adding processors would benefit from technical and financial support from the government.

Forest growers and forest industries increasingly view manufactured products with greater value-added potential as strategic goals for forest product industries (Lantz, 2005; Sathre & Gustavsson, 2009). Value-adding requires various different physical inputs to manufacture products (Lantz, 2005) and adds exchange value to primary resources, creating products with higher exchange value than the total input that can be sold profitably in the market (Sathre & Gustavsson, 2009). Apart from adding value to products this process also contributes to job creation, government revenue and capitalist incentives.
4.6.4 Whitewood consumers

Most of the whitewood consumers interviewed on Santo and Efate were living in urban centres. The majority of the consumers (56%) on Santo were builders as well as joinery makers, compared to Efate where most (59%) were exclusively builders. Timber yards were the main timber suppliers for the consumers with 75% on Santo and 81% on Efate compared to saw-millers.

Whitewood pressure-treated structural timbers are the most consumed product compared to furniture and mouldings. The three timber yards on Santo with fully operational vacuum/pressured treatment plants are the main suppliers of these products. Santo timber yards offered half the market price ($531/m$^3$) for pressured treated structural timber compared to Efate ($930/m^3$) with a vacuum/treatment plant that operates only periodically due to the shortage of whitewood timber supply. Whitewood is preferred more than imported soft wood by building construction companies as it contains fewer knots and is easy to work with, even though the supply of whitewood from both natural and plantation forests is unable to meet the demand. Imported soft wood is readily available in hardware
stores and delivered to building sites by suppliers, and is supplied dry, dressed, in standard sizes and lengths pressure treated to required H3 and H4 standards (Viranamangga et al., 2012).

Moulding is another common value-added product from whitewood and is bought by more consumers on Santo (26%) compared to Efate (7%). Efate consumers preferred imported mouldings (41%) over Santo consumers (17%), while imported furniture from other countries is not commonly bought by consumers on either island (Santo 0% and Efate 0%). The majority of the whitewood consumers on Santo (40%) and Efate (42%), preferred general furniture manufactured from local hardwood species over whitewood furniture (Santo 17% and Efate 10%). Similarly, consumers purchased more furniture manufactured from local hardwood species, and imported mouldings than similar whitewood products due to the limited supply of whitewood raw material. Many average income earners from urban and rural areas are able to purchase furniture and mouldings at a price ranges from $50 to $100 manufactured from whitewood at affordable prices compared to the high prices normally offered for furniture manufactured from local hardwood species.

The knowledge and skills of whitewood consumers on timber grading rules was reasonably distributed from poor to excellent among the consumers on Santo (poor 22%, average 34%, good 22% & excellent 22%), and mostly poor and average among the consumers on Efate (poor 58%, average 33%, good 9% & excellent 8%). Again the knowledge and skills related to pressure treating of timber were reasonably evenly distributed from poor to excellent on Santo (poor 44%, average 11%, good 33% & excellent 11%) and mostly poor and average on Efate (poor 58%, average 33%, good 8% & excellent 0%). Most of the individual and building construction consumers lack sufficient knowledge of timber grading and durability. However, consumers who have excellent knowledge and skills of timber grading and durability, complained that whitewood timbers are not properly pressure treated and are less durable than imported softwood (Viranamangga et al. 2012). The timber yards with pressure treatment plants need to improve the standard of whitewood pressure treatment to be competitive with imported softwood.
Figure 4-20: Other means of income generations from natural resources and other businesses apart from forestry on Efate

Short rotation agricultural crops are most common in Efate Northeast and are grown by all the respondents, while agricultural cash crops are widespread and reported by all respondents on Efate Northwest and Northeast. Livestock production is well distributed within the areas with Efate Northeast having the highest at 80%. With regard to fisheries, 20% of respondents are recorded as being involved on Efate Northeast and none in all other areas. Finally, 60% of respondents were recorded as operating other businesses on Efate Northeast and Southwest, 20% at Efate Northwest and none at Efate Southeast.

It is usual for the economic activities adopted by rural households in Vanuatu to be complex and a systematic evaluation of the existing farming systems is important to have better understanding of the rural income-generating activities. As whitewood plantations are long-term investments, it is vital to investigate the levels and composition of income sources adopted by the farmers in order to understand their involvement in whitewood plantation investment. This will help to formulate clear policy instruments and extension materials to boost the whitewood planting programs in rural areas.
4.7 The level of training in forestry farming, processing and management among whitewood stakeholders

![Graph showing percentage of respondents who undertook formal or informal training in forestry farming, processing and management]

**Figure 4-21: The percentage of respondents who undertook formal or informal training in forestry farming, processing and management**

Farmers who obtained formal and informal training on nursery establishment, woodlot management and silviculture management were under 50% on both Santo and Efate with similar levels of training on sawmilling, value-adding processing and financial management on both islands.

Higher percentages of saw-millers on Santo indicated having received training in chainsaw and sawmilling (100%), value-adding processing (40%) and financial management (60%) compared to Efate where training on chainsaw and sawmilling was 50%, value-adding processing 0% and 20% in financial management. Santo saw-millers obtained more training on nursery establishment, woodlot management and silviculture management than farmers did.

Timber yards owners and value-adding processors on both Santo and Efate indicated a higher percentage of training in value-adding and financial management and on chainsaw...
and sawmilling. Santo timber yards and value-adding processors indicated higher percentage of training on nursery establishment, woodlot management and silviculture management compared to farmers on Santo and Efate.

Formal training on various aspects of farm forestry, sawmilling and chainsaw use are usually delivered by the Department of Forests through combinations of information sessions and field days. In recent years, training on nursery establishment, plantation/woodlot establishment and management, silviculture management, rehabilitation of degraded forests and land was delivered by the Department of Forests, with most funding coming from external projects. Capacity building for forest officers, farmers and processors are major components of the projects. Apart from the Department of Forests; sawmill and chainsaw trainings are also delivered by NGOs and portable sawmill agents, especially Lucas Mills.

Sawmilling and chainsaw training is normally combined with education in log scaling, timber grading and preparing forest harvesting plans as in the Forestry Act Cap 147. The Act requires all sawmill operators to have sawmill and chainsaw operator licenses to be able to process timber. Royalty payments to landowners and reforestation management charges (3% of royalty) paid to Vanuatu National Government depend on log volumes being measured and calculated correctly by the sawmill operators. Sawmill operations are continuously monitored by Forestry Field Officers who will randomly measure logs to cross-check with saw-millers and normally submit their registers to the Department of Forests on the 15th of each month. Training on value-adding processing are delivered by technical and vocational/rural vocational schools that offer carpentry and joinery courses. The majority of owners for value-adding processing companies are graduates from these technical and vocational schools. The owners of value-adding processing facilities normally obtained their experience and skills by working for large sawmill companies, or value adding processing companies and building construction companies, before setting up their own business. However, wood science and technology is not included in technical and vocational schools syllabuses therefore, the knowledge and skills on timber grading and treatments are normally obtained from work experience and short training delivered by the Department of Forests.

Training on business and financial management is normally delivered by training institutions, NGOs, government departments and government statuary bodies such as the Chamber of Commerce. Since the late 1990, Vanuatu has adopted a policy of fostering
private sector-led economic growth and development. Institutions such as Chamber of Commerce, Provincial Governments and Cooperative Department are the major institutions providing training on business and financial management to farmers and industry.

However, our results indicate that more forestry farmers required training on business and financial management to boost their woodlot management and utilisation. Most of the participants in the downstream of the value chain have a higher level of education than those in the upstream of the chain. This increases their ability in planning for successful business enterprises.

The level of education and understanding of the activities performed by each stakeholder along the whitewood value chain is very important. The forestry industry is not a stand-alone entity with a single value chain, but is complex and comprised of various linkages both horizontally and vertically, with main stakeholders performing specific tasks along the value chain. A finished product or an output for a stakeholder on the chain is a raw material or an input for another stakeholder further down the value chain. Modern markets are highly competitive and shift rapidly and each stakeholder on the value chain needs to take appropriate actions to meet market requirements and demand conditions of the consumers.

Developing competitive technologies and processes to create high-value products along the value chain always creates great challenges to the rural small forestry farmers in the developing countries (Herr & Muzira, 2009). They are attempting to secure niche markets for their forestry products that are described by Kaplinsky and Morris (2000) as entry barriers. However, Anyonge and Toshetko (2003) emphasis that the small-scale timber producers are able overcome the trade barriers by producing timber of the quality and quantity sought by markets and become competitive in contractual and open-market situations.

4.8 Mapping the flow of whitewood products in the value chain

Mapping of whitewood products in the value chain involved identifying the products at each stage of the process as they are transformed from inputs to raw materials, to intermediate materials and final products. It creates a clear picture of what forms of whitewood products are handled, transformed and transported in each process stage of the value chain as indicated in Figure 4.17. Value chain analysis is a systematic approach in
examining the development of competitive advantage as it identifies key generic activities that actors perform in order to generate value for the customers. Porter (1980) categorises the activities into primary and supportive, where primary activities are activities that are involved in the creation of the products, the sale of the products, the transport to the buyer and the service provided to the clients afterwards and supportive activities are firm infrastructures, human resources, technology development and others that support the primary activities.
Figure 4-22: The flow of whitewood products processed and marketed by the core actors in the value chain
4.8.1 Whitewood farmers processing timber and market chains

Vanuatu farmers depend on agricultural production for their livelihood, by producing agricultural raw materials, or intermediate products with limited value added. Forestry farming is an additional mean of generating income for the households with less socio-economic impacts on people’s lives compared to agricultural production. Therefore, of the sixty whitewood farmers interviewed on Santo and Efate in this study only three are currently harvesting from their whitewood plantations. The whitewood woodlots for the rest of the 53 farmers are still too young to harvest or have grown past thinning ages and farmers either would not allow uncommercial thinning or would not accept lower prices offered by saw-millers.

Three farmers are currently harvesting from their whitewood plantations; Neil Croucher (Melcoffee Sawmills Company) from Luganville on Santo, Jean Pie Tranut and Serge Taga, both from the Tauma area on Efate. Like most of the forestry farmers, the Tranut and Taga plantings include other native timber and nut species such as *Terminalia catapa* and *Canerium indicum*, while Neil Croucher planted whitewood only.

The three farmers’ harvesting, processing and marketing practices are dissimilar. Croucher is clear felling his 17-year old whitewood trees and selling logs to his son Steve Croucher at $78/m³. Neil Croucher and Steve Croucher operate under Melcoffee Sawmills Company and, being major investors in whitewood plantation, processing and marketing in both domestic and export, their operation covers most of the whitewood value chain.

![Figure 4-23: Dr Graeme Palmer (left) sitting on 17 year old whitewood logs talking to Neil Croucher (right) the owner of the whitewood plantation at the log landing, where logs are ready to be transported to Luganville, Santo to be processed by Steve Croucher, Melcoffee Sawmills.](image-url)
Tranut is commercially thinning his 10-year-old whitewood with his portable sawmill (Lucas mill). The selected trees are processed at stump sites with an estimated processing cost of $131/m$^3$. Only first-grade clear timber is sold to consumers at $305/m^3$ and second grade knotty timber is used on the farm. Tahos Timber Yard is the main consumer but occasionally supplies individual consumers especially from Port Vila. Taga harvesting is also thinning his 10-year-old whitewood trees but he uses the timber for his own household, farm and extended family consumptions. The trees are processed at his backyard with his own portable sawmill (Lucas mill). The first grade timber is air seasoned and used for furniture manufacturing and while the second grade is used for temporary sheds in the farm. Taga is an employee of the Vanuatu National Bank and planting trees and inter cropping with agricultural crops is a hobby and for his own consumption: he does not depend on whitewood for his primary income. Apart from whitewood he is also processing other planted native hardwood species to build his own rental houses.

![Figure 4-24: Taga processing thinning whitewood in the backyard with a Lucas mill and air seasoned before being manufactured into furniture, Port Vila](image)

### 4.8.2 Processing and market chain anticipated by whitewood farmers

Since the majority of the whitewood farmers have yet to harvest, process and market their trees the farmers were asked to provide their ideas on the level of processing and marketing strategies they are planning to embark on. It is very important for the farmers to understand how their products are marketed and consumed (Kotler et al., 2004) and the product should have both functional (what the product does) and non-functional features (size, colour, packaging, brand etc) (Dunn, 1999). The marketing strategy should have clear decisions on whether to address the total market for a product with a single marketing strategy, or whether to research and identify market segments, which are supplied with a
different product and marketing to match their separate needs (Haines, 2003). Product development is dynamic and so is demand for products as the offerings of competitors and marketing environment change over time.

The majority of the whitewood farmers anticipated to produce green timber from their whitewood woodlots rather than advancing their operation into further treatment and value-adding processing (Figure 4.25) to maximise benefits from their woodlots.

![Figure 4-25: The level of processing and market chain the whitewood farmers anticipated for their woodlots.](image)

In addition, the largest percentage of farmers did not have plans on the type of sawmill to be used to process their woodlots. The second largest percentage of the farmers anticipated to hire sawmills to process their woodlots and the rest planned to process their woodlots with their own chainsaw mini-mills or portable sawmills (Figure 4.26).
Husqvarna and Lucas mills were the most preferred chainsaw mini-mills and portable sawmills. However, a few farmers have indicated that Wood-Mizer would be the most appropriate sawmill to process small size logs due to the thin curve blade with high recovery rate. A thin curve blade not only allows a high recovery rate but also it is economic and environmentally friendly as it uses less horsepower compared to traditional bandsaw blades.

The range of prices anticipated by the farmers for green sawn timber were higher than the range of prices currently offered by the consumers on both Santo and Efate (Figure 4.17). The average prices offered for first grade timber was $433 (range $315 - $472), $243 ($157 – $369) for second grade and $69 ($52 - $157) for third grade. The majority of the farmers have indicated that they plan to sell timber only to consumers who offered the highest prices and under signed agreements.
Figure 4-27: The percentage of farmers indicating whether they agreed or disagreed with the current market prices.

Proportional percentages of farmers were neutral and disagreed with the current market prices offered by the consumers, while 12% agree and none of the farmer indicated that they strongly agreed or strongly disagreed.

The observed explanations to why the majority of the farmers do not have firm plans on how to process the trees but anticipated processing and marketing their woodlots as green sawn timber, include:

1. the small sizes of woodlots with low holding capacity are uncommercial for individual farmers to operate a portable mill purchased via personal loan,
2. low commercial volume of woodlots due to poor management of the trees,
3. farmers having limited knowledge and skills in processing and marketing of their woodlots,
4. timber prices offered at the current market are not attractive to farmers,
5. farmers do not have the capital to harvest their woodlots.

A high percentage of farmers chose the option of hiring portable mills to process their trees. Farmers with medium to large-size whitewood plantations preferred to purchase their own sawmill by a personal loan (either chainsaw mini-mill or portable mill). They were also involved in value-added processing to maximise the benefits accruing to them.
The question of how to improve the capacity of poor agro-forestry farmers in the developing countries to access dynamic markets and overcome market barriers has been a common theme in efforts to achieve the millennium development goals (Bartlett et al., 2001). However, Anyonge and Roshetko (2003) state that most efforts to boost small-scale timber production have focused on woodlot establishment and management and little attention has been given to the marketing of the farm-grown timber. Likewise, forestry farmers in Vanuatu often start planting trees without conducting a market analysis to identify the products and species for which market opportunities exist to ensure the trees grown will have a positive impact on farmers’ livelihoods. They lack knowledge, of not only market opportunities, but also lack understanding of the sequence of operations in the market chain from production to final point of sale and the governance, functions, participations and linkages of the actors in the value chain. Whitewood farmers need to maximise their production efficiency to have competitive advantage in the forest product industry.

4.8.3 Saw-miller Processing and Market Chains of Whitewood Products

The general sawmilling operation is described by Van Beukering et al. (2000) as an upstream activity in the value chain as it involves exploitation of natural resources and the output is primary commodity or virgin materials. This study models the internal process of the sawmill in terms of two transformation stages, sawing and marketing of timber as green or air seasoned.

The first stage begins with the purchasing of raw material, which are logs from the landowners. As indicated earlier in the discussion of sawmill operations, natural forest is the main supply of whitewood logs apart from the case of three farmers who harvest from their plantations. The productivity of the sawing process is measured in terms of the volume of logs. The log price ($/m³) is negotiated between the saw-miller and the landowners. Log scalers for the sawmilling companies measure and calculate the log volumes before timber is processed.

