

Constraints to whitewood (*Endospermum medullosum*) plantation development on Santo Island, Vanuatu

R. ARU¹, J.D. NICHOLS², J.C. GRANT², A.J. LEYS², K. GLENCROSS², M. SETHY³, K. CONVERY⁴ and R. VIRANAMANGGA³

¹*Melcoffee Sawmills and Vanuatu Agricultural College, Luganville, Espiritu Santo, Vanuatu*

²*Forest Research Centre, School of Environment, Science and Engineering, Southern Cross University, Lismore, NSW, Australia*

³*Department of Forests Vanuatu, Luganville, Santo, Vanuatu*

⁴*Australian Youth Ambassadors in Development; Southern Cross University*

Email: doland.nichols@scu.edu.au

SUMMARY

Valuable timber trees in accessible sites in Vanuatu have been mostly removed by logging. There are large areas where plantations would likely be successful. Yet plantation establishment among landholders in Vanuatu has been limited to date, even with considerable extension support. There has been little systematic investigation of why this has occurred. The purpose of this research was to identify constraints to whitewood (*Endospermum medullosum*) plantation development. A participatory social research approach was used on Espiritu Santo Island to look for trends in attitudes toward plantations. This was achieved through the use of mixed methods social research to survey 139 local landholders from 42 villages. Most landholders on Santo Island were not convinced that there are good reasons to plant whitewood, at least not in large extensions. Future efforts should be focused on the development of local capacity for plantation establishment, maintenance, processing and export marketing, at a variety of scales.

Keywords: sustainable forest management, agroforestry systems, traditional land-use, plantation development, livelihoods

Contraintes affectant le développement des plantations de bois blanc (*Endospermum medullosum*) sur l'île Santo, Vanuatu

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Les arbres de bois de coupe de valeur dans les sites accessibles à Vanuatu ont été pour la plupart éclaircis par la coupe. Il existe de vastes zones où les plantations seraient à même d'avoir du succès. Cependant, l'établissement des plantations a été limitée chez les propriétaires terriens de Vanuatu jusqu'à présent, malgré un support considérable pour les extensions. Il n'y a eu que très peu d'investigations systématiques pour comprendre les raisons de cette timidité. Le but de cette recherche a été d'identifier les contraintes affectant le développement des plantations de bois blanc (*Endospermum medullosum*). Une approche de recherche sociale participative a été utilisée sur l'île Espiritu Santo pour chercher des courants dans l'attitude vis à vis des plantations. Ils ont été obtenus en utilisant des méthodes mixtes de recherche sociale pour interviewer 139 propriétaires locaux provenant de 42 villages différents. La plupart des propriétaires de l'île Santo n'étaient pas convaincus de l'existence de bonnes raisons pour planter du bois blanc, du moins, pas en extensions larges. Les efforts futurs devraient se concentrer sur le développement de la capacité locale d'établir, de maintenir, de traiter, et d'effectuer le marketing des exportations des plantations, à une variété d'échelles.

Barreras al desarrollo de plantaciones de *Endospermum medullosum* en la isla de Espiritu Santo, Vanuatu

R. ARU, J.D. NICHOLS, J.C. GRANT, A.J. LEYS, K. GLENCROSS, M. SETHY, K. CONVERY y R. VIRANAMANGGA

En Vanuatu, los árboles de especies maderables valiosas han sido talados en su mayoría en los lugares accesibles. Existen grandes áreas donde las plantaciones tendrían una gran probabilidad de éxito. Sin embargo, el establecimiento de plantaciones en Vanuatu por parte de propietarios ha sido limitado hasta la fecha, a pesar del considerable apoyo de los servicios de extensión. Apenas se han realizado estudios sistemáticos para averiguar por qué sucede esto. El propósito de esta investigación fue identificar impedimentos al desarrollo de plantaciones de *Endospermum medullosum*. Se empleó un enfoque de investigación social participativa en la isla de Espiritu Santo, en busca de pautas de comportamiento y actitudes respecto de las plantaciones. Esto se logró mediante el empleo de una mezcla de métodos de investigación social a través de una encuesta a 139 propietarios locales residentes en 42 localidades. La mayoría de propietarios de la isla de Espiritu Santo no estaban convencidos

de que existan buenas razones para plantar *Endospermum medullosum*, sobre todo en grandes extensiones. Los esfuerzos futuros deberían centrarse en el desarrollo a diferentes escalas de la capacidad local para el establecimiento de plantaciones, así como para el mantenimiento, procesamiento y comercialización para la exportación.