Proper scaling of logs is very important to both the landowner and the saw miller as it determines the value of the log to be paid to the landowners. It also provides an understanding on quantity (recovery rate) and quality of timber produced from the log. Either party can lose money if the log is over or under estimated. The log scalers are trained by the Department of Forests and issued with a certificate of registration that serves
as proof they have been tested and qualified to scale logs. Department of Forests also provide the log scalers with the log scaling manual and make sure the saw milling companies purchase the correct log scaling equipment. The log scalers are regularly monitored by the Department of Forests who check scalers’ assessments to make sure logs are properly scaled.

Figure 4-28: Rodney Aru (right) the Head of Forestry at the Vanuatu Agriculture College (VAC), Luganville, Santo conducts training on log scaling to VAC students on thinned whitewood logs from Melcoffee Sawmill plantation.

The log is processed according to market demand and sorted into three grades. The first grade is clear timber with no knots, second grade is timber with knots and third grade is timber with numerous knots, bark-on and various sizes and lengths. Third grade is usually rejected and left at processing sites or sold to local/village consumers at a very low price to be used for temporary construction.
Figure 4-29: The chain of processing by stationary mill at Melcoffee Sawmill sites, from left; whitewood logs are processed into slabs by a bandsaw, processed into timber with a circular saw and finally docked and sorted into different grades.

Figure 4-30: The chain of processing by portable sawmills which only involved sorting and processing of logs and because of the absence of a bench saw and circular saw to resize and dock between knots most of the second and third grades boards are normally left at the processing sites.

Figure 4-31: Sorted whitewood timber, from left; first, second and third grades. First grade normally has standard sizes and lengths required by the market while second grade may has standard sizes but not lengths and third grade has irregular sizes and lengths with many defects.
Table 4.6: Distributions of gross profit margins of green sawn whitewood timber produced by portable sawmills on Santo and Efate.

<table>
<thead>
<tr>
<th>Island</th>
<th>Timber grade</th>
<th>Anticipated end product</th>
<th>Average production cost</th>
<th>Selling price ($/m³)</th>
<th>Gross Profit ($/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santo</td>
<td>1st grade</td>
<td>Air seasoning and moulding</td>
<td>153</td>
<td>$425 - $493</td>
<td>$272-$340</td>
</tr>
<tr>
<td></td>
<td>Pressure treatment</td>
<td>153</td>
<td>$244 - $340</td>
<td>$91-$187</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressure treatment</td>
<td>77</td>
<td>$139 - $218</td>
<td>$63-$142</td>
<td></td>
</tr>
<tr>
<td>Efate</td>
<td>1st grade</td>
<td>Air seasoning and moulding</td>
<td>153</td>
<td>$380 - $490</td>
<td>$227 - $337</td>
</tr>
<tr>
<td></td>
<td>Pressure treatment</td>
<td>153</td>
<td>$305 - $340</td>
<td>$152 - $187</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressure treatment</td>
<td>77</td>
<td>$131 - $205</td>
<td>$54 - $128</td>
<td></td>
</tr>
</tbody>
</table>

The cost of processing one cubic metre of timber by portable sawmill was estimated as ranging from $131 to $175 per m³ (Figure 4.17), based on data provided to the interviewers. It was difficult for the sawmillers interviewed to provide a definitive figure as to the cost of milling timber due to variation in log quality, recovery rates, lack of detailed cost recording and the commercial sensitivity of the information. The processing costs were estimated from figures made available by the interviewers and it only included machining cost and wages while excluding depreciation cost of the machines, spare parts and utility costs. However, the estimated average processing cost are compatible with the estimated processing costs reported by Smorffit et al. (2003) on portable sawmills and stationary sawmills on high-value rainforest cabinet timber industry in northern Queensland.

The estimated processing cost for a stationary sawmill of $139 and $218 per m³ (Figure 4.17) was provided by Melcoffee Sawmills as it is the only stationary sawmill in the country and was not included in Table 4.5. Melcoffee Sawmills does not sell green sawn
timber; the timber it produces is sorted and prepared for pressure treatment and air seasoning and then either sold as air-seasoned timber or further processed into mouldings, furniture, joineries, and engineered timber products.

4.8.4 Timber Yard Processing and Market Chains of Whitewood Products.

The functions and definitions of timber yards are similar to timber traders, timber wholesalers, timber suppliers, and other names commonly used in the literature. However, the major reasons that timber yards are categorised in this study as one of the key actors in the whitewood value chain, is that they play an important role in timber treatment and dressing to a required standard before selling on to private and professional consumers. Additionally as most timber is processed by portable sawmills, timber yards create an important linkage between the sawmillers and the consumers. Portable sawmills are usually located in remote areas away from timber markets so that the majority of the portable sawmills do not have financial capacity to establish timber yards to be able to store, treat, and dress the timber before selling to consumers. Portable sawmillers depend on their working capital for operation and having the timber yards in the value chain provides a just-in-time and niche market for the portable sawmillers to financially be able to continue their sawmilling operations.

4.8.5 Air Drying

Air seasoning as the common timber treatment in timber yards is a lengthy process. Air seasoning is drying of timber to appropriate moisture content (MC) before use for its intended purpose. Air drying timber is done to evaporate as much of the water as possible and usually extends until wood moisture content is as low as 20% to 25% before the timber is transferred to a kiln dryer if dying to a lower MC is required (Simpson, 1999). Most timber yards on Santo and Efate do not have a kiln dryer and air drying is the only means of drying timber. The warm tropical weather year-round provides excellent air drying conditions with less cost compared to a drying kiln. Approximately half of the energy consumption in a typical high-production sawmill may be in running a kiln dryer (Haque, 2007). This is a lengthy process that involves many expenses including wages and salaries, utility charges and other expenses obligatory to timber yard owners to get the timber treated before selling to the consumers.

The timing and handling methods for whitewood timber before and during air drying is very crucial to avoid infestations of timber by fungus and insects. Timber is air seasoned
in timber sheds, above the floor (at least 450mm) on timber beds and stacked with spacing strips (25 or 50 mm thick) placed in the middle of each layer of timber (600 to 1200 mm apart) to allow fresh air to enter from the side. The spacing strips have to be set in a vertical row as shown in Figure 4.27. The time taken for the air drying depends upon several factors, such as type of timber, size of boards, time of the year, site on which the stack is built and the method of stacking.

*Figure 4-32: Air drying of whitewood timbers in timber sheds, stacked on timber beds with spacing stripers separating the timbers to allow air circulation.*

Following consistent standards of air-drying is vital to avoid or minimise drying defects, such as checks, bow, spring, cup, twists, end splits, and others. The drying defects are caused by drying stresses and can adversely affect the serviceability and economics of the product. The cause of drying stresses is the differential shrinkage between the shell (outer) and the core (interior) part of the timber. Early in drying, the fibres in the shell begin to shrink when the core has not yet begun to dry and shrink. As the core prevents the shell from shrinking the shell goes into tension and the core into compression (Simpson, 1999).

Whitewood timber is stable and it does not experience major drying defects compared to many other angiosperm trees. The most important problems are blue stain mould, fungal decay and termites; thus it is important that the timber is immediately stacked appropriately in timber sheds with adequate air circulation. It is a challenge for portable sawmillers operating in remote rural areas to avoid these drying defects. Thus, portable sawmillers normally process whitewood timbers during sunny days, use shed cloths to cover the timber while still in the forest, and attempt to sell the timber to timber yards or other consumers as quickly as possible.
The cost of air-drying is difficult to estimate by the timber yard owners and was not evaluated in this study. However, because whitewood timber is rarely sold in the local market it is not usually air seasoned to required MC before selling to the consumers. Value-adding processors as the main consumers of air-seasoned whitewood timber either purchased the timber from timber yards or directly from sawmillers and air seasoned the timber to the MC required for the products they are manufacturing at their processing sites.

Table 4.7: Distributions of gross profit margins of air seasoned whitewood timber produced by timber yards on Santo and Efate.

<table>
<thead>
<tr>
<th>Island</th>
<th>Timber grades</th>
<th>Purchasing price for green timber ($/m³)</th>
<th>Selling price for air seasoned timber ($/m³)</th>
<th>Gross Profit ($/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santo</td>
<td>1st grade</td>
<td>$425 - $493</td>
<td>$822</td>
<td>$329 - $397</td>
</tr>
<tr>
<td>Efate</td>
<td>1st grade</td>
<td>$380 - $490</td>
<td>$658 - $767</td>
<td>$168 - $278</td>
</tr>
<tr>
<td></td>
<td>2nd grade</td>
<td>$131 - $205</td>
<td>$531</td>
<td>$326 - $400</td>
</tr>
</tbody>
</table>

High value timber products such as furniture and mouldings are the end products normally manufactured from whitewood air-seasoned timber and therefore first grade timber (clear timber with no knots or air drying stresses) is more preferable. The high selling prices and gross profit margins are driven by the value of the products.

Nevertheless, even though the gross profit margins are high, the supply of air seasoned whitewood timber from timber yards is less compared to that of pressured-treated timber and other timber species. This is because most of the value-adding processors purchased green sawn timber directly from portable sawmills at lower prices and also timber yards with limited space in their timber sheds preferred not to take the risk of air drying whitewood timber due to its susceptibility to fungus and insect attack.

Air seasoned whitewood timber is common in timber yards where their operations also involve sawmilling and value-adding processing as it does not involve as much accrued expense. Their main consumers are: small furniture shops that do not have space in their shops for air drying, builders who include basic house or office furniture such as kitchen benches, cabinets, wardrobes, tables, chairs etc, individuals that manufacture their own furniture, and value-adding processors when their stock of air-seasoned timber is limited.
4.8.6 Pressure Treatment

Pressure treatment is a process of forcing chemical preservatives deep into the cellular structure of the whitewood timber. It is the major timber treatment carried out at the timber yards in Vanuatu. However, since it is expensive to purchase and operate a timber treatment plant there are only four timber treatment plants in the entire country, three on Santo and one on Efate, all owned by expatriates and corporations. Small timber yards, especially on Efate owned by Ni-Vanuatu, purchase treated whitewood timber from Santo timber yards and sell to consumers on Efate.

Whitewood has low durability to biological degradation (Viranamangga et al., 2012) but readily takes chemical preservative treatment (Groves & Wood, 1998). All the pressure treatment plants in Vanuatu use water-borne preservatives such as copper chromium arsenic (CCA), tanalith E and boron compounds. Copper chromium arsenic is most commonly used as copper will control fungi, arsenic will control termites and chromium will fix the copper and arsenic in the wood.

The processes of timber treatment are:

- timber is placed in the chamber and all the air is pumped out,
- chamber is flooded with preservative,
- pressure is applied to force the preservative into the timber,
- excess solution is pumped out and the chamber is kept in low pressure in a vacuum
- preservatives on the surface of the timber are forced in by atmospheric pressure when the chamber is opened (NTDP, 2004).

Figure 4-33: John Bong (right) the pressure treatment plant operator showing Doland Nichols (left) how the whitewood timbers were treated with tanalith E, and stacked outside the treatment plant for the atmospheric pressure to force the preservative into the timber.
and also dry the timber before purchased by customers or moved into the timber shed for storage.

Table 4.8: Distributions of gross profit margins of pressure treated whitewood timber produced by timber yards on Santo and Efate Island

<table>
<thead>
<tr>
<th>Island</th>
<th>Timber grades</th>
<th>Purchasing price for green timber ($/m³)</th>
<th>Cost of pressure treatment ($/m³)</th>
<th>Selling price for pressure treated timber ($/m³)</th>
<th>Gross Profit ($/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santo</td>
<td>1st grade</td>
<td>$244 - $340</td>
<td>$78</td>
<td>$531</td>
<td>$113 - $206</td>
</tr>
<tr>
<td></td>
<td>2nd grade</td>
<td>$138 - $218</td>
<td>$78</td>
<td>$314 - $366</td>
<td>$70 - $97</td>
</tr>
<tr>
<td>Efate</td>
<td>1st grade</td>
<td>$305 - $340</td>
<td>$78</td>
<td>$930</td>
<td>$512 - $547</td>
</tr>
</tbody>
</table>

The estimated cost of production provided in this study only involved the cost of purchasing green sawn timber from the portable sawmills and the cost of pressure treatment per cubic metre. The estimated cost of production does not include salary, wages and utility costs.

The higher gross profit margins were obtained from 1st grade timber while the gross profit margins for 2nd grade timber are significantly lower. However, all the timber yards with pressure treatment plants also operate sawmills and engage in value-adding processing that enable them to cover the cost for the timber treatment. The timber they produce from their own sawmills at a lower cost generally yields higher profit margins. Companies such as Melcoffee Sawmills, which harvest whitewood from both the natural forests and its own whitewood plantation and is involved in all level productions along the whitewood value chain, has the capacity and economy of scale to process and market lower grade timber competitively. Melanesian Commerce and Industry is in a similar situation, as it is the only company operating a pressure treatment plant on Efate, where treated whitewood is in high demand and low supply in Port Vila. This allows the company to trade the timber at a significantly higher market price compared to the timber yards on Santo.

The main timber supplied by Melanesian Commerce and Industry is imported *P. radiata* from New Zealand followed by the local premium hardwood species. However the
management of Melanesian Commerce and Industry perceived treated and air seasoned whitewood timber as a lucrative commodity compared to imported *P radiate*. The demand for treated whitewood in the local market is high as the timber has fewer knots compared to *P radiata*.

### 4.8.7 Value-adding Processing and Market Chains of Whitewood Products

Value-adding is normally referred to in the forestry industry as secondary wood processing, where primary wood products such as logs and timber are down processed into higher value products such as furniture, joinery and carpentry mouldings and engineered wood products (Sathre & Gustavsson, 2009). It is the difference between physical input in a form of raw materials, human resources, funds, utilities, and information and outputs, which are consumable products and services (Lantz, 2005, Sathre & Gustavsson, 2009). Value-adding not only adds value to the products but also creates jobs, government income and capitalist incentives and is normally driven by housing construction activities.

The most common value-adding products manufactured from whitewood timber are furniture and carpentry moulding. Most of furniture and moulding makers are still using basic tools to produce their products and some even modified their own machines and manufacturing tools to produce the products. Melanesian Furniture is the only furniture shop with proper and standard furniture making machines and tools apart from the vocational schools that were included in this study. The small furniture shops are operating on an ad hoc basis due to the irregularity of the furniture market. All small furniture shops included in this study also own construction companies and this is the market outlet for the furniture they produce. Normally they offer the house buyers a cheaper rate for the building construction, which includes the basic house furniture such as kitchen bench, built-in wardrobes, cabinets, doors, table, chairs, arm chairs and other pieces which would be expensive to get manufactured from another contractor, or buy from furniture shops and hardware stores. A similar situation exists for furniture shops that are producing mouldings. They produce furniture and own construction companies as it is the only way they could manage to operate their business and employ full time workers.
Figure 4.34: Whitewood timbers air seasoned and processed into corner, flat mouldings and skirtings with a Carba-Tec ¾ spindle moulder by Franklyn’s Joinery & Construction at Luganville, Santo

Table 4.9: Distributions of gross profit margins of moulding produced by value-adding processors on Santo and Efate

<table>
<thead>
<tr>
<th>Santo/Efate</th>
<th>Timber grades</th>
<th>Purchasing price for green timber ($/3.44m³)</th>
<th>Selling price for mouldings ($/m³)</th>
<th>Gross Profit ($/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moulding</td>
<td>1st grade</td>
<td>$1462 - $1696</td>
<td>$5,393</td>
<td>$1719 - $1953</td>
</tr>
<tr>
<td></td>
<td>2nd grade</td>
<td>$1462 - $1696</td>
<td>$3,852</td>
<td>$551 - $785</td>
</tr>
</tbody>
</table>

The estimated cost of moulding only includes the price ($/m³) of timber required to process one m³ of moulding, excluding processing costs, spare parts, depreciation cost of machines, wages, salaries and utility costs. The existing small moulding makers do not have automatic injection moulding machines to produce tongue & grooved, V-jointed and other panelling products, they only produce quarter round and round two edge moulding, rounded skirting and doorstopper.

The cost for the moulding production (Table 4.9) is estimated based on the quarter round and rounded two edge mouldings since they are the most common types of moulding produced by the processors in the country. The standard size of the moulding is 15mm x 15mm and 3m in length and it takes 3.44m³ of air seasoned rough sawn timber to produce 1m³ of mouldings. The total number of mouldings in one m³ is 1,481 and the selling price for 1st grade is $3.64/piece and $2.60/piece for 2nd grade.

Moulding is the most lucrative commodity for whitewood in the current market but because it is not treated with either CCA or light organic solvent preservatives (LOSPs), hardware stores are no longer buying from the moulding processors. Moulding processors
such as Franklyn’s Joinery & Construction in Luganville and Tahols Timber in Port Vila sell their moulding directly from their factories to professional consumers. All the hardware stores in Port Vila and Luganville sell only imported mouldings (mainly from *P. radiata*) at a price twice that of whitewood mouldings.

### 4.9 Export market

The Japanese market was the main export market for whitewood timber products until the mid-1990s when the resource stock from the natural forest was depleted and export ceased. Whitewood timber is desired by the Japanese market because it is easy to dry, stain and process, adaptable and suited to face and back veneer uses and has a high recovery rate compared to many of the tropical timber species (McGregor & McGregor, 2010).

The only export market now existing for whitewood timber is Noumea, New Caledonia and Melcoffee Sawmills is the sole supplier of that market. Les Bois du Pacifique is the timber company in Noumea that is importing from Melcoffee Sawmills, specifically for moulding manufacturing. The exported timber sizes are either 152.40mm x 25.40mm x 3m or 127.00mm x 25.40mm x 3m and treated with CCA to H3 standards. The export price for the timber is between $639/m$^3$ and $659/m^3$. Melcoffee Sawmills is supplying Les Bois du Pacifique with one container every six weeks.

Didier Vernay, the Managing Director for Les Bois du Pacifique is satisfied with the quality of timber produced by Melcoffee Sawmills and commented that whitewood is one of the best timber species for moulding manufacturing. Didier also mentioned that the quality of moulding depends on the log processing techniques. Most of the consumers of whitewood mouldings are professionals such as builders and joinery shops and consumers are not selective on price when buying mouldings. *Pinus radiata* moulding from New Zealand is the major competitor to whitewood moulding in the New Caledonia market however; Didier is prepared to increase the quantity of whitewood timber imported, provided the quality of the timber is maintained.

Nevertheless, Melcoffee Sawmills is negotiating with the Japanese whitewood importing company to reopen the export market of kiln seasoned S4S dressed timber, laminated board and finger jointed boards. The 2\textsuperscript{nd} grade and knotty timber from thinned whitewood trees and top section of the logs will be processed and docked in between knots for finger joint production. These market specifications must be met by farmers to manage their whitewood woodlots and efficiently supply the raw materials for those products.
4.10 Plantation-grown whitewood timber in Vanuatu: challenges and opportunities for export and domestic use


Please see the full article i.e. (Viranamangga et al., 2012) in Appendix 1

4.10.1 Declaration of Authorship

Components of this section relating to developing uses for wood from plantation-grown whitewood trees, for domestic uses and export: opportunities for value-adding were done by Rexon Viranamangga and Graeme Palmer in partial fulfilment of Rexon Viranamangga Masters. Rexon Viranamangga and Graeme Palmer led the writing of the paper and Kevin Glencross reviewed the manuscript prior to submission to the International Forestry Review Journal. The relative contributions of the three authors to the manuscript are indicated below.

Conception of the study: RV (50%), GP (40%), KG (10%)
Design of the study: RV (50%), GP (40%), KG (10%)
Collection of data: RV (50%), GP (40%), KG (10%)
Analysis of data: RV (50%), GP (40%), KG (10%)
Interpretation of data: RV (50%), GP (40%), KG (10%)
Conclusion: RV (70%), GP (20%), KG (10%)
Writing up Manuscript: RV (70%), GP (30%)

4.10.2 Abstract

Whitewood (*Endospermum medullosum*) has historically been used in Vanuatu for light construction, furniture, joinery and moulding. The large stem with umbrella-shaped crown is noted for its production of defect-free wood when sawn; knotty wood is generally discarded.

A timber industry based on whitewood processing and utilisation may be developed in Vanuatu based on plantation-grown resources. An assessment of sawn plantation-grown
whitewood has indicated that this resource produces larger proportions (~65%) of knotty wood compared to native forest resource (~50%). In order to optimise the returns to growers and processors, opportunities are sought to utilise knotty wood.

Two opportunities to add value to knotty wood are identified. These are the production of large section structural wood, and the recovery short lengths of wood between defects. Additionally, the capacity to penetrate the heartwood of whitewood with preservative chemicals offers opportunities to use structural wood in outdoor and in-ground locations.

4.10.3 Acknowledgements

I wish to thank all those who contributed to this study in all ways. I am greatly indebted to my supervisor Dr. Graeme Palmer for his guidance and supervision contributed immensely to the success of this study and the article. Highly appreciate the invaluable time of Dr Kevin Glencross, Associate Professor Doland Nichols and Professor Jerry Vanclay for editing the draft manuscript. The ACIAR project FST/2005/085 for funding the sawmill study, Neil and Steve Croucher of Melcoffee Sawmills for providing the logs, Rodney Aru, Head of Forestry, Vanuatu Agriculture College, Luganville (VAC), Santo and the VAC students for assisting in the visual grading of the timbers.

4.10.4 Introduction

Sustained production and marketing of wood products has the potential to assist rural poor people in overcoming poverty, and to provide cash to purchase goods and services not directly recoverable form the land (Scherr et al., 2003). Among the most important and desirable services in Vanuatu is education, which is available only to fee-paying students. Cash is also required for people, households and farming necessities to be able to exist as subsistence farmers in the rural areas. Additionally, the development of a wood production and processing industry in Vanuatu has the potential to bring foreign income into the national economy that is dependent on critical imports such as transport fuels.

Developing uses for wood requires a consideration of the properties of the wood that is available, resource supply, processing opportunities and markets. These elements form a supply chain that may include many businesses. The objective of product development is to add value, or profit, to a collection of inputs. Lantz (2005) explains that value-adding is a strategic goal for the contemporary forest products industries and is defined as the ‘economic value of products earned by the processing company’, and it is the difference between ‘physical inputs’ and ‘outputs’ required to manufacture the products.
A forest resource can be exploited to produce a variety of products, from fibres where processing input is high, to poles where processing input is much less. All conversion processes however produce a range of outputs. For example, sawn milling produces saw dust, chips and sawn wood in a variety of sizes and quality classes. All must be disposed of, and some at net negative returns. These later products are often viewed as waste. For any processor, a primary challenge is to find markets for all products recovered from any harvested forest resource, such that the sum of net returns on all products is positive. This study examines product development opportunities for plantation grown *Endospermum medullosum* (whitewood) in Vanuatu. A review of all elements and development of whitewood provided has been collected from the literature and interviewing the whitewood processors. Also, a small sample of plantation grown logs was assessed for wood properties. Finally the value-adding opportunities for the value-adding these products were recommended.

### 4.10.5 Literature Review

Whitewood is one of the tallest emergent species in Vanuatu’s forest and compares with other major species including *Antiaris toxicaria*, *Agathis macrophilly* and *Callophyllum neobodicum*. It normally grows to an average height of 40m, and sometimes up to 60m with a 15m – 30m clear stem and a diameter above buttresses of 60cm to 100cm (Thomson, 2006).

Whitewood is one of the native premium timber species in Vanuatu, that has contributed more than 50% of the country’s annual log production in the past (Vutilolo et al. 2005). However, in an environment of high demand for Whitewood products in both local and export markets from the early nineteen nineties, the merchantable volume from the natural forest was almost exhausted (McGregor and McGregor, 2010).

Groves and Wood (1998) described Whitewood as a hardwood with a density of 400-450 kg/m$^3$ and sometimes conspicuous growth rings. Following the substantial economic return from Whitewood utilisation that influenced by its’ chemical, physical and working properties, it is readily accepted by wood manufacturing industries in both domestic and export market. Whitewood is used locally in light to medium structural works, furniture and cabinet making, veneer, plywood, interior trim, joinery, carving, turnery, and panelling. It can also be used in vehicle bodies, sporting goods, musical instruments, vats, wooden toys and pattern making. Whitewood is also very light compared to competing species available in the south Pacific,
and is highly susceptible to blue staining fungi, pinhole borers, marine borers and termites. The impact of blue staining fungi in particular, requires logs are sawn within two days of felling and the sawn wood seasoned, if biodegradation is to be avoided. Alternatively, Whitewood can be vacuum/pressure treated with cromated copper arsenate (CCA) or copper (e.g. Tanalith). In the green state this produces an envelope treatment only, that serves to protect the timber from insects and fungi temporarily, but does not confer long term protection under exposed conditions.

The small volumes of Whitewood that are currently recovered from the native forests on Efate are processed by portable sawmills, similarly to Santo except for Melcoffee Sawmills that is still operating stationary sawmills and harvesting from the natural forests and its’ Whitewood plantations. On Efate the portable sawmillers are selling first grade untreated green timber for air drying at $380-$490/m$^3$ and $305-$340/m$^3$ for first grade pressure treated timber. The timber yards buy the timber, air seasoned and pressure treated then sell to consumers at $658-$767/m3 for air seasoned and $930/m$^3$ for pressure treated. While on Santo the portable sawmillers are selling first grade untreated timber for air drying at $425-$493/m$^3$ and $244-$340/m$^3$ for first grade pressure treated timber. The timbers yard buy and treat the timber and sell to consumers at $822/m^3$ for air seasoned and $531/m^3$ for pressure treated. There are only three preservation plants operating in Vanuatu, all located on Santo Island. These processors are able to exert some control of price in domestic markets due to susceptibility to biodegradation however diminishing supplies of wood in general, is increasing green sawn wood prices.

Gaps in the market flowing from diminishing local wood supply, has caused a reduction in the use of Whitewood, especially in construction. Under these conditions Whitewood has been replaced by imported radiata pine (\textit{Pinus radiata} D.Don) from New Zealand and Caribbean pine (\textit{Pinus caribaea} Mor.) from Fiji.

Imported softwood is sold at an average price of $740/m^3$ in hardware and wood supply stores in Vanuatu, and in 2011 softwood imports amounted to 2.1 USD million or 88% of the total value of imports of forest products (Vanuatu National Statistics Office, 2012). Using retail selling price as a guide, this represents a potential domestic consumption of approximately 5,000m$^3$, and this market is located in higher population centres of Port Vila and Luganville. It is notable that an informal survey of sawn softwood products available for sale in Luganville indicated that imported softwood from New Zealand was of an unsuitable grade for structural purposes, suggesting disposal of rejected structural wood in
Vanuatu. This observation indicates a shortfall in knowledge of wood users regarding grading systems. There is an urgent need for such systems and education of users in Vanuatu if structures are to be designed and built to weather cyclonic conditions.

Whitewood was able to secure a niche market, primarily for mouldings, in Japan during the nineteen nineties, because of its weight, appearance and workability (Thomson, 2006). However, the export of Whitewood products ceased in 2008 (McGregor and McGregor, 2010). The majority of Whitewood harvested in the nineteen nineties was exported to Japan by Melcoffee Sawmill Co. The proprietor, Mr Neil Croucher, describes this trade as including kiln seasoned clear boards, at a free on board (FOB) price of $766/m³ to $1,094/m³; $656/m³ for finger jointed laminated board and up to $1,116/m³ for solid laminated board.

Currently domestic markets exist for defect-free (clear) wood; it is the lack of whitewood resources that limits market expansion. In addition to this, some additional market related issues exist for the species, namely:

1. Consumers complain that Whitewood is much less durable after treatment compared to imported softwood. This is a consequence of envelope treatment of Whitewood while green to limit biological degrade during trade, rather than providing long term protection.
2. Imported softwood is provided in standard lengths of 6m which construction companies prefer, and is dry and dressed to provide a stable and easily handled product.
3. Imported softwood is available everywhere and especially in hardware stores which is more convenient for builders. It is also common for hardware stores to deliver to site.
4. Most builders lack the knowledge in timber grading and timber durability to understand what they are purchasing and its suitability for purpose.
5. The construction industry in Port Vila is large, where imports are common and domestic wood supply is limited. The Whitewood industry is based primarily on Santo Island and small construction companies rarely purchase timber in large quantity.
6. Timber yards only purchased clear grade and rarely second grade Whitewood timbers. Most of the lower grade timbers are either left at the processing sites or used by local people for burning or temporary building. This represents poor efficiency of utilisation and an economic loss. It is noteworthy that native forest resources is described as producing approximately 50% of sawn wood recovered in clear grade class (pers. comms. Neil Croucher Melcoffee Sawmill Co.). This high rate of clear wood recovery has impacted the trade in Whitewood such that lower grades are essentially wasted.
In an environment of diminishing wood supply, plantation production has been explored. A two scale planting program was introduced in Vanuatu during the 1970’s. These were known as local supply plantations (LSP’s) and industrial forest plantations (IFP’s). The LSP’s were intended to supply the future local demand of timber and the IFP’s were to provide future timber for export. Many IFP’s were discontinued when introduced species failed to survive the extreme weather conditions, pests and diseases. Whitewood has been highly regarded as a plantation species because, as a native, it is well adapted to the habitat and is regarded as wind firm in an environment where cyclones occur frequently (Thomson, 2006). The species has also been shown to be productive under plantation production conditions (Grant et al. 2012).

The form of the stem, long internodes between branch whorls and the capacity to produce a large merchantable stem free of branches with an umbrella like crown (Thomson, 2006), also offers advantages as improved recovery of defect free wood, compared for example to radiata pine that exhibits smaller branch internodes and more persistent branching (Fielding 1960).

A future Whitewood industry in Vanuatu will likely depend on plantation production. An estimated total plantation area of 730 Ha is currently established, the majority of which (470Ha) is located on Santo Island along the eastern coast. Melcoffee Sawmill Co. invested in establishing 270 Ha of Whitewood plantation on Santo in 1995. At the time of publication this forest was being harvested at age 17 years. The remaining area is distributed among 270 sites on 12 islands.

Due to high growth rates of greater than 20m³/Ha/ann. the potential rate of return on investment to growers of Whitewood in Vanuatu is high e.g. NPV of $9,200 at 5% discount rate (Grant et al. 2012). This is based on a simulated optimum rotation of 37 years, and log prices ranging from $30 for smaller logs (30cm) to $85 large logs (60+cm). The potential annual production of Whitewood forest logs in 10 years time could be 14,000m³/ann., and it possible for this resource to support a viable wood industry if this wood is of a sufficient quality such as native forest has produced. It is more likely however given the different growth conditions in plantations and a possibly reduced final harvest age that this resource will be different in size and character, and provide significant product development challenges.

It has been shown that a domestic market of approximately 5,000 m³ is currently occupied by imported softwood, which could be displaced by supplies of plantation
grown Whitewood. Similarly, the peak in Whitewood exports that occurred during 2003 of over 3000m³ (Vanuatu National Statistics Office, 2012) further indicates the potential of plantation grown Whitewood to produce income for forest growers.

Current pricing indicates that Whitewood is cheaper than imported wood, and it is secure supply that is the main impediment to increasing domestic consumption and export. Despite this and the apparent potential volume available in the future, it is the distribution of plantations in small wood lots in many regions that will inhibit flows of viable quantities logs to processors, and difficulties filling larger orders from merchants, that will limit opportunities for investment and expansion of the industry. Future plantation establishment should be located to aggregate the available estate near processors, new processing facilities can be established in areas of sufficient planting and/or further work is required to develop methods of preliminary processing in the forest followed by transport to centralised final processing. In particular low cost methods of protecting sawn wood against biodegradation (blue staining fungal attack) are needed.

4.10.6 Methods

SAWMILL STUDY

A sawmill study of plantation grown whitewood was designed to measure sawn wood recovery, recovery in selected quality (or grade) classes and some mechanical properties. A sample of wood in large sections was also tested for penetration of preservative in heartwood.

A sample of six whitewood trees was selected from a 16 year old plantation grown at Lorum on the south east coast of Santo Island. Trees were selected to represent the range in diameter at breast height of the stand. This plantation was established by Melcoffee Sawmill Co., in an effort to provide ongoing supply of sawlogs and exports to Japan. The trees were established at wide spacing (10m X 4m) and pruned to approximately 6m by removing branch shoots from each stem manually as they were initiated.