INTRODUCTION

Vanuatu's forests and people

Vanuatu is an archipelago of 83 islands in the south-west Pacific with approximately 36% forest cover (>10m tree height), another 34% in lower woody vegetation. The island chain is vulnerable to tropical cyclones between the months of January to April (Bakeo *et al.* 2003, Hickey 2008). The islands of Vanuatu have been settled for approximately three thousand years. Before European settlement the population of Vanuatu may have been as high as one million. Colonisation by European peoples caused steep declines in population due to disease, 'blackbirding' and other impacts. By the beginning of the nineteenth century the well-watered and fertile areas of the islands were supporting around 500,000 people. The current population is approximately 229,000, divided into around 110 different cultural-linguistic groups with 80% still living subsistence livelihoods (Regenvanu *et al.* 1997, Hickey 2008).

Colonial rule was instituted in 1906 with a condominium government shared between France and England, leading to massive changes in land-use and loss of traditional practices (Nari 2000). Since 1980 when independence was achieved, there has been a large escalation in land disputes, given that traditional patterns of ownership had been disrupted by Europeans followed by uncertain rules in a newly independent country. Until recently most land has been under customary communal tenure; estimates were that 97–98% of land in Vanuatu was in communal ownership (Nari 2000, Codippily 1996). Long-term leases for both ni-Van people and foreigners (especially for tourism development) have become problematic in that under the constitution lease agreements are not supposed to be prejudicial to the custom owners of the land, to other indigenous people or to the country as a whole but the government has not always enforced these provisions (Regenvanu 2008).

As in other Pacific Island nations, native stands of timber have been under considerable pressure from clearing for agriculture and for domestic and export timber production. During the period prior to colonial rule much deforestation took place for shifting cultivation and by the time of arrival of Europeans there were large cultivated areas and anthropomorphic grasslands. Sandalwood (*Santalum austrocaledonicum*) was heavily exploited from 1825 for export to China and other Asian countries. The exploitation of whitewood, *Endospermum medullosum*, from native forests, among other native tree species, has been an important economic activity and has virtually exhausted whitewood resources in accessible areas in native forest (Vutilolo *et al.* 2005, 2008).

Value of whitewood in plantations

In 1996 the Vanuatu government, through the Vanuatu National Forest policy, set a goal of establishing 20,000 hectares of forest plantations by 2023 (Department of Forests 1999). The Vanuatu forest industry has led the development of whitewood as a plantation species with private commercial scale plantations and associated processing infrastructure. Small community based plantings of whitewood have also expanded during the past decade in the form of agroforestry plantings or woodlots. The Department of Forests has also encouraged planting of the species by small-holder farmers by providing seedlings and silvicultural information (Thomson 2006).

This native species, a fast-growing pioneer species, and a primary target of loggers working in native forests, has been an obvious candidate for domestication since at least the mid-1980s. Its growth is quite rapid in the first five years or so (Thomson 2006), and reasonable estimates of production of 15–20 m³/ha/yr for 15–20 years have been made (Bartlett 1996, European Union *et al.* 1998, DPI Forestry Queensland 2000, Thomson 2006). The South Pacific Regional Initiative on Forest Genetics (SPRIG) was an AusAID program that lasted from 1996 to 2006 and concentrated on conserving forest genetic resources and on the domestication of key tree species in Vanuatu, Solomon Islands, Fiji, Tonga and Samoa. Whitewood was the major species studied in Vanuatu and through this project and other initiatives in Vanuatu protocols for seed collection, nursery techniques, and plantation establishment were developed.

Whitewood is not durable in contact with the soil or moisture but can be employed for structural purposes as well as indoor uses where a plain, white, characterless appearance is desired. This latter characteristic has made it possible to sell material such as moulding into Japan at a premium price. A strategy for genetic conservation and tree improvement in whitewood was devised in 1999 (Corrigan 1999) and that same year a provenance trial/seed orchard was established near Shark Bay (SPRIG 1997, 2002). Growth rates are high, with mean annual increments of plantation whitewood reaching 25–29 m³/ha/yr (Vutilolo *et al.* 2008, Grant *et al.* 2012), and the variation in growth by provenance and family is well understood (Vutilolo *et al.* 2005, 2008, Doran *et al.* 2012).