The six trees were felled and cross cut in the forest to produce the straightest pieces possible and then transported by road to Melcoffee sawmill. The logs were sawn to produce 25mm boards from the outer clear wood sections of the logs, and 50mm thick random width boards from knotty and pith included wood that comprised the centre of the logs. The sawmill included a band primary saw and a circular secondary rip saw with
round about capacity to facilitate re-sawing of central cants.

The resulting sawn wood was strip stacked and placed undercover to dry in the air.

Following drying, all sawn boards were visually graded under supervision by students of the Agricultural College at Luganville on Santo Island, Vanuatu. Whole boards were sorted into one of four appearance grades. These were clear wood (1), clear on one face and edges (2), knotty wood excluding pith (3) and pith included (4). The dimensions of each board were measured using a cloth tape (length) and ruler (thickness and width). Each board was then marked to define clear sections between any defects, simulating cross cutting. The length of clear sections was measured and collated to form a total clear wood volume.

A random sub sample of 30 boards, nominally 100mm X 50mm was selected from the sawn timber and tested for strength and stiffness in bending. Sample selection and tests were conducted according to specifications in Australian and New Zealand standard AS/NZS 4063:1992 Timber - Stress-graded - In-grade strength and stiffness evaluation. The data derived from these tests was used to calculate basic working stress \( R_{\text{basic}} \) and characteristic stiffness \( E_k \) in bending and compared to current structural grade specifications used in Australia. In addition to these tests, each board was visually sorted into 4 structural grades. These grades were defined as clear wood (1), boards with only small diameter (<50mm) knots (2), boards with some larger diameter (>50mm) knots (3) and pith included boards (4).

A sample of sawn (4 pieces 100mm X 100mm) and round (2 pieces 100mm diameter)
whitewood were selected and transported to Australia where it was pressure vacuum treated with Koppers Tanalith E in the research facility at Southern Cross University (Lloyd et al 2011). Each sample was end coated with a sealant prior to treatment. Penetration of preservative was qualitatively assessed on cross cut sections after treatment.

4.10.7 Study Results
The total volume over bark of logs sawn was 6.35 m$^3$. The average small end diameter (SED) was 29.0cm. The smallest SED was 19.2cm and the largest 42.8cm. Maximum length was 4m and minimum 2.8m.

The total recovery of sawn wood was 1.91m$^3$ or 30% of over bark log volume after docking to nominal sale lengths (i.e. factors of 0.3m). Figure 4.30 shows the proportions of sawn volume recovered for each grade defined.

After simulated cross cutting to remove all defects, the recovery of clear wood as a proportion of all sawn timber was determined to be 83%. The distribution of clear wood piece length recovered from simulated cross cutting is shown in Figure 4.30.

The basic working stress ($R_{\text{basic}}$) for the sample was 2.3 MPa and characteristic stiffness ($E_k$) 3812 MPa. The distribution of strength values by visually sorted structural grade is shown in Figure 3. The wide variety in the data shows potential for genetic improvement and higher strength (Doran et al. 2012).

The approximately equal proportions of sawn wood in each grade (Figure 4.30) indicate a reduced clear wood recovery (35% of sawn recovery) than has been reported for native forest resource (50%). This is despite early age pruning of the lower stem. The cross cut clear wood volume and the distribution of clear wood cut lengths shown in Figure 4.31, indicates potential to produce clear wood in shorter pieces that can be used in furniture joinery, if set length bundles can be supplied, adding value by reducing processing (cross cutting) costs for furniture manufacturers.
Figure 4-36: Proportions of over bark stem volume recovered in each appearance grade. 1 = clear faces and edges, 2 = clear on one face and both edges, 3 = knotty excluding pith, 4 = pith included

Figure 4-37: Frequency distribution (number of pieces) of clear wood recovered from knotty wood after cross cutting to remove defects
Structural grade specifications are determined by the weaker timber in any population to ensure the whole population meets a minimum requirement. AS/NZS 4063:1992 Timber - Stress-graded - In-grade strength and stiffness evaluation uses the 5th percentile ranked value for various mechanical properties of a population, which is further scaled to account for a safety factor and the duration of load.

It is possible to remove the weaker pieces from a population by visually grading to optimise the grade and volume of a structural product. The distribution of strength by grade class shown in figure 4.32 indicates many pieces of whitewood were of a strength that meets common structural grades used in Australia (AS 1720.1 Timber Structure Part 1 Design Methods); however there are many weaker pieces that diminish the population statistics. All visual grade classes displayed some weaker pieces, and therefore visual grading is not useful in removing these. Despite this, an opportunity exists to produce a structural product if a suitable sorting mechanism can be developed. This may be as simple as measuring wood density for example.

A comparison of whitewood to Australian structural grade specifications can be made by considering what sawn section sizes provide equivalent structural performance. The stiffness (modulus of elasticity) results indicated that a sectional dimension of 90mm X 45mm in whitewood is approximately equivalent to a section of 70mm X 35mm of Australian softwood in a commonly used grade (MGP 10 - Plantation Timber Assoc. Australia 1996). In respect of strength however, a section of 150mm X 60mm of
whitewood equates to a section 70mm X 35mm of material graded as MGP 10. While these sectional comparisons indicate less efficient utilisation of whitewood, it is noteworthy that large sections offer opportunities to utilise the pith by sawing this defect into single boxed pith pieces, and the impact of larger knot defects can be more readily accommodated in large sections. Further research is required to establish mechanical properties in these larger sizes to develop building design specifications using knotty structural whitewood.

Whitewood has low durability to biological degradation, however it has been reported (Groves & Wood 1998) that whitewood will take chemical preservative readily including into the heartwood. This is not the case for Pinus species (Bootle 1985). This capacity represents significant opportunity to add value. That is, outdoor and in ground exposed products may be produced from any part of a log. The results of preservation experiments is summarised by Figure 4.38 below. Further research is required to test the efficacy of preservative treatment in service.

Figure 4-39: Penetration of copper based preservative (Tanalith E.) into the heartwood of whitewood. The end sections shown are of a piece 100mm X 100mm X 1m long that has been cross cut at its mid length. The pith can be seen as a small circular section near one face and is surrounded by heartwood. Irregular penetration of preservative is indicated by wood of lighter green colour. The sample shown was selected as the poorest penetration pattern of six samples

4.10.8 Discussions and Conclusions

The study confirms that the economic success of whitewood plantation depends on maximising the returns on investment from the lower (knotty) grades of wood.
Apparently it constitutes more than 65% of the cubic metre of wood produced from plantation logs. The two broad options identified for utilising knotty wood are the development of knotty structural, and/or short (cross cut) clear wood for furniture manufacturing. Further research development is required on structural wood; to characterise the mechanical properties of sawn wood in larger section sizes, to develop strength sorting technology and to develop engineering and design information for builders. This process will require a parallel program of capacity building for wood users and building material suppliers in respect of structural design and durability to biodegradation.

The development of a whitewood production and processing industry will also depend on expansion of processing capacity to build a competitive trade context. This trade may be in whitewood logs; however the current market is based on sawn wood trade, and implies some primary processing by forest growers. At the moment the processes that add greatest value are air drying and preservative treatment and allegedly they are not easily achieved in a portable saw mill context and require more significant investment in processing infrastructures. Nonetheless, at a small scale wood can be protected from borers and blue stain by spraying and dip diffusion of preservative chemicals specifically for interior uses. The exterior and ground contact uses demand pressure and vacuum treatment processes to allow the chemical to fix to the wood.

One very concerning insight observed by this study was the lack of resource base to supply the whitewood production and value-adding processing industry in Vanuatu. Successful establishment of a small-scale resource has been achieved, but a larger-scale resource is mandatory, before any significant domestic and export markets can be redeveloped or investment into value-adding process infrastructure can be made. Despite this, historical import and export data show that domestic demand in 2011 satisfied by softwood imports is relatively small (5,000m$^3$), and a peak in export of whitewood in 2003 (3,000m$^3$), indicates potential to initiate development of a viable production and processing industry with modest volumes. The primary challenges in the short term are aggregation newly established resource near processing facilities, the establishment of processing facilities in regions where suitable areas of plantation have been established, and/or development of infield pre processing to facilitate efficient transport of wood for final processing.
4.10.9 References


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5. CONCLUSION

This concluding chapter aims at condensing the findings and highlighting the contributions to the third objective of this study ie; identifying how efficient the various levels of governance in the whitewood value chain are in contributing to the whitewood industry, and propose changes and new initiatives required to improve the governing system. The contributions are to the whitewood farmers, industry, Vanuatu Government and other relevant institutions. Value chain analysis makes it possible to identity the issues and policies that can be implemented for whitewood farmers to increase their share of these gains.

5.1 Existing whitewood value chain

The main actors in the whitewood value chain are the farmers, sawmillers, timber yards, value-adding processors and consumers. Out of the 60 farmers participated in the study, 58 are small scale woodlots with an average area of 1.25 ha. The one medium scale plantation (25 ha) included in the study is owned by Mr. Jean Pie Tranut on Efate and the large scale plantation (270 ha) is owned by Melcoffee Sawmills on Santo. Government nurseries are the main suppliers of seedlings for the farmers. The largest area planted was on Santo between 1993 and 1997 and between 1998 and 2002 on Efate and was driven by free seedling distributions through forestry projects. Slash and burn and use of cover crop were the most common methods of site preparation (92%) and weed control (92%) and 65% of the farmers responded to establish own woodlot, 25% employed casual workers and 10% hired social groups. The average income for the casual workers is $118/ha with no significant difference on income generated by male and female (P>0.05). The distribution of planting space, 5m x 5m was high in the early plantings from 1993 to 2002 but then reduced, while 6m x 6m and 8m x 6m spacings started to increase from 2002 onwards. The wider planting space of 6m x 6m and 8m x 6m were purposely introduced for agro-forestry activities and to avoid early thinning. Of the 60 farmers interviewed only 3% thinned their woodlots and the majority of the woodlots are not thinned and left unmanaged with less growth due to high competitions for space, light and nutrients. Applied research is required on processing, product development and marketing of thinned trees to maximise farmer’s benefits. Natural forest is the main source of whitewood logs (Santo 90% and Efate 80%) compared to forestry plantations (Santo 10% and Efate 20%). The average market price of first grade whitewood timber on Santo and Efate for rough
sawn green is $435/m³, $749/m³ for air drying and $731/m³ for pressure treated timber. Air seasoned timber are purposely used for furniture and joineries and mouldings productions and pressure treated for structural and moulding.

The majority of the whitewood timber is processed by the portable mills and dominated by Lucas Sawmill comprising 70% of the Santo sawmills and 100% of Efate sawmills. Stationary bandsaws and semi-stationary Mahoe Sawmill only exist on Santo. The low recovery rate of 40 to 49% is an ongoing wasteful practice by the portable sawmills with lower grade timber either left at the processing site or scavenged by local people for fuel wood and temporary structures. The average cost of processing one cubic metre of timber by sawmill was estimated between $131 and $175 per m³ and stationary sawmill between $139 and $218.

Timber yards are key actors who play an important role in timber treatment and dressing to the required standard before sale to consumers. Portable sawmillers’ operations depend on their working capital and having the timber yard in the value chain provides a just-in-time and niche market for the portable sawmillers to financially continue their sawmilling operations. Air drying and timber pressure treatment are the two main timber processes undertaken by the timber yard apart from timber grading, sorting and stacking, docking and dressing as required by the consumer. Air seasoned timber is used for furniture and joinery and pressure treated as structural timber. Most timber yards have extended their operations to sawmilling, value-adding processing and building construction to obtain economy of scale and be competitive in their operations.

The most common value-adding products manufactured from whitewood timber are furniture & joinery (67% on Santo and 78% on Efate) and carpentry mouldings (33% on Santo and 22% on Efate). One hundred percent of the value-adding processors on Santo operate other businesses, while on Efate 75% operate other business and for 25%, value-adding processing is their only means of livelihood. Building construction and timber yard are the main other businesses operated by the value-adding processors.

The average number of females employed in value-adding processing on Santo was two with average monthly income of $297 and two females earning $311 on Efate. While the average number of males employed on Santo was six with monthly income of $386 and seven earning $470 for males on Efate.

The cost of furniture and joinery production is difficult to estimate as it depends on the product. For mouldings, the production cost per cubic metre is estimated to be $1462 to $1696 based on the standard size of 15mm x 15mm and 3 m length. This includes the cost
of timber only (3.44 m³ to produce 1 m³ of moulding), not salary and utility costs. The average selling price for 1st grade is $3.64/piece and $2.60/piece for 2nd grade. The high cost of production, little knowledge and access to market information and lack of modern equipment and technology is always a challenge to the small value-adding processors to compete with imported products.

The majority of whitewood consumers on Santo (56%) and Efate (59%) were builders and timber yards are the main supplier of timber (75% on Santo and 81% on Efate). Even though the consumers preferred whitewood to imported softwood, the current supply of whitewood timber is limited in meeting the local demand. Imported soft wood is readily available in hardware stores and delivered to building sites by suppliers who also supplied dry dressed whitewood, in standard sizes and lengths pressure treated to required H3 and H4 standards.

5.2 Developing the resource base for whitewood

The study revealed that the lack of a whitewood resource base to supply a whitewood production and value-adding processing industry in Vanuatu is the main impediment to the development of a whitewood industry. The native forests were the major source of whitewood resources, but these have been exploited beyond their capacity to support a whitewood industry that is competitive in the local and export market. The estimated 732 ha of whitewood planted in Vanuatu will not provide the economies of scale that whitewood farmers, producers and value-adding processors require in order to invest in new technologies and machinery and compete in local and export markets.

The establishment of small-scale woodlot plantations has been successfully adopted by some local farmers, but medium to large-scale plantations are needed before major domestic and export markets can be strengthened and developed. Using as a benchmark the 1994 peak annual timber production (25,000 m³), the 2003 peak exports (10,000 m³), and the 2011 imports (5,000 m³) (Viranamangga et al., 2012), Vanuatu needs to establish up to 10,000 ha of whitewood plantation to support the domestic and export markets. The 10,000 ha could produce up to 200,000 m³ of logs or 100,000 m³ of timber with an estimated mean annual increment of 20 m³/ha and a 36-year rotation (Grant et al., 2012).

The most important features of forest plantations is their economies of scale and a resource base of a size that can reduce unit output costs, especially in marketing and achieving a higher net return for the farm. The average cost of logging, haulage over long distance and
sawmilling drops significantly when there is a continuous supply of large volumes of logs. The economic benefits from large plantations can be shared with the surrounding small-scale farms by offering higher prices for either logs or timber.

5.2.1 Large-scale whitewood plantation incentives

Forestry plantation establishment in Vanuatu should involve extensive economic, environmental and social considerations and planning. The most obvious is consideration of the long-term nature of tree growing where there is a high proportion of expenditure occurring at the early stages, with most of the revenue coming at the end of the rotation. The long-term period increases the uncertainties and risks of the plantation investments. The risks and uncertainties on future marketability and prices of the products, land disputes, pest and diseases, and extreme weather such as tropical cyclones should be considered in plantation economics.

It is important that the government develops forestry plantation incentive strategies to attract investors to medium to large-scale (up to 10,000 ha) whitewood plantations. A whitewood plantation incentive strategy needs to be developed and adopted by both the national government and provincial governments to effectively facilitate the plantation industry including the growing, managing, harvesting and processing of the trees. The national and provincial governments need to extend their activities from those that only benefit society to activities that will attract sector investment. Lack of investment in large-scale forestry plantation is a market failure, in which the private sector is unable or unwilling to invest to the extent required by society, and where public investment can be justified to maximise community benefit.