The timber of whitewood is used locally, especially in preservative-treated form, for light construction, furniture and interior joinery, and there is a significant local value-adding industry providing sawn timber and edge-glued panels for export to Japan (Thompson 2006). There is a ban on round log exports to Japan by the Vanuatu government aimed at facilitating local employment opportunities and value-adding timber products prior to export (McGregor and McGregor 2010). Samples of plantation material have shown timber

quality to be comparable to that from natural forest that is easily processed, white in colour and highly stable, producing acceptable quality timber for domestic purposes or that can be value-added into sawn boards and finger-jointed lumberboards for export (SPRIG 2002). The amenability of the species to plantation silviculture, short rotation length (thinned at 5 to 10 years, 15 year final harvest) (Nichols 2003) and the high quality of plantation timber suggests that the species has sound potential to form the basis of a local plantation and value-adding industry.

The silvicultural prescriptions outlined in Thompson (2006) have been empirically tested and are being quantitatively verified by the current Australian Centre for International Agricultural Research (ACIAR) project, 'Improved silvicultural management of *Endospermum medullosum* (whitewood) for enhanced plantation forestry outcomes in Vanuatu' (see <http://aciarc.gov.au/project/FST/2005/089>). Large investors have misgivings about traditional Melanesian customs regarding land and tree ownership, questioning the security of ownership (Bazeley and Mullen 2006). Finally local landholders are not certain of the price they will receive for any trees they might grow nor do they yet have the capacity to harvest and add value to timber products themselves.

Several islands of Vanuatu have significant areas suitable for plantations: Erromango (4 000 ha), Malekula (3 000 ha), Vanua Lava (2,000 ha) and Efate (2,000 ha) (Bazeley and Mullen 2006). On Santo island soil surveys combined with a Geographic Information System assessment by the authors reveal approximately 69,000 ha suitable for whitewood plantations. With the current stands of whitewood of approximately 400 ha on Santo, the plantation estate has only begun to be established. Since the 1980s there have been numerous studies and consultant reports on the potential to create a significant plantation resource of whitewood on Santo, particularly at a site called the Industrial Forestry Plantation, near Shark Bay (Leslie 1994, Bennett 1989, Keating 1989, European Union *et al.* 1998, DPI Forestry 2000, Department of Forests Vanuatu 2002, Nichols 2003, Bazeley and Mullen 2006). These have generally concluded that, with the high growth rate of whitewood, the presence of idle land, and availability of inexpensive labour, whitewood plantations would be a reasonable investment. These reports have suggested that a 5,000 ha piece of land near Shark Bay could in fact support a local plantation-based community, either through a large enterprise which supplies jobs or through smaller landholder-based plantings, where value is added locally. Neither of these options has yet taken place.

This paper addresses several questions:

- (i) What areas of whitewood have already been established and how much whitewood do local landholders intend to plant? Are there other tree species that landholders have planted and/or intend to plant in the future?
- (ii) If landholders were to establish whitewood plantations, what systems would they use? Would they combine their trees with traditional mixed agroforestry gardens, existing coconut plantations, or single

crops like peanuts and kava? What spacings would they use?

- (iii) What other land-uses are in competition with plantation forestry for livelihood support?
- (iv) What are the constraints for individual landholders in establishing whitewood plantations?
- (v) What mechanisms could help overcome the identified constraints that could improve livelihoods of indigenous people in Vanuatu?

METHODS

Case study regions

Espirito Santo Island (often shortened to 'Santo') covers an area of 3 956 square kilometres. Most terrestrial areas were originally dominated by rainforest (Mueller-Dombois and Fosber 1998) and soils are predominantly highly fertile brown volcanic loams over ancient coral platforms (Melteras *et al.* 2008). The main population centre is Luganville with a population of approximately 10,700; the remainder reside in small villages and engage in subsistence farming. The island was divided into three main geographical regions, commonly referred to by local people, of relatively equal size from north to south, for comparison of existing and potential plantation areas between regions, and for developing regional insights on attitudes towards whitewood (Figure 1).

Participatory social research

Participatory social research techniques were employed to collect survey data from small landholders on Santo Island, Vanuatu. These included structured interviews, with a total of 139 interviews being conducted by ni-Vanuatu project staff throughout the year 2008. The advantages of having indigenous workers employed included ability to speak local languages, quickly develop trust among local people, and foster participation in the project. The ability to develop trust in communities was also considered an important criterion for effective participatory research by Leys and Vanclay (2010, 2011).

All local landholders from a village were invited to participate, to prevent bias that could have occurred through selective sampling. The mixed methods approach was considered the most suitable for obtaining information on areas of existing and potential plantings while eliciting additional information on reasons, rationalisations, arguments and constraints (Table 1) that would help the research team develop greater insights for predicting future plantation opportunities and mechanisms for further community engagement.