A whitewood plantation incentive strategy needs involved the following aspects:

- Development of a forestry plantation and reforestation act to guide and facilitate private investment in medium and large-scale forestry plantations,

- Improvement and enhancement of the Department of Forests Planning Section to effectively formulate, coordinate and implement policy, legislation and regulations, program and projects that promote private investment in whitewood plantations,

- Promote training for forestry technical and extension officers to effectively work with the private investors in developing whitewood plantations,
- Identify suitable land for whitewood plantations and facilitate land negotiations between the investor, the landowners and the Department of Lands and Survey to register and lease the land for plantation establishment,

- Provide the technical and financial means to construct and maintain access roads, power and water supply to proposed forestry station sites for the private investor to establish forestry camp, nursery, timber processing site, timber treatment yard and storage,

- Continue research on improved tree genetics and tree breeding to advance growth rates and increase volumes of wood produced, branch shedding and pest resistance, and increase return to the plantation grower,

- Continue research on silvicultural practices, stocking, pruning and early thinning, reduce knots and tension wood to improve processing recovery rates and efficiencies and thus, reduces processing costs,

- Carry out agro-forestry research, enhancing the production of intercropping whitewood with crops and a combination of pasture and trees for the tree growers to obtain early returns from the crops,

- Carry out research on how the whitewood plantation products are developed to match market needs, and continue to expand markets for wood products in both domestic and export trends and become competitive and adaptable to market changes.

### 5.2.2 Enhancing the capacity of small-scale woodlot farmers

Small-scale woodlot farmers are the main investors in whitewood plantings, and while they are well informed about the long-term benefits from the woodlots, their lack of knowledge and skill in woodlot management and silvicultural practice have contributed significantly to the poor performance of the trees. The lack of research information on whitewood establishment and management from the Department of Forests during the early plantings also partially contributed to the failure of the woodlots.

However, most of the information on how to establish commercial whitewood plantations has been developed by the Whitewood Silviculture Project (ACIAR FST/2005/089) and information is provided in project technical reports, published papers and especially in the Whitewood Silviculture Manual. The focus of the Whitewood Silviculture Manual
(Glencross & Viranamangga, 2012) is on the design of plantations, site preparation and establishment, spacing, thinning, pruning and weed control programs. This manual also includes prescriptions for native timber/nut species and agricultural root crops intercropped with whitewood and some aspects of marketing for the whitewood and integrated crops (Glencross & Viranamangga, 2012). The published papers involved specific data and results from the research experiments carried on the various aspects of whitewood silvicultural prescriptions and challenges and opportunities for export and domestic use of juvenile whitewood trees. Published paper on the early growth response, branching and stem quality at different spacing (Glencross et al., 2012), resolution of appropriate establishment techniques (Smith et al., 2012), growth modelling (Grant et al., 2012), domestication of native species (Nichols & Vanclay, 2012) and opportunities of value adding (Viranamangga et al., 2012).

Based on the Whitewood Silviculture Manual and research findings the Department of Forests needs to begin standardising the information in its forestry extension materials and transfer the knowledge and skills to the farmers, using appropriate methods such as posters, brochures publications, demonstrations (forestry field day) and/or short training courses. The extension materials should present at a level that is suitable, motivating, educational, and of benefit to the farmers. Delivering the extension materials to the farmers is very important and the Department of Forests, Extension Officers including the environmental NGOs who work with forestry farmers must be properly trained to ensure they are acquainted with the knowledge and skills to transfer to the farmers.

The Department of Forests should ensure that the farmers have clear objectives on the level of farming they want to pursue. If the farmers want to intercrop agricultural crops with whitewood then they must choose between low and moderate density levels of whitewood and the type of crops to plant in between the trees as this will determine the planting density. With low density there will be less than 300 trees/ha at the spacing of 6m x 8m and 400 to 500 trees/ha at 6m x 4m or 5m x 5m spacing. If the farmers decide to pursue high density then there should be up to 800 trees/ha with 4m x 3m spacing and thinned (7 to 10 years) to 250 to 300 as the final crop (Glencross & Viranamangga, 2012).

The advantages of high-density plantation establishment are; the need for weed control is reduced, competition among the trees increases growth rate, trees grow straighter than at wider spacings, there can be a longer space between branches and smaller branches, trees more easily self-prune and there are a larger number of trees from which to select crop
trees. The advantages for low and moderate density are that food/nuts, building/fencing materials can be produced in the early years of the plantation, and these generate income. The disadvantages in wider spacings are: more weed growth, low and heavy branching, and large branches and slower growth if not enough competition among the trees (Glencross et al., 2012). However, trees in wider spacing can grow better than those in close spacing if weeds are adequately controlled.

Smith et al. (2012) report weed control is less of a problem in lower density plantings where weed control of agricultural crops is more regular. However, trials on agro-forestry planting designs required further investigation to ascertain whether integrated crops or other trees species such as Flueggia provide adequate competition and growing environment that enhance whitewood growth, form and branching habit and maximise clear timber from the trees. The longer-term impact of the forest plantation on the nutrient flow in the agro-forestry are also important factors to investigate.

### 5.2.3 Orienting small-scale woodlot farmers towards markets

Managing trees on farms is a common practice for subsistence farmers in rural areas and the value of trees has long been recognised for fruits/nuts, fuel-wood, construction materials for traditional houses, fencing, provision of shade, windbreaks, protecting and enhancing soil fertility and helping to maintain biodiversity. The management of trees for the environmental services provided by the trees is different to managing trees for timber as the end product. Farmers need to understand not only the differences between managing trees on the farm and managing trees for commercial purposes but also managing and linking the trees to future potential markets.

Small-scale woodlot farmers often plant trees without knowledge of market information and specifications for products, and have weak or no linkages with the markets provided by the other stakeholders along the whitewood value chain. As a result, farmers are disadvantaged in negotiating with the portable sawmillers who go to villages searching for trees to process and many woodlots are still not thinned because of lower log price offered by the sawmillers. Farmers need to understand the various stages of processing (primary and secondary) along the value chain, processing costs, market prices and the quality of log and timber required to produce the products. Assisting the farmers to understand the different Whitewood products produced by the various actors along the value chain and the market analysis of the products will allow them to identify the products they will be
aiming for and managed the woodlots accordingly. The farmers should be encouraged to consider the following questions when managing their woodlots (Anyonge & Roshetko 2003)

- Do the trees in the woodlot meet market demand and what are the market specifications?
- Can the trees and other crops in the woodlot sustainably supply the existing market?
- Do the tree and the other crops provide short and long-term benefits to the farmers?
- Are the trees from improved materials?

5.2.4 Formation of collective action by farmers

The small-scale woodlots are dispersed and isolated in the rural areas of Vanuatu and generally, the farmers do not communicate, share ideas or advice with each other on how to efficiently manage the woodlots. Additionally, due to limited operational budgets from the government, it is difficult for the Department of Forests to be effective in its extension programme to all the forestry farmers.

Therefore, the Department of Forests should consider working with the farmers to setup co-operative societies, or farmers associations to link farmers to the market and to have collective actions to solve their common problems, share ideas and pursue their interests. The advantages of collective action through co-operative or farmers associations establishment are that: this model provides farmers with the bargaining power to negotiate prices with the buyers and achieve economies of scale by pooling resources together and reducing the unit cost of production. Large-scale timber buyers will also benefit because they do not have to negotiate with individual farmers and would have a consistent and standard supply of timber products. Sherr (2004) reports how the collective actions of smallholder agro-foresters and farm foresters in India, Uttar Pradesh, the Philippines, Bangladesh and Nepal have successfully supplied dynamic domestic wood markets.

5.3 Enhancing on farm processing using portable sawmills

The impact of poor road infrastructure on portable sawmiller operations in the rural areas is a national and provincial government issue that has been a setback to rural development for decades. The competitiveness of the portable sawmillers depend on the government’s success in not only improving the road infrastructure but also in lowering the costs of doing business in relation to timber licenses, business licences and utility costs. The high
costs and generally poor quality of domestic intra-island transport is also a major issue which limits the access to the high demanding timber market on Efate. The government needs to recognise the importance of improving the road infrastructure and reducing business costs to boost the competitiveness of the local producers.

Portable sawmillers are accustomed to processing whitewood trees from the natural forests and not from woodlots and especially have little experience maximising recovery of timber from small size thinning logs. It is recommended that the Department of Forests research log processing using various brands of portable mills and chainsaw mini-mills. The sawing techniques, recovery rates and cost:benefit analysis for each of the sawmill makes and models should be investigated for the farmers to decide which portable sawmill or chainsaw mini-mill type to use. The research should also investigate the cost:benefit ratios of sawmillers/farmers either processing and marketing their timbers through a co-operative or sawmillers/farmers association, or acting autonomously and selling logs to the large sawmillers.

The timber sizes, quality and quantity produced have to be determined by existing domestic and export markets to enhance the sawmillers/farmers knowledge and participation in the production and establishing links and governance with the actors in the whitewood value chain. Recommended research will not only link the sawmillers/farmers to the market but also identify vital economic considerations and opportunities for the farmers to value-add their trees and continue to invest in whitewood woodlots establishment. Anyonge and Roshetko (2003) specify processing and conversion of timber on-farm is an effective way of training and advising farmers in how to meet market specifications as it maximises the returns for the farmers, creates employment in the rural areas and lower grade timbers are used by the local consumers.

Handling of whitewood timber to limit biodegradation is another major challenge to the portable sawmillers. Harvesting and processing and immediate sale to the consumers as rough green sawn timber is the processing and handling method used to avoid biodegradation. To certain degrees it does not work and difficult because of the poor road infrastructures and unpredictable tropical weather and timber is downgraded because of blue stain, moulds, borers and termites infestations.

There is a need to investigate various methods of dying (air-drying and kiln drying) and preservative treatment options that are practical and economically viable for the farmers to adopt. The research should involve analysis of the existing environmental factors that are
currently affecting the whitewood product values and returns and analyse possible solutions by modifying the current techniques used to suit the local farmer’s needs. The drying and preservative options will not only benefit the farmers/sawmillers but also standardised to specifications required by the next actors on the value chain. As specified by Sathre and Gustavsson, (2009) the finished product (output) from an actor in the value chain is an input for another actor.

5.4 Enhancing value-adding processing

Similar to primary processing (portable sawmill operation), for the value-adding processing (secondary) to be competitive in the domestic and export market the government has to develop policies and regulations that reduces the costs of operating business. Vanuatu’s dependence on imported refined petroleum fuel for its commercial energy and the electricity prices of 52 US cents/kWh is very high compared to many countries in the world (Bakeo et al. 2004). Transport by land, sea and air also depends on imported refined petroleum and transport costs are normally high. The government needs to provide incentives through exemptions to reduce utility costs and domestic transport costs to encourage competitive advantage for value-adding processors.

5.4.1 Product development and market access for value-adding processing

Typical of value-adding processing for small logs in general, marketing the product is a major challenge. For small operations, the time required to learn about potential markets through extensive research is an overwhelming task and the necessary resources are often expensive. Thus, the Department of Forests and its developing partners need to conduct product development research into the potential range of high value wood products from young plantation-grown trees, the market information concerning the value-added products demand and price, improve knowledge on market specification and potential linkages with market agents.

Low-quality wood with knots and pith-in generally constitutes more than 65% of the timber processed from forestry plantation (Viranamangga et al., 2012), and especially thinned trees. Viranamangga et al. (2012), conducted a sawmill study on sixteen year old whitewood plantation trees and found a recovery of 83% clear timber, cross cutting between knots. The short clear timber revealed potential for furniture and joinery and the need to investigate the possibility of value adding using engineered wood products. The value-adding processors are used to working with whitewood timber from natural forests.
but not plantation grown whitewood which has different wood properties therefore the suitability for products such as finger jointing, moulding, furniture and joinery, engineered wood products *etc*. needs investigation. The modernisation of value-adding equipment and technologies is very important to be able to compete with imported products. Viranamangga *et al.* (2012) reported the stiffness (modulus of elasticity) of whitewood timber size 90 x 25 mm is roughly the same to 70 x 35 mm Australian softwood and according to strength 150 x 60 mm of whitewood is equivalent to 70 x 35 mm. Therefore, further research on mechanical properties for larger sizes pith-in and knotty structural timber is required to develop specifications for building designs.

The use of low quality wood for structural applications requires investigation to quantify the mechanical properties through mechanical testing setting the timber quality parameters for structural purposes. The results for whitewood structural timber will be incorporated into the Vanuatu code of building proving performance, particularly with cyclone and earthquake ratings.

Wood preservation is other area that requires investigating to quantify the effectiveness of various preservative treatment options for whitewood. Even though there is considerable treatment of whitewood taking place, many consumers are complaining that whitewood preservative treatment is not efficient compared to treatment for imported softwood. The efficacy of various treatments has not been established and investigation is required on treatment options through measurement of graveyard trials of treated samples. Options for surface hardening systems require investigation, particularly for the furniture and moulding market, where whitewood has limitations due to low durability, low resistance to wear and biodegradation. Surface hardening in combination with preservative treatment research will be able to provide designs for appropriate wood modification system.

Finally consumers need to be made aware of the improved durability of the whitewood wood products and value-adding products or engineered products. The products may then be used appropriately and product and market promotion may lead to an increase in consumer demand, increased supply and allow the producers to be more competitive in both domestic and export markets. The awareness could be done through training, media, forestry shows and forestry extension materials such as posters and brochures.

Nevertheless, woodlot establishment alone will not be able to save the forestry industry in Vanuatu. The country requires encouraging and facilitating the establishment of medium
to large whitewood plantations to boost the timber industry. While forestry plantation is a long-term investment from a financial perspective, it requires more than forestry research information on genetic improvement and silvicultural management and practices to encourage investors to invest in whitewood plantation. It requires research on processing and products development, marketing development for both domestic and export and government incentives through its policies and regulations. The investors should understand the value chain of whitewood plantation from farming to processing and the relationships and linkages among the stakeholders to be competitive in the whitewood timber products market.
6. References


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Kaplinsky, R. (2000). Globalisation and Unequalisation; What Can be Learned from Value Chain


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http://www.pacifictradestatistics.com/index.cfm


Governance, The Crawford School, Canberra, Australia.


### 7. Appendices

**Appendix 1: Whitewood Farmers Survey**

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Researcher’s Name(s)</td>
<td></td>
</tr>
<tr>
<td>2 Date</td>
<td></td>
</tr>
<tr>
<td>3 Respondent’s name</td>
<td></td>
</tr>
<tr>
<td>4 Gender (Male or Female)</td>
<td></td>
</tr>
<tr>
<td>5 Age</td>
<td></td>
</tr>
<tr>
<td>6 Address (village name, Island, phone no. and GPS position)</td>
<td></td>
</tr>
<tr>
<td>7 What is the landownership of the land?</td>
<td>1 Individual traditional owner</td>
</tr>
<tr>
<td></td>
<td>2 Family land</td>
</tr>
<tr>
<td></td>
<td>3 Clan land</td>
</tr>
<tr>
<td></td>
<td>4 Community land</td>
</tr>
<tr>
<td></td>
<td>5 Lease land</td>
</tr>
<tr>
<td></td>
<td>6 Others, specify ___________________________________________</td>
</tr>
<tr>
<td>8 What is the ownership status of the whitewood farm/plantation?</td>
<td>1 Only one landowner</td>
</tr>
<tr>
<td></td>
<td>2 Family (only one household)</td>
</tr>
<tr>
<td></td>
<td>3 Clan (including numbers of extended families)</td>
</tr>
<tr>
<td></td>
<td>4 Land lease holder</td>
</tr>
<tr>
<td></td>
<td>5 Joint venture</td>
</tr>
<tr>
<td></td>
<td>6 Trust company</td>
</tr>
<tr>
<td></td>
<td>7 Cooperation</td>
</tr>
<tr>
<td></td>
<td>8 Others, specify ___________________________________________</td>
</tr>
<tr>
<td>9 What is the total area of whitewood farm/plantation (ha) or total number of whitewood trees planted?</td>
<td></td>
</tr>
<tr>
<td>10 What is the planting space(s)</td>
<td></td>
</tr>
<tr>
<td>11 What year(s) did you plant the trees?</td>
<td></td>
</tr>
<tr>
<td>12 What year(s) are you expecting to harvest the trees?</td>
<td></td>
</tr>
<tr>
<td>13 Why did you choose to plant whitewood apart from other local timber species?</td>
<td></td>
</tr>
</tbody>
</table>
14 Do you or are you planning to continue planting whitewood in the future? If no why?

15 Where did you obtain your planting materials and at what are the costs?

<table>
<thead>
<tr>
<th>Nursery</th>
<th>Seedlings cost</th>
<th>Seedlings no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Forestry nursery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Own forestry nursery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Private forestry nursery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Wildings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16 What method(s) of site preparation used to establish the whitewood plantation and at what cost per hectare? This includes the materials/supplies, transport, labour, land rent etc?

<table>
<thead>
<tr>
<th>Site prep. Methods</th>
<th>Cost (vt/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Slash and burnt</td>
<td></td>
</tr>
<tr>
<td>2 Line cutting</td>
<td></td>
</tr>
<tr>
<td>3 Clearing with bulldozer</td>
<td></td>
</tr>
<tr>
<td>4 Roll over with bulldozer</td>
<td></td>
</tr>
<tr>
<td>5 Others</td>
<td></td>
</tr>
</tbody>
</table>

17 How many people were employed during the site preparation and planting?

<table>
<thead>
<tr>
<th>Gender</th>
<th>no. of people</th>
<th>Monthly income (vt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contract (group)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18 Does your farm establishment involve agro-forestry activities? And if yes, what are the short rotation crops planted and are they all consumed by your household or some are sold at the market?

| Crops                    | Consume        | Market           | Income (vt) |
|--------------------------|----------------|------------------|
|                          |                |                  |             |

19 What other tree species (mahogany, nagai, natapoa etc) did you plant?

<table>
<thead>
<tr>
<th>Species</th>
<th>Area planted (ha)</th>
<th>Year planted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. What method(s) of weed maintenance did you use and what is the cost per hectare per year and for how many years before maintenance is

<table>
<thead>
<tr>
<th>Methods of Maintenance</th>
<th>Cost (vt/ha/mnth)</th>
<th>Yr ceased</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Stripe line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Herbicides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Cover crops</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

23 All costs and prices are in Vatu (Vanuatu currency) at the exchange rate of 100 VT to 1.07 AUD (19 July 2011)
<table>
<thead>
<tr>
<th>Question</th>
<th>Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many people were employed during the entire maintenance operations?</td>
<td></td>
</tr>
<tr>
<td>Gender no. of people……Monthly income (vt)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>Contract (group)</td>
<td></td>
</tr>
<tr>
<td>Others__________________</td>
<td></td>
</tr>
<tr>
<td>What methods of silvicultural prescriptions are applied and what are the costs of the entire operations per hectare (pruning, thinning etc)?</td>
<td></td>
</tr>
<tr>
<td>Silvicultural methods……….. Cost (vt/ha)……….. Year</td>
<td></td>
</tr>
<tr>
<td>1 Pruning</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2 Thinning</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>Others__________________</td>
<td></td>
</tr>
<tr>
<td>What methods of silvicultural prescriptions are applied and what are the costs of the entire operations per hectare (pruning, thinning etc)?</td>
<td></td>
</tr>
<tr>
<td>Visual stress grades Production cost Market price (vt/m³)</td>
<td></td>
</tr>
<tr>
<td>Clear timber</td>
<td></td>
</tr>
<tr>
<td>Knotty (but good)</td>
<td></td>
</tr>
<tr>
<td>Pith in/bad defect</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>If it was a commercial thinning what products were produced and what are the operation costs and market prices (vt/m³)?</td>
<td></td>
</tr>
<tr>
<td>Very poor Poor Average Good Excellent</td>
<td></td>
</tr>
<tr>
<td>1 Site preparation__________</td>
<td></td>
</tr>
<tr>
<td>2 Fast growing and healthy seedlings__________</td>
<td></td>
</tr>
<tr>
<td>3 Planting stock__________</td>
<td></td>
</tr>
<tr>
<td>4 Adding fertilizer__________</td>
<td></td>
</tr>
<tr>
<td>5 Control of weeds__________</td>
<td></td>
</tr>
<tr>
<td>6 Control of pests and diseases__________</td>
<td></td>
</tr>
<tr>
<td>7 Pruning__________</td>
<td></td>
</tr>
<tr>
<td>8 Thinning__________</td>
<td></td>
</tr>
<tr>
<td>If you are harvesting from your whitewood plantation, what volume of logs or number of trees do you harvest each year?</td>
<td></td>
</tr>
<tr>
<td>28 What are your understandings and experiences on visual stress</td>
<td></td>
</tr>
<tr>
<td>1 Site preparation__________</td>
<td></td>
</tr>
<tr>
<td>2 Fast growing and healthy seedlings__________</td>
<td></td>
</tr>
<tr>
<td>3 Planting stock__________</td>
<td></td>
</tr>
<tr>
<td>4 Adding fertilizer__________</td>
<td></td>
</tr>
<tr>
<td>5 Control of weeds__________</td>
<td></td>
</tr>
<tr>
<td>6 Control of pests and diseases__________</td>
<td></td>
</tr>
<tr>
<td>7 Pruning__________</td>
<td></td>
</tr>
<tr>
<td>8 Thinning__________</td>
<td></td>
</tr>
<tr>
<td>27 If you are harvesting from your whitewood plantation, what volume of logs or number of trees do you harvest each year?</td>
<td></td>
</tr>
<tr>
<td>Provide reasons:</td>
<td></td>
</tr>
<tr>
<td>26 Do you understand the reasons for applying silvicultural prescriptions and how would you rate your knowledge?</td>
<td></td>
</tr>
<tr>
<td>Very poor Poor Average Good Excellent</td>
<td></td>
</tr>
<tr>
<td>1 Site preparation__________</td>
<td></td>
</tr>
<tr>
<td>2 Fast growing and healthy seedlings__________</td>
<td></td>
</tr>
<tr>
<td>3 Planting stock__________</td>
<td></td>
</tr>
<tr>
<td>4 Adding fertilizer__________</td>
<td></td>
</tr>
<tr>
<td>5 Control of weeds__________</td>
<td></td>
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<tr>
<td>6 Control of pests and diseases__________</td>
<td></td>
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<tr>
<td>7 Pruning__________</td>
<td></td>
</tr>
<tr>
<td>8 Thinning__________</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Answers</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| 29 What level of processing are you or planning to involve in at what market price are you willing to the products? | 1 Sell standing trees  
2 Logs  
3 Bucking  
4 Green sawn  
5 Dry sawn  
6 Defect docking/ripping  
7 Reconstitution (furniture, engineered products etc)  
Others__________________________  
Provide reasons:                                                                                                                                                                                                 |
| 30 If you are marketing untreated whitewood timber, who are the buyers for these visual stress grades? | Visual stress grades  
Potential buyers  
Marketing prices (vt/m³)  
Clear timber  
Knotty (but good)  
Pith in/bad defect                                                                                                                                                                                                 |
| 31 What are your understandings and experiences in whitewood timber preservative treatment and drying? How would you rate your knowledge? | Rate your knowledge to each timber preservative treatment and drying with the knowledge rating scale.  
1 know it well, 2 Have seen it and heard of it, 3. Have no clue,  
1 Pressure treatment________  
2 Dip diffusion treatment ________  
3 Spray with anti-mold_________  
4 Air seasoning_________  
5 Kiln drying_________  
6 Others__________________________ |
| 32 If you are planning to treat your whitewood timber what timber treatment plants are you planning to establish? | 1 Pressure treatment  
2 Dip diffusion treatment  
3 Spray with anti-mold  
4 Others__________________________ |
| 33 If you are planning to dry your whitewood timber what drying process are you planning to establish? | 1 Air seasoning  
2 Kiln drying  
3 Others__________________________ |
| 34 With the current whitewood market, who determines the market prices of the end products mentioned above? | 1 Market price  
2 Producers  
3 Buyers  
4 Negotiated price between producers and buyers  
5 Others__________________________ |
| 35 Are the purchasing prices fair and economical to both the producers and the buyers? | Strongly disagree 1 2 3 4 5 6 Strongly agree  
Provide reasons for your rating: |
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
</table>
| If you are planning to harvest and process your whitewood trees, what brand of chainsaws and sawmills are you planning to use and why? | 1 Chainsaw mini-mill______________  
2 Portable mill______________  
3 Stationary mill______________  
4 Others______________  
Provide reasons: |
| How are you planning to obtain the chainsaw and sawmill require to process the trees? | 1 Purchase in cash  
2 Personal loan  
3 Hire machines from others  
4 Others______________  
Provide reasons: |
| How are you planning to sell your If you are considering value-adding, what level of processing are you planning to establish? | 1 Logs  
2 Bucking  
3 Green sawn  
4 Dry sawn  
5 Defect docking/ripping  
6 Reconstitution (furniture, engineered products etc)  
7 Others______________  
Provide reasons: |
| Are there any other value-added or segmented products that still to be considered for whitewood? | |
| Have you or any of your family members attended any training on general forestry operations, nursery establishment, plantation establishment, maintenance and management and forest utilization? If yes what institutions? | F/member            Training              Institutions         Year |
| Have you or any of your family members attended any training on chain saw and milling operations, log scaling and timber volume calculation? If yes what institutions? | F/member            Training              Institutions         Year |
| Have you or any of your family members attended any training on value-adding or carpentry? If yes what institution(s)? | F/member            Training              Institutions         Year |
43 Have you or any of your family members attended any training on financial management, book keeping and marketing? If yes what institutions?

<table>
<thead>
<tr>
<th>F/member</th>
<th>Training</th>
<th>Institutions</th>
<th>Year</th>
</tr>
</thead>
</table>

44 Are you affiliated with any association or cooperative that may assist you on harvesting your whitewood plantation in the future?

45 Do you think joining or forming an association or cooperative will create better opportunities and power to efficiently process and market your trees in the future with other members of the association or cooperative?

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

Provide reasons for your rating:

46 Are you aware of any other successful associations or cooperatives in other sectors within the area, and what makes them successful?

47 Are you aware of any failed associations or cooperatives in other sectors within the area, and what are the reasons for their failures?

48 Are you aware of any entry barriers in the whitewood industry that are creating difficulties to market your products? If yes, what actions are you expecting from the government (product promotion, subsidies, import controls etc)?

49 Are you aware of any governance that displayed by key actors in the whitewood value chain that helps boost the whitewood industry?

<p>| Design and standard setting | Monitoring the standards | Just in time production | On time delivery | Advertisement and promotions | Others |</p>
<table>
<thead>
<tr>
<th>Question</th>
<th>Rating Options</th>
</tr>
</thead>
</table>
| 50 How would you categorised the current relationships between the      | Very poor  Poor  Average  Good  Excellent  
| stakeholders along the whitewood value chain?                          | 1  2  3  4  5  
| Provide reasons:                                                        |                                                                                 |
| 51 What you think would help to buildup the whitewood industry?         |                                                                                 |
| 52 How would you assess the technical or financial support by the      | Very poor  Poor  Average  Good  Excellent  
| Department of Forests?                                                  | 1  2  3  4  5  
| Provide reasons:                                                        |                                                                                 |
| 53 Are you aware of forest products certification? How would you rate  | 1 Know it well, 2 Have heard of it, 3. Have no clue,  
| your knowledge?                                                         | 1 Environmental benefits____________________  
| 2 Carbon sink_____________________________  
| Comments:                                                               |                                                                                 |
| 54 Are there any urgent matters that you think are important for       |                                                                                 |
| Department of Forests to address?                                       |                                                                                 |
| 55 What policy, management strategies and regulation areas you would    | Short Agricultural crops  
| like the government to review, amend or introduce to adequately boost  | Crops Monthly income (vt) Harvest/trading months  
| the development of the whitewood industry in Vanuatu?                   | Agricultural cash crops  
|                                                                     | Crops Monthly income (vt) Harvest/trading months  
|                                                                     | Livestock  
|                                                                     | Animal Monthly income (vt) Harvest/trading months  
|                                                                     | Fisheries  
|                                                                     | Fish Monthly income (vt) Harvest/trading months  
|                                                                     | Other products (carving, local mats, local baskets, etc)  
|                                                                     | Crops Monthly income (vt) Harvest/trading months  
| 56 What are the main sources of income for the household?               |                                                                                 |
| 57 What other business are you operating (Store, Land transport, Food   |                                                                                 |
| stall etc)                                                               |                                                                                 |
| 58 What are the family main expenses?                                   |                                                                                 |
### Appendix 2: Whitewood Processors (Sawmillers) Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Researcher’s Name(s)</td>
<td></td>
</tr>
<tr>
<td>2 Date</td>
<td></td>
</tr>
<tr>
<td>3 Respondent’s name</td>
<td></td>
</tr>
<tr>
<td>4 Gender (Male or Female)</td>
<td></td>
</tr>
<tr>
<td>5 Age</td>
<td></td>
</tr>
<tr>
<td>6 Address (village name, Island, phone no. and GPS position)</td>
<td></td>
</tr>
<tr>
<td>7 Is this your only means of livelihood or not?</td>
<td></td>
</tr>
<tr>
<td>8 How long have you been in this business?</td>
<td></td>
</tr>
<tr>
<td>9 Is this your only means of livelihood or not?</td>
<td></td>
</tr>
<tr>
<td>10 What type of sawmill are you operating (chainsaw minimill, portable sawmill, bench saw, forest mill, etc)?</td>
<td></td>
</tr>
<tr>
<td>11 How would you grade the machine you are currently using to process whitewood?</td>
<td>Very poor Poor Average Good Excellent</td>
</tr>
<tr>
<td>Provide reasons:</td>
<td></td>
</tr>
<tr>
<td>22 Are there other sawmills that would be more efficient?</td>
<td></td>
</tr>
<tr>
<td>23 Where do you get your whitewood logs to process?</td>
<td>1 Own whitewood plantation</td>
</tr>
<tr>
<td>24 Are you processing the logs at stump site or at the sawmill yard?</td>
<td></td>
</tr>
<tr>
<td>25 If you are purchasing logs from other farmers, what are the purchasing prices(^{24}) (vt/m(^3)) and who are these farmers (names, villages, island etc)?</td>
<td>Farmers</td>
</tr>
<tr>
<td>26 If you are hired by farmers to process their trees what are your hired prices (vt/m(^3)) and who are these farmers (names, villages, island etc)?</td>
<td>Farmers</td>
</tr>
</tbody>
</table>

\(^{24}\) All costs and prices are in Vatu (Vanuatu currency) at an exchange rate of 100 VT to 1.07 AUD (19 July 2011)
island etc) and how many number of trees or m\(^3\) of logs agreed to harvest?

<table>
<thead>
<tr>
<th>27 The trees you are processing are they from thinning or final crops?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Contract (group)</td>
</tr>
<tr>
<td>Others</td>
</tr>
</tbody>
</table>

28 How many people are you employing to operate the saw mill (male and female)?

<table>
<thead>
<tr>
<th>28 How many people are you employing to operate the saw mill (male and female)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Contract (group)</td>
</tr>
<tr>
<td>Others</td>
</tr>
</tbody>
</table>

29 What is your average recovery rate?

<table>
<thead>
<tr>
<th>29 What is your average recovery rate?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 70%+</td>
</tr>
<tr>
<td>2 60% to 69%</td>
</tr>
<tr>
<td>3 50% to 59</td>
</tr>
<tr>
<td>4 40% to 49%</td>
</tr>
<tr>
<td>5 30% to 39%</td>
</tr>
<tr>
<td>6 20% to 29%</td>
</tr>
<tr>
<td>7 20-</td>
</tr>
</tbody>
</table>

Provide reasons:

30 From your experience in whitewood processing what other milling technologies or equipment do you think are necessary to improve your recovery rate?

<table>
<thead>
<tr>
<th>30 From your experience in whitewood processing what other milling technologies or equipment do you think are necessary to improve your recovery rate?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

Provide reasons:

31 What are your understandings and experiences on visual stress grading of whitewood timber?

<table>
<thead>
<tr>
<th>31 What are your understandings and experiences on visual stress grading of whitewood timber?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual stress grades</td>
</tr>
<tr>
<td>Clear timber</td>
</tr>
<tr>
<td>Knotty (but good)</td>
</tr>
<tr>
<td>Pith in/bad defect</td>
</tr>
</tbody>
</table>

32 What are the costs (vt/m\(^3\)) to produce these types of visual stress grading of whitewood timbers?

<table>
<thead>
<tr>
<th>32 What are the costs (vt/m(^3)) to produce these types of visual stress grading of whitewood timbers?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual stress grades</td>
</tr>
<tr>
<td>Clear timber</td>
</tr>
<tr>
<td>Knotty (but good)</td>
</tr>
<tr>
<td>Pith in/bad defect</td>
</tr>
</tbody>
</table>

33 If you are marketing untreated whitewood, who are your buyers for these visual stress grade timbers and at what market prices (vt/m\(^3\))?  