Survey design

Survey questions were developed through collaboration of all authors on the ACIAR project. This is a four-year project lead by Southern Cross University, focused on developing and providing information on best practices for management of plantations of whitewood. One of the objectives of the project

FIGURE 1 Case study regions for plantation assessment of Whitewood on Santo Island, Vanuatu. (Map by Greg Luker, Geographic Information Systems Laboratory Manager, SCU, 10-12-2010)

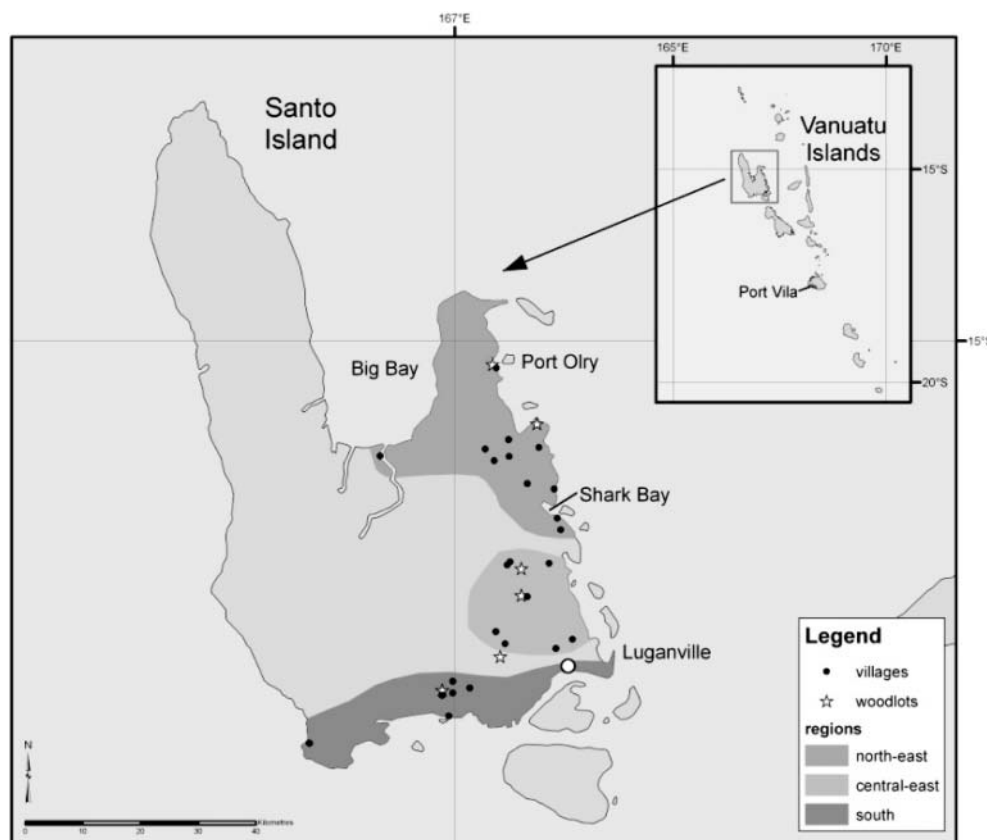


TABLE 1 Synthesis of questions asked and analysis applied in Santo Island landholder survey

Mixed method approach	Theme covered in questions	Analysis applied
Quantitative	Areas and age of whitewood plantings Spacing of whitewood trees in woodlots Types and areas of other tree species and food crops grown Additional areas of land available for whitewood versus areas willing to plant Number of people land areas support	Anova (Analysis of Variance) and descriptive statistics using SPSS (Statistical Package for the Social Sciences)
Qualitative	Attitudes towards whitewood plantations Inter-row crops grown and marketing details Reasons for tree/crop selections Type of land best suited for plantations	Thematic coding and inductive analysis

was to evaluate the effects of approximately 25 years of promotion of tree planting, specifically to assess the development of whitewood plantations and the intentions of landholders to establish more plantings.

The questions were designed to elicit information from landholders on areas currently planted to whitewood, land available for future whitewood planting, and subsistence crops grown under whitewood (Table 1). Questions related to attitudes towards plantation forestry, and marketing timber and crop produce to develop insights into interest and constraints for further whitewood plantation development.

Landholders were asked if they would plant whitewood in monocultures, mixed species, or agroforestry combinations.

Categorical and quantitative data was analysed using analysis of variance techniques (Table 1). In addition, qualitative data was analysed using thematic coding to determine emerging themes in attitudes and constraints to plantation development among landholders (Leys and Vanclay 2010).