<table>
<thead>
<tr>
<th>33 If you are marketing untreated whitewood, who are your buyers for these visual stress grade timbers and at what market prices (vt/m(^3))?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual stress grades</td>
</tr>
<tr>
<td>Clear timber</td>
</tr>
<tr>
<td>Knotty (but good)</td>
</tr>
<tr>
<td>Pith in/bad defect</td>
</tr>
<tr>
<td>Others</td>
</tr>
</tbody>
</table>

34 Are there any potential buyers for these untreated visual stress grade whitewood timbers (vt/m\(^3\)) that you will be supplying in the future?

<table>
<thead>
<tr>
<th>34 Are there any potential buyers for these untreated visual stress grade whitewood timbers (vt/m(^3)) that you will be supplying in the future?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual stress grades</td>
</tr>
<tr>
<td>Clear timber</td>
</tr>
<tr>
<td>Knotty (but good)</td>
</tr>
<tr>
<td>Pith in/bad defect</td>
</tr>
<tr>
<td>Others</td>
</tr>
</tbody>
</table>

35 What sorts of technologies or utilization techniques are required to improve the visual stress grades of whitewood timbers, especially

<table>
<thead>
<tr>
<th>35 What sorts of technologies or utilization techniques are required to improve the visual stress grades of whitewood timbers, especially</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual stress grades</td>
</tr>
<tr>
<td>Clear timber</td>
</tr>
<tr>
<td>Knotty (but good)</td>
</tr>
<tr>
<td>Pith in/bad defect</td>
</tr>
<tr>
<td>Question</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Who determines the market prices of your products (you, buyers or a</td>
</tr>
<tr>
<td>negotiated price between you and the buyers)?</td>
</tr>
<tr>
<td>If the buyer determines the market prices, what market prices are you</td>
</tr>
<tr>
<td>willing to offer for these visual stress grades?</td>
</tr>
<tr>
<td>How would you assess your business relationship with your customers?</td>
</tr>
<tr>
<td>What are your market strategies to gain your consumer’s confidence and</td>
</tr>
<tr>
<td>satisfaction? How would rate their importance?</td>
</tr>
<tr>
<td>Who sets the standards (quality, quantity) of the products you are</td>
</tr>
<tr>
<td>producing, deciding when to deliver and how often?</td>
</tr>
<tr>
<td>Who monitors the set standards to make sure the products meet the</td>
</tr>
<tr>
<td>requirements, on time production and on time delivery?</td>
</tr>
<tr>
<td>What inputs comprise the highest costs in your entire operation</td>
</tr>
<tr>
<td>(materials/suppliers, labour, fuel, transport etc)?</td>
</tr>
<tr>
<td>Do you agree that processing wastes such as excess inventory,</td>
</tr>
<tr>
<td>moving of sawmill to stump site and setup of sawmill, machines</td>
</tr>
<tr>
<td>breakdown, delay in transport, delay in spare parts, etc are also</td>
</tr>
<tr>
<td>contributing to the cost of your operation?</td>
</tr>
<tr>
<td>Question</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>44 How do you manage these processing wastes?</td>
</tr>
<tr>
<td>45 Have you been changing your products over time and why?</td>
</tr>
<tr>
<td>46 Are there any other value-added or segmented products that still</td>
</tr>
<tr>
<td>should be considered for whitewood?</td>
</tr>
<tr>
<td>47 Are there any timber imports that create high competition to your</td>
</tr>
<tr>
<td>business? If yes what actions would you expect the government to</td>
</tr>
<tr>
<td>consider limiting the competition?</td>
</tr>
<tr>
<td>48 Are aware of any export markets for whitewood products</td>
</tr>
<tr>
<td>49 If you are considering value-adding your own timber what type</td>
</tr>
<tr>
<td>facilities are planning to establish to produce the desired products?</td>
</tr>
<tr>
<td>50 Are you aware or confronted by any entry barriers in the whitewood</td>
</tr>
<tr>
<td>industry creating difficulties for you to market your products and</td>
</tr>
<tr>
<td>how strongly would you agree to the following entry barriers?</td>
</tr>
<tr>
<td>51 How would you rate the importance of market and production</td>
</tr>
<tr>
<td>strategies to address these entry barriers?</td>
</tr>
<tr>
<td>52 What roles would you expect the government to act on to break down</td>
</tr>
<tr>
<td>these entry barriers and rate their importance?</td>
</tr>
<tr>
<td>Strongly disagree 1 2 3 4 5 6 Strongly agree</td>
</tr>
<tr>
<td>1 Economy of scale___________</td>
</tr>
<tr>
<td>2 Product differentiation___________</td>
</tr>
<tr>
<td>3 Capital requirement___________</td>
</tr>
<tr>
<td>4 Switching costs___________</td>
</tr>
<tr>
<td>5 Access to distribution channels___________</td>
</tr>
<tr>
<td>6 Cost disadvantages independent of scale____________________________</td>
</tr>
<tr>
<td>Government policy________________</td>
</tr>
<tr>
<td>Others________________________</td>
</tr>
<tr>
<td>1 not important 2 important 3 moderately important 4 fairly</td>
</tr>
<tr>
<td>important 5 critically important</td>
</tr>
<tr>
<td>1 Overall cost leadership___________</td>
</tr>
<tr>
<td>2 Develop segmented products___________</td>
</tr>
<tr>
<td>3 Focus market___________</td>
</tr>
<tr>
<td>4 Products advertisement and promotions__________</td>
</tr>
<tr>
<td>5 Technologies improvement___________</td>
</tr>
<tr>
<td>6 Others________________________</td>
</tr>
<tr>
<td>1 Government deregulate burden policies &amp; regulations__________</td>
</tr>
<tr>
<td>2 Government develop policies and regulations that favor market driven</td>
</tr>
<tr>
<td>whitewood industry___________</td>
</tr>
<tr>
<td>3 Government advertise and promote whitewood industry__________</td>
</tr>
<tr>
<td>4 Government provide subsidies to whitewood</td>
</tr>
</tbody>
</table>
53 Are you aware of any governance that displayed by key actors in the whitewood value chain that helps boost the whitewood industry?

1 Design and standard setting  
2 Monitoring the standards  
3 Just on time production  
4 On time delivery  
5 Advertisement and promotions  
6 Others______________________________

54 What you think would help to build the whitewood industry?

55 Have you or any of your family members attended any training on general forestry operations, nursery establishment, plantation establishment, maintenance and management and log scaling and timber volume calculations?

56 Have you or any members of your family or the sawmill operators attended any trainings on chain saw and milling operations, log scaling and timber volume calculation? If yes what institutions?

57 Have you or any of your family members attended any training on value-adding or carpentry? If yes what institution?

58 Have you or any of your family members attended any training on financial management, book keeping and marketing? If yes what institutions?

59 Have you affiliated to any association or cooperative that may assist in the harvesting of your whitewood plantation in the future?

60 If not do you think joining association or cooperative will create a better opportunities to efficiently process and market your trees in the future with other members of the association or cooperative?

61 Are you aware of any other
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>successful associations or cooperatives and what makes them successful?</td>
<td></td>
</tr>
<tr>
<td>62 Are you aware of any failed associations or cooperative and what are the reasons for them failing?</td>
<td></td>
</tr>
<tr>
<td>63 How often do you get assistance, advice and support from the department of forests? And how would you assess their support?</td>
<td>Very poor Poor Average Good Excellent 1 2 3 4 5 Provide reasons and suggestions for improvement:</td>
</tr>
<tr>
<td>64 Are there any urgent issues that you think are important for Department of Forests to address?</td>
<td></td>
</tr>
<tr>
<td>65 What policy, management strategies and regulation areas you would you like the government to review, amend or introduce to adequately boost the development of the whitewood industry in Vanuatu?</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix 3: Whitewood Processors (Timber Yards) Survey

<table>
<thead>
<tr>
<th>1</th>
<th>Researcher’s Name(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Date</td>
</tr>
<tr>
<td>3</td>
<td>Respondent’s name</td>
</tr>
<tr>
<td>4</td>
<td>Gender (Male or Female)</td>
</tr>
<tr>
<td>5</td>
<td>Age</td>
</tr>
<tr>
<td>5</td>
<td>Address (village name, Island, phone no. and GPS position)</td>
</tr>
<tr>
<td>5</td>
<td>Is this your only means of livelihood or not?</td>
</tr>
<tr>
<td>6</td>
<td>What is the capacity of your timber yard (total m³ of timber)?</td>
</tr>
<tr>
<td>7</td>
<td>How long have you been in this business?</td>
</tr>
<tr>
<td>8</td>
<td>How many people are you employing (Male and Female)?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>no. of people</th>
<th>Monthly income (vt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contract (group)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9 | Apart from whitewood what other timber species do you purchase, from where and who are your main timber suppliers and market prices (vt/m³)? |

<table>
<thead>
<tr>
<th>Species</th>
<th>Suppliers/where</th>
<th>Market price (vt/m³)</th>
</tr>
</thead>
</table>

10 | If you are importing timber, what are the timber species, market prices (vt/m³), suppliers and from what countries? |

<table>
<thead>
<tr>
<th>Species</th>
<th>Suppliers/Country</th>
<th>Market price (vt/m³)</th>
</tr>
</thead>
</table>

11 | Are you purchasing whitewood timber from plantation or natural forests? And what percentage of whitewood from plantation and natural forests? |

<table>
<thead>
<tr>
<th>Whitewood plantation</th>
<th>Natural forests</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>1. 100%</td>
</tr>
<tr>
<td>80% to 99%</td>
<td>2. 80% to 99%</td>
</tr>
<tr>
<td>60% to 79%</td>
<td>3. 60% to 79%</td>
</tr>
<tr>
<td>50% to 69%</td>
<td>4. 50% to 69%</td>
</tr>
<tr>
<td>40% to 59%</td>
<td>5. 40% to 59%</td>
</tr>
<tr>
<td>30% to 49%</td>
<td>6. 30% to 49%</td>
</tr>
<tr>
<td>20% to 39%</td>
<td>7. 20% to 39%</td>
</tr>
<tr>
<td>10% to 19%</td>
<td>8. 10% to 19%</td>
</tr>
<tr>
<td>9%=&lt;</td>
<td>9. 9%=&lt;</td>
</tr>
</tbody>
</table>

12 | How would you rate your understandings and experiences on visual stress grading of whitewood timber? |

<table>
<thead>
<tr>
<th>Very poor</th>
<th>Poor</th>
<th>Average</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Provide reasons:

---

25 All costs and prices are in Vatu (Vanuatu currency) at an exchange rate of 100 VT to 1.07 AUD (19 July 2011)
13 If you are purchasing green untreated whitewood, who are your suppliers for the different timber visual stress grades and at what market price (vt/m³)?

<table>
<thead>
<tr>
<th>Visual stress grades</th>
<th>Suppliers</th>
<th>Market prices (vt/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear timber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knotty (but good)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pith in/bad defect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14 If you are selling untreated whitewood timber, who are your buyers for the different timber visual stress grades and at what market price (vt/m³)?

<table>
<thead>
<tr>
<th>Visual stress grading</th>
<th>Buyers</th>
<th>Market prices (vt/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear timber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knotty (but good)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pith in/bad defect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15 If you are selling air seasoned whitewood, who are your buyers for the different timber visual stress grades and at what market price (vt/m³)?

<table>
<thead>
<tr>
<th>Visual stress grading</th>
<th>Buyers</th>
<th>Market prices (vt/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear timber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knotty (but good)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pith in/bad defect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16 If you are pressure treating the whitewood timber, what chemical (CCA, Tanalite, Boron etc) are you using?

1 CCA
2 Boron
3 Tanalite
4 Others

Provide reasons for choosing the chemical:

17 What are the costs (vt/m³) of pressure treating clear standard whitewood timber at different level of treatment, the cost of treatment and the market price?

<table>
<thead>
<tr>
<th>Level of Treatment</th>
<th>Clear timber</th>
<th>Cost (vt/m³)</th>
<th>Market price (vtm3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelop</td>
<td>H1</td>
<td>H2</td>
<td>H3</td>
</tr>
<tr>
<td></td>
<td>H4</td>
<td>H5</td>
<td>H6</td>
</tr>
</tbody>
</table>

18 What are the costs (vt/m³) of pressure treating knotty (but good) whitewood timber at different level of treatment, the cost of treatment and the market price?

<table>
<thead>
<tr>
<th>Level of Treatment</th>
<th>Knotty (but good)</th>
<th>Cost (vt/m³)</th>
<th>Market price (vtm3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelop</td>
<td>H1</td>
<td>H2</td>
<td>H3</td>
</tr>
<tr>
<td></td>
<td>H4</td>
<td>H5</td>
<td>H6</td>
</tr>
</tbody>
</table>

19 What are the costs (vt/m³) of pressure treating pith-in/bad defect standard whitewood timber at different level of treatment, the cost of treatment and the market price?

<table>
<thead>
<tr>
<th>Level of Treatment</th>
<th>Pith-in/bad defect</th>
<th>Cost (vt/m³)</th>
<th>Market price (vtm3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelop</td>
<td>H1</td>
<td>H2</td>
<td>H3</td>
</tr>
<tr>
<td></td>
<td>H4</td>
<td>H5</td>
<td>H6</td>
</tr>
</tbody>
</table>

20 Who are your main customers for the different hazard classes of whitewood

<table>
<thead>
<tr>
<th>Visual stress grades</th>
<th>Buyers</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear timber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Options</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| timber treatment mentioned above?                                       | Knotty  
Pith-in/bad defect  
Others                                                                 |
| 21 Are you operating a kiln dryer? If yes what are the costs (vt/m³) of kiln dying of whitewood timber and what are the market prices (vt/m³) and who are your main customers? | Visual stress grades  
Clear timber  
Knotty (but good)  
Pith-in/bad defect  
Others  
Buyers  
Market prices (vt/m³)                                                                 |
| 22 Are you air seasoned the whitewood timbers? If yes what are the market prices (vt/m³) and who are your main customers? | Visual stress grades  
Clear timber  
Knotty (but good)  
Pith-in/bad defect  
Others  
Buyers  
Market prices (vt/m³)                                                                 |
| 23 How would you describe your business relationship with your customers? | Very poor  
Poor  
Average  
Good  
Excellent  
1  
2  
3  
4  
5  
Provide reasons:                                                                 |
| 24 What are your market strategies to gain your consumer’s confidence and satisfaction? How would you rate their importance? | 1 not important  
2 important  
3 moderately important  
4 fairly important  
5 critically important  
1 Quality  
2 Quantity  
3 Just in time production  
4 On time deliver  
5 Affordable prices  
6 Good service delivery  
Others                                                                 |
| 25 Who sets the standards (quality, quantity) of the products you are producing, deciding when to deliver and how often? | Provide reasons:                                                                 |
| 26 Who monitors the set standards to make sure the products meets the requirements, on time production and on time delivery? |                                                                                           |
| 27 What inputs comprise the highest costs in your entire operation (materials/suppliers, labour, energy, transport etc)? | Provide reasons for your rating:                                                            |
| 28 Would you say processing wastes such as excess inventory, moving of sawmill to stump site and setup of sawmill, machines breakdown, delay in transport, delay in spare parts, etc are also contributing to the cost of your operation? | Strongly disagree  
1  
2  
3  
4  
5  
6 Strongly agree  
Provide reasons for your rating:                                                            |
<p>| 29 How do you manage these process wastes?                               |                                                                                           |</p>
<table>
<thead>
<tr>
<th>Question</th>
<th>Options / Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 Have you been changing your products over time and why?</td>
<td></td>
</tr>
<tr>
<td>31 Are there any other value-added or segmented products that still should be considered for whitewood?</td>
<td></td>
</tr>
<tr>
<td>32 Are there any timber imports that create high competition to your business? If yes what actions would you expect the government to consider limiting competition?</td>
<td></td>
</tr>
<tr>
<td>33 Are you planning to improve your production to value-adding in the future?</td>
<td></td>
</tr>
</tbody>
</table>
| 34 If you are considering value-adding your own timber what types facilities are planning to establish to produce the desire products? | 1 Timber yard  
2 Timber yard with timber treatment, specify treatment__________________  
3 Furniture making  
4 Others________________________  |
| 35 Are you aware or confronted of any entry barriers in the whitewood industry that are creating difficulties for you to market your products? | Strongly disagree 1 2 3 4 5 6 Strongly agree  
1 Economy of scale_________  
2 Product differentiation_________  
3 Capital requirement_________  
4 Switching costs_________  
5 Access to distribution channels_________  
6 Cost disadvantages independent of scale_________  
7 Government policy_________  
Others_________________________  |
| 36 How would you rate the importance of market and production strategies to address the entry barriers? | 1 not important 2 important 3 moderately important 4 fairly important 5 critically important  
1 Overall cost leadership_________  
2 Develop segmented products_________  
3 Focus market_________  
4 Products advertisement and promotions_________  
5 Technologies improvement_________  
6 Others_________________________  |
| 37 What roles would you expect the government to act on to break down these entry barriers and rate their importance? | 1 not important 2 important 3 moderately important 4 fairly important 5 critically important  
1 Government deregulate burden policies & regulations_________  
G2 Government develop policies and regulations that favor market driven whitewood industry_________  
3 Government advertise and promote whitewood industry_________  
4 Government provide subsidies to whitewood industry_________  
5 Others_________________________  |
38 Are you aware of any governance that displayed by key actors in the whitewood value chain that helps boost the whitewood industry?

1 Design and standard setting  
2 Monitoring the standards  
3 Just on time production  
4 On time delivery  
5 Advertisement and promotions  
Others ________________________________

39 What you think would help to build the whitewood industry?

40 Have you or any of your employers attended any training on general forestry operations, nursery establishment, plantation establishment, maintenance and management and log scaling and timber volume calculations?

F/member  Training  Institutions  Year

41 Have you or any of your employers or the sawmill operators attended any training on chain saw and milling operations, log scaling and timber volume calculation? If yes what institutions?

F/member  Training  Institutions  Year

42 Have you or any of your employers attended any training on value-adding or carpentry? If yes what institution(s)?

F/member  Training  Institutions  Year

43 Have you or any of your employers attended any training on financial management, book keeping and marketing? If yes what institutions?

F/member  Training  Institutions  Year

44 What policy, management strategies and regulation areas you would you like the government to review, amend or introduce to adequately boost the development of the whitewood industry in Vanuatu?
### Appendix 4: Whitewood Processors (Furniture makers) Survey

<table>
<thead>
<tr>
<th>1 Researcher’s Name(s)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Date</td>
<td></td>
</tr>
<tr>
<td>3 Respondent’s name</td>
<td></td>
</tr>
<tr>
<td>4 Gender (Male or Female)</td>
<td></td>
</tr>
<tr>
<td>5 Age</td>
<td></td>
</tr>
<tr>
<td>6 Address (village name, Island, phone no. and GPS position)</td>
<td></td>
</tr>
<tr>
<td>7 How long have you been in this business?</td>
<td></td>
</tr>
<tr>
<td>8 Is this your only way of livelihood or not?</td>
<td></td>
</tr>
</tbody>
</table>
| 9 How many people are you employing (Female & Male)? | Gender | no. of people……Monthly income (vt)
|                        | Female |   |
|                        | Male   |   |
|                        | Contract (group) |   |
|                        | Others |   |
| 10 Apart from whitewood what other local species do you purchase and who are your main timber suppliers and what are the market prices (vt\$/m^3)? | Species | Suppliers | Market price (vt/m^3) |
| 11 If you are purchasing imported timber, what species, market prices (vt/m3), suppliers and countries? | Species | Suppliers/Country | Market price (vt/m^3) |
| 12 Are you purchasing whitewood timbers from the plantation or the natural forests? And what percentage of timber from plantation and natural forests? | Whitewood plantation | Natural forests
| 1 100% | 1. 100% |
| 2 80% to 99% | 2. 80% 99% |
| 3 60% to 79% | 3. 60% to 79% |
| 4 50% to 69% | 4. 50% to 69% |
| 5 40% to 59% | 5. 40% to 59% |
| 6 30% to 49% | 6. 30% to 49% |
| 7 20% to 39% | 7. 20% to 39% |
| 8 10% to 19% | 8. 10% to 19% |
| 9 9%< | 9. 9%< |
| 13 How would you rate your understandings and experiences on visual stress grading of whitewood timber? | Very poor | Poor | Average | Good | Excellent
| | 1 | 2 | 3 | 4 | 5 |
| Provide reasons: | |
| 14 If you are purchasing green untreated whitewood, who are your suppliers for Visual stress grades | Suppliers | Market prices (vt/m^3)
| Clear timber | |

26 All costs and prices are in Vatu (Vanuatu currency) at an exchange rate of 100 VT to 1.07 AUD (19 July 2011)
<table>
<thead>
<tr>
<th>Question</th>
<th>Visual stress grading</th>
<th>Suppliers</th>
<th>Market prices (vt/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 If you purchasing air seasoned whitewood timbers, who are your suppliers for these types of visual stress grades and at what market prices (vt/m³)?</td>
<td>Clear timber</td>
<td>Knotty (but good)</td>
<td>Pith in/bad defect</td>
</tr>
<tr>
<td>16 If you purchasing kiln drying whitewood timbers, who are your suppliers for these types of visual stress grades and at what market prices (vt/m³)?</td>
<td>Clear timber</td>
<td>Knotty (but good)</td>
<td>Pith in/bad defect</td>
</tr>
<tr>
<td>17 How do you find the price of the whitewood products (too high/too low/ok etc)</td>
<td>Clear timber</td>
<td>Knotty (but good)</td>
<td>Pith in/bad defect</td>
</tr>
<tr>
<td>18 If quality is improved will you be willing to pay more? How much more?</td>
<td>Very poor</td>
<td>Poor</td>
<td>Average</td>
</tr>
<tr>
<td>19 If you buying pressure treated whitewood timbers, do you know what chemical is used and what are your understandings and experiences on hazards classes of timber treatment?</td>
<td>Clear timber</td>
<td>Knotty (but good)</td>
<td>Pith in/bad defect</td>
</tr>
<tr>
<td>20 Who are your main suppliers for pressure treated whitewood, timbers, market prices (vt/m³) and for of various treatment (envelop, H1 to H6)?</td>
<td>Clear timber</td>
<td>Knotty (but good)</td>
<td>Pith-in/bad defect</td>
</tr>
<tr>
<td>21 What are the value-added products produced from air seasoned whitewood timbers?</td>
<td>Clear timber (vt/m³)</td>
<td>Products</td>
<td>Processing costs</td>
</tr>
<tr>
<td>22 What are the value-added products produced from kiln drying whitewood timbers?</td>
<td>Clear timber (vt/m³)</td>
<td>Products</td>
<td>Processing costs</td>
</tr>
<tr>
<td>Question</td>
<td>Other grades (vt/m³)</td>
<td>Clear timber (vt/m³)</td>
<td>Knotty timbers (vt/m³)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>23 What are the value-added products produced from pressure treated of</td>
<td>Products Processing costs Market prices Customers</td>
<td>Products Processing costs Market prices Customers</td>
<td>Products Processing costs Market prices Customers</td>
</tr>
<tr>
<td>whitewood timbers?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Which of the whitewood timber do you use most in your value-adding;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>air season untreated, pressure treated or kiln seasoned and why?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 How would you assess your business relationship with your customers?</td>
<td>Very poor Poor Average Good Excellent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 What are your market strategies to gain your consumer’s confidence</td>
<td>1 not important 2 important 3 moderately important 4 fairly important 5 critically</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and satisfaction? How would you rate their importance?</td>
<td>important</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 Who sets the standards (design, quality, quantity) of the products you</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>are producing, deciding when to deliver and how often?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 Who monitors the set standards to make sure the set standards are met,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>including on time delivery?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 What inputs comprise the highest costs of your entire operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(materials/suppliers, labour, energy, transport etc)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 How strongly would you consider processing wastes such as excess</td>
<td>Strongly disagree 1 2 3 4 5 6 Strongly agree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>inventory, moving of sawmill to stump site and setup of sawmill,</td>
<td>Provide reasons for your rating:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>machines breakdown, delay in transport, delay in spare parts, etc are</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>also major cost of your operation?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 How do you manage these process</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Answer Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 Would you categorised your manufacturing as lean production and just in time?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33 Who are your major competitors?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34 Assessing the importance of whitewood timber to your company, out of five how would you rate the whitewood timber?</td>
<td>1 not important 2 important 3 moderately important 4 fairly important 5 critically important</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Quality:__________  
Process innovation capacity:__________  
Price:__________  
Delivery reliability:__________  
Location:_____________ |
| 35 Have you been changing your products over time and why?               |                |
| 36 Are there any other value-added products or segmented products that still should be considered for whitewood? Please list. |                |
| 37 Are there any furniture imports that create high competition to your business? If yes what actions would you expect the government to consider limiting competitions? |                |
| 38 Are you planning to improve your value-adding in the future?          |                |
| 39 What type of facilities are you planning to establish to produce the desire products? |                |
| 40 Are you aware or confronted by any entry barriers in the whitewood industry creating difficulties for you to market your products and how strongly would you agree to the following entry barriers? | Strongly disagree 1  2  3  4  5  6 Strongly agree |
| 1 Economy of scale:__________  
2 Product differentiation:__________  
3 Capital requirement:__________  
4 Switching costs:__________  
5 Access to distribution channels:__________  
6 Cost disadvantages independent of scale:__________  
7 Government policy:__________  
8 Others:__________ |
| 41 How would you rate the importance of market and production strategies to address the entry barriers? | 1 not important 2 important 3 moderately important 4 fairly important 5 critically important |
| 1 Overall cost leadership:__________  
2 Develop segmented products:__________ |
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>42. What roles would you expect the government to act on to break down</td>
<td>1. Government deregulate burden policies &amp; regulations</td>
</tr>
<tr>
<td>these entry barriers and rate their importance?</td>
<td>2. Government develop policies and regulations that favor market driven</td>
</tr>
<tr>
<td></td>
<td>3. Government advertise and promote whitewood industry</td>
</tr>
<tr>
<td></td>
<td>4. Government provide subsidies to whitewood industry</td>
</tr>
<tr>
<td></td>
<td>5. Others</td>
</tr>
<tr>
<td>43. Are you aware of any governance that displayed by key actors in</td>
<td>1. Design and standard setting</td>
</tr>
<tr>
<td>the whitewood value chain that helps boost the whitewood industry?</td>
<td>2. Monitoring the standards</td>
</tr>
<tr>
<td></td>
<td>3. Just on time production</td>
</tr>
<tr>
<td></td>
<td>4. On time delivery</td>
</tr>
<tr>
<td></td>
<td>5. Advertisement and promotions</td>
</tr>
<tr>
<td></td>
<td>Others</td>
</tr>
<tr>
<td>44. What you think would help to build the whitewood industry?</td>
<td></td>
</tr>
<tr>
<td>45. Have you or any of your employers attended any trainings or</td>
<td>F/member Training Institutions Year</td>
</tr>
<tr>
<td>awareness on general forestry operations and especially wood</td>
<td></td>
</tr>
<tr>
<td>technology? If yes what institution(s)?</td>
<td></td>
</tr>
<tr>
<td>46. Have you or any of your employers attended any training on value-</td>
<td>F/member Training Institutions Year</td>
</tr>
<tr>
<td>adding or carpentry? If yes what institution(s)?</td>
<td></td>
</tr>
<tr>
<td>47. Have you or any of your employers attended any training on</td>
<td>F/member Training Institutions Year</td>
</tr>
<tr>
<td>financial management, book keeping and marketing? If yes what</td>
<td></td>
</tr>
<tr>
<td>institutions?</td>
<td></td>
</tr>
<tr>
<td>48. What policy, management strategies and regulation areas you would</td>
<td></td>
</tr>
<tr>
<td>like the government to review, amend or introduce to adequately boost</td>
<td></td>
</tr>
<tr>
<td>the development of the whitewood industry in Vanuatu?</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5: Whitewood Consumers Survey

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Researcher’s Name(s)</td>
</tr>
<tr>
<td>2</td>
<td>Date</td>
</tr>
<tr>
<td>3</td>
<td>Respondent’s name</td>
</tr>
<tr>
<td>4</td>
<td>Gender (Male or Female)</td>
</tr>
<tr>
<td>5</td>
<td>Age</td>
</tr>
<tr>
<td>6</td>
<td>Address (village name, Island, phone no. and GPS position)</td>
</tr>
<tr>
<td>7</td>
<td>Type of consumers?</td>
</tr>
<tr>
<td>8</td>
<td>How long have you been in this business?</td>
</tr>
<tr>
<td>9</td>
<td>How many people are you employing?</td>
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<td></td>
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</tr>
<tr>
<td>10</td>
<td>Apart from whitewood what other local timber species are you using, from where and who are your main timber suppliers?</td>
</tr>
<tr>
<td>11</td>
<td>If you are purchasing imported timber, what species, market prices (vt/m$^3$), supplies and countries?</td>
</tr>
<tr>
<td>12</td>
<td>If you are purchasing green untreated whitewood, who are your suppliers for these types of visual stress grades and at what market prices (vt/m$^3$)</td>
</tr>
<tr>
<td>13</td>
<td>If you are purchasing air seasoned whitewood timber, who are your suppliers for these types of visual stress grades and at what market prices (vt/m$^3$)</td>
</tr>
<tr>
<td>14</td>
<td>If you are purchasing kiln seasoned whitewood timber, who are your suppliers for these types of visual stress grades and at what market prices (vt/m$^3$)</td>
</tr>
</tbody>
</table>

27 Consumers are end users of whitewood, they only buy whitewood products and use and not sell (construction companies, individuals, etc).

28 All costs and prices are in Vatu (Vanuatu currency) at an exchange rate of 100 VT to 1.07 AUD (19 July 2011)
<table>
<thead>
<tr>
<th>Question</th>
<th>Clear timber</th>
<th>Supplier</th>
<th>Visual stress grading</th>
<th>Untreated</th>
<th>A/seasoned</th>
<th>Kiln</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 How do you find the price of the whitewood products (too high/low/ok etc)?</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Suppliers</td>
<td>Market prices (vt/m³)</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Price</td>
<td></td>
</tr>
<tr>
<td>16 If quality is improved will you be willing to pay more? How much more?</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Suppliers</td>
<td>Market prices (vt/m³)</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Delivery reliability</td>
<td></td>
</tr>
<tr>
<td>17 If you are buying pressure treated whitewood timber, do you know what chemical is used and what are your understandings and experiences on hazards class for timber treatment?</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Suppliers</td>
<td>Market prices (vt/m³)</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>18 Who are your main suppliers for pressure treated whitewood timbers, market prices (vt/m³) and for various treatment (envelop, H1 to H6)?</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Suppliers</td>
<td>Market prices (vt/m³)</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Process innovation capacity</td>
<td></td>
</tr>
<tr>
<td>19 How would you describe your business relationship with your suppliers (good, very good or excellent)?</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Suppliers</td>
<td>Market prices (vt/m³)</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Quality</td>
<td></td>
</tr>
<tr>
<td>20 Who sets the standards (quality, quantity) of the products you are purchasing, deciding when to deliver and how often?</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Suppliers</td>
<td>Market prices (vt/m³)</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Process innovation capacity</td>
<td></td>
</tr>
<tr>
<td>21 Who monitors the sets standards to make sure the set standards are met, and on time delivery</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Suppliers</td>
<td>Market prices (vt/m³)</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Process innovation capacity</td>
<td></td>
</tr>
<tr>
<td>22 Assessing the importance of whitewood timber for your consumption, out of five how would you rate the whitewood timber?</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Suppliers</td>
<td>Market prices (vt/m³)</td>
<td>Clear timber Knotty (but good) Pith in/bad defect Others</td>
<td>Process innovation capacity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rating</th>
<th>1 not important</th>
<th>2 important</th>
<th>3 moderately important</th>
<th>4 fairly important</th>
<th>5 critically important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Process innovation capacity</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Price</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Delivery reliability</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Location</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>23 Are there any other value-added products or segmented products that still to be considered for whitewood? Please list.</td>
<td></td>
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</tr>
<tr>
<td>24 Do you ever purchase any imported furniture or timber and how could you compare the market prices and the quality of the products compare to whitewood?</td>
<td>Species</td>
<td>Suppliers/Country</td>
<td>Market price (vt/m³)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 What policy, management strategies and regulation areas you would you like the government to review, amend or introduce to adequately boost the development of the whitewood industry in Vanuatu?</td>
<td></td>
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<td></td>
<td></td>
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</tbody>
</table>