A total of 139 one-on-one interviews were conducted with participants from 42 villages across the three regions. These were held in the local language Bislama, however translation was done at the time to complete surveys in English. The

average age of the respondents was 46 years, and 100% were male. The respondents were all local landholders as confirmed by the Department of Forests Vanuatu.

Given the large number of surveys completed in each of the regions, findings were considered representative of landholders from three major inhabited regions across Santo.

RESULTS

Land areas planted and available for whitewood plantations

Data on the distribution of whitewood areas planted and prepared to be planted by landholders from the three regions of Santo Island are presented in Table 2. The average areas of whitewood already established did not vary significantly across regions; although landholders from the central-east had the largest areas planted, on average at 1.0 hectares, and the south-east the smallest at 0.4 hectares. Notable among the responses was the finding that fewer than half of the landholders interviewed from the central-east and south-east regions were willing to plant additional areas of whitewood on remaining arable land (at 45% and 42% respectively), while the majority of respondents in the north-east said they were willing to plant more whitewood (80.2%). Respondents indicated that the major types of land available for future planting were 'flat' areas (92% of respondents), and also 'dark bush' areas (88%). Flat areas were described by participants as those areas that were not sloping or hilly, while dark bush areas were those that remained under dense natural forest, in contrast with brushy secondary forest. Fewer respondents considered areas such as their vegetable gardens (25%), hill country (9%) and pasture country (3%) as being suitable by their standards for plantations or woodlots, and less than 1%

considered planting on the customary lands or leased land available.

The total area planted in whitewood amongst 139 landholders interviewed added up to 63 ha, as estimated by the landholders themselves (though it is not entirely clear that they had proper understanding of the size of a hectare), with average area planted to whitewood being less than one ha. Even if many more landholders were identified it is unlikely that more than a few hundred ha of whitewood plantations would exist in this small woodlot form. One enterprise, Melcoffee Sawmills, planted approximately 270 ha of whitewood in 1993, which is now being harvested. The Department of Forests Vanuatu does not currently have a data base that quantifies the actual number of trees or of ha established in plantations, either on Santo Island or in the main office in Port Vila, Efate.

Landholder attitudes towards whitewood plantation establishment

While 98% of surveyed landholders claimed they strongly supported the development of whitewood plantations in general, 6% of landholders who had grown them in the past did not plan to plant more in the future (Figure 2). Reasons given included lack of land area available for woodlots, and need to use land for food crops. Interestingly 37% of participants who had not grown whitewood in the past all planned to try them in the future.

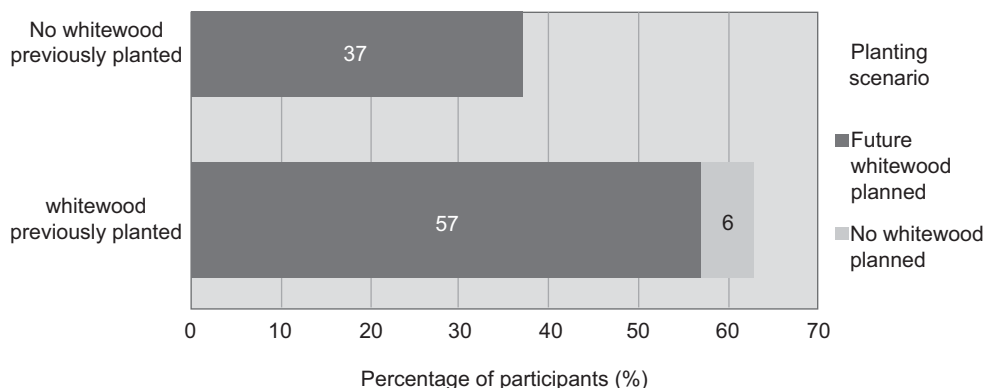
The majority of landholders felt the main reason for planting whitewood would be to generate income from timber sales (136 responses), while only three felt the major benefit would come from timber for housing or other on-farm uses, one for soil restoration through a fallow from market gardening, and five for replenishing the depleted timber resource on Santo Island.

TABLE 2 Land areas planted and considered available for future planting to whitewood by land-holders surveyed on Santo Island, Vanuatu

Aspect surveyed	Region of Santo			Total
	North-east	Central-east	South-east	
Land-holders surveyed (number)	42	46	51	139
Land-holders who have grown whitewood (numbers)	28	34	26	88
Land-holders willing to grow whitewood in future (numbers)	37	42	51	130
Total whitewood area planted (ha)	21.2	31.4	10.8	63.4
Average whitewood area planted (ha/ land-holder)	0.8 a	1.0 a	0.4 a	–
Additional arable land area available for plantations (total ha)	91	173	152	416
Area that land-holders are willing to plant to whitewood (total ha)	73	77	64	214
Additional area that land-holders are willing to plant to whitewood (%)	80	45	42	51
Average additional area potentially available (ha/land-holder)	2.5 b	4.7 d	3.0 bc	–

Note: For 'a' N=87, F=2.23, P=0.112 ; for 'b-d' N=128, F=3.23, P=0.043

FIGURE 2 Comparison of past and planned whitewood plantation establishment among surveyed landholders on Santo Island (N=139)



Whitewood silvicultural spacings used by small landholders

The most common tree spacing used in existing whitewood plantations across the three regions was 5m × 5m, being the distance between and within rows of trees, given by 57% of growers. However this contrasted with 59% of respondents who said they would prefer to use spacings of 8m × 6m in future plantings. This difference was based on grower experience where original plantings were considered too close and trees limited growth of the under-cover crops. Respondents and local forestry workers suggested that production of food crops could be improved if woodlots were thinned to let extra light in.

Cultural and livelihood factors influencing land-use

Of all the landholders surveyed, 41% indicated they grew tree species other than whitewood in small woodlots, with big-leaf mahogany (*Swietenia macrophylla*) the most common grown for timber and seed, followed by sandalwood (*Santalum album*), grown for oil and seed. It was found during the study that big-leaf mahogany apparently was the major species being promoted by local government forestry extension officers in some regions. No mention was made of trees being grown for medicinal qualities, which was unexpected considering that trees such as Nangai (*Canarium indicum* var. *indicum*) are commonly encountered, a species reported to have special medicinal qualities by Siwatibau *et al.* (1998).

A great diversity of crops are grown in traditional ni-Vanuatu agroforestry plantings (Walter and Lebot 2007). Landholders were found to grow many different types of food crops in agroforestry gardens during the first two to five years of a whitewood plantation. Produce was firstly used to support families' food needs, then excess production was sold at local markets (Figure 3). The most popular staple crops that had been grown were kumala (sweet potato) *Ipomoea batatas*, 75% of landholders surveyed that had grown whitewood), island cabbage (*Abelmoschus manihot*, 59%) and island taro (*Colocasia esculenta*, 46%), manioc (*Manihot*

esculenta, 42%) and corn (*Zea mays*, 35%). Landholders who had previously grown whitewood reported they would increase areas grown to these same crops underneath trees in the future as well as increase areas to other crops including peanuts (*Arachis hypogea*), yam (*Dioscorea alata*), spring onions (*Allium fistulosum*), Fiji taro (*Xanthosoma sagittifolium*) and Chinese cabbage (*Brassica rapa L. ssp chinensis*). Interestingly, landholders were planning not to expand areas planted to kava (*Piper methysticum*), bananas (*Musa sp.*), sugarcane (*Saccharum officinarum*), capsicum (*Capsicum annum*), ginger (*Zingiber officinale*), tomatoes (*Lycopersicon esculentum*) and pineapples (*Ananas comosus*) (Figure 3).

The proportion of food crop production additional to family needs that was sold at local markets varied by crop type, but not significantly across regions except for peanuts (F=5.45, P<0.01), tomatoes (F=9.94, P<0.001) and sugarcane (F=30.0, P<0.001). Approximately 75% of kava grown was sold at market, while around one-third (average 34%; range 24 to 37%) of the volume of the remaining varieties of crop produce was sold to generate household income.

The average area of land under control of each survey respondent on Santo Island was higher on in the north-east region at 113 hectares, compared to the other two regions (central-east mean = 42.5ha, south mean = 75.9ha). However this difference was not significantly different between regions, with median values for these regions (north-east = 50ha, central-east = 15ha, and south = 50ha; Figure 4) suggesting the difference in means was due to some unusually large outliers. The average land area available for livelihood support is therefore relatively similar across regions. Further, there were no differences in the average number of people these total land areas supported (mean = 6 people per land-holding).

The level of education and skills in forest management was found to be somewhat limited, particularly in relation to silvicultural practices such as pruning and thinning, indicating that extension efforts had not been particularly effective. Researchers observed limited local knowledge and expertise in tree harvesting operations and timber marketing. There appears to be little collaborative capacity to develop mills and markets among landholders to date, other than through one milling company.

FIGURE 3 Types of food crops being grown and planned to be grown under whitewood trees by landholders on Santo Island, Vanuatu (N=65)

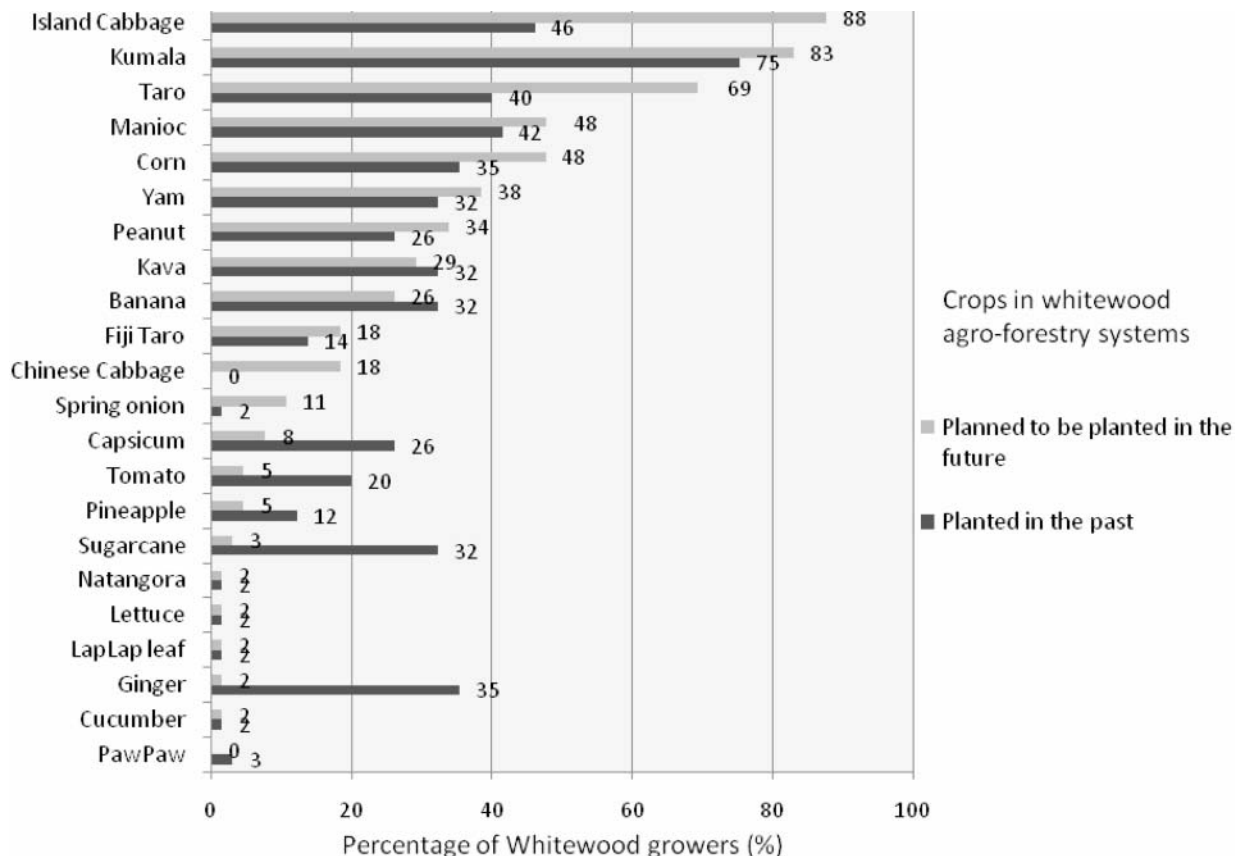
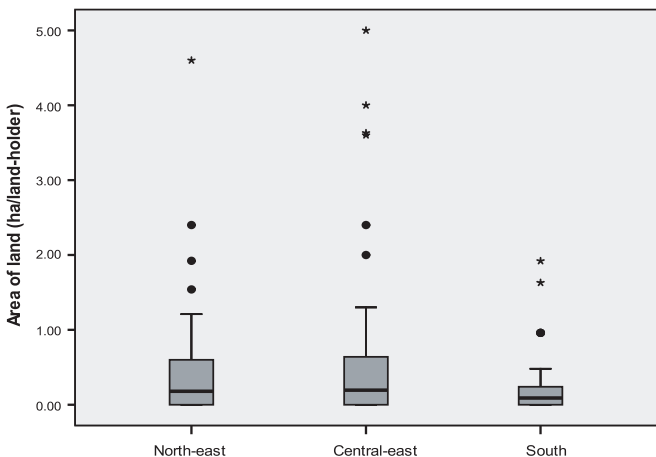


FIGURE 4 Size of land-holdings across case regions for survey respondents on Santo Island (n=133, excluding 6 missing values). Note: Dark lines in box plots indicate medians; • and * indicate outlying values



DISCUSSION

A participatory social research approach using landholder surveys on the island of Santo helped develop a sound understanding of ni-Vanuatu farmer attitudes towards the use of the

native whitewood tree in plantation development. Even though the majority of respondents surveyed said they supported whitewood plantations (98%) mainly for the potential to generate cash income, many landholders had planted few trees themselves and had limited plans to do so. Future plantation establishment was also constrained by competition with other tree species, particularly big-leaf mahogany (*Swietenia macrophylla*) grown for its high-value timber and seed, and land competition for food crops. In regard to future plantings, landholders in the central-east region were least likely to plant more trees at only 23% of the additional land area available, being an extra 0.9ha/landholder compared to landholders in the north-east who were prepared to increase plantings by 1.7 ha per landholder, using some 80% of the additional arable land available.

Our findings suggest that additional plantings of woodlots will be well below those needed to achieve the target set by the Vanuatu National Forest Policy of 20 000 hectares by year 2023 (Bakeo et al. 2003). If significant increases in plantation areas are to be achieved, these will likely need to come from larger organisations, perhaps companies or government agencies, rather than small-landholders, who are generally struggling to produce adequate food supplies and supplementary produce for cash income.

The export market for whitewood products between the years of 2003–2004, specifically to Japan, has shrunk, given

an on-going decline in sawnwood consumption. This has been in response to a slowing economy, increased competition from imported softwood, increasing availability of domestic log supplies, and the global financial crisis (ITTO 2009). According to McGregor and McGregor (2010) there have been no timber exports from Vanuatu to Japan since 2007 due to lack supply from natural forests and suspension of a pilot reforestation program. Timber export earnings declined from 15% in 2003 to 2.5% in 2008. New Caledonia has since emerged as the dominant export market for Vanuatu hardwoods. Nevertheless, whitewood is considered to provide a niche timber product with values projected to remain stable at around US\$819/m³ as processed mouldings and other products for interior use as of June 2009 (McGregor and McGregor 2010) Another trend in timber marketing has been the large volume of New Zealand radiata pine (*Pinus radiata*) structural timber imported since year 2002 for use in the Vanuatu construction industry.

Another constraint to further whitewood planting by small landholders on Santo Island was found to be the preference given to big-leaf mahogany (*Swietenia macrophylla*) by this survey. This could be explained in part by the substantial body of research already conducted on this species (SPRIG 1997) and the existence of established markets for mahogany. Shono and Snook (2006) highlight the potential high growth rates of mahogany in plantations in the tropics, where it is not attacked by shoot borers (*Hypsipyla* spp.) which are found in areas where the tree is native (Mayhew and Newton 1998). Mahogany produces highly valued timber, with 2009 prices of US\$300/m³ for finished lumber (ITTO 2009). While the *Hypsipyla* shoot borer has been found in Vanuatu (Floyd *et al.* 2003), it is too early to know whether the pest will create serious long-term problems.

This study developed further insights into indigenous forest management practices and food cropping. The most common silvicultural plantings were found to be 5m × 5m, however plans were to increase these to 8m × 6m (tree by row spacings) to create greater room for food crops such as kava. An average of 75% of kava produced was sold at market, and other crops such as island cabbage and taro, corn, manioc, peanuts, accounting for approximately one third of produce sold above household needs. The importance for creating livelihood balance between meeting basic food needs and regular cash flow from local marketing of excess food, against long-term investments in timber crops was made evident.

Further research and education is recommended for understanding attitudes toward plantation forestry amongst landholders, particularly the development of whitewood plantations. While Manley (2007) claims that the most successful community-based approaches are those that build on existing organisational and traditional structures, this study highlighted that cultural norm and customs can also create constraints to development that could benefit from external and independent assistance and management. These findings are supported in research by Richardson *et al.* (2011) and Nielsen and Reenberg (2010), who suggest that culture can act as a major barrier to livelihood improvement strategies, particularly in

developing improved strategies for forest management and human adaptation to climate change.

The need for continued extension efforts to help develop skills and capacity in forest management and marketing among indigenous rural landholders of Vanuatu was found to be crucial for achieving long-term income enhancement and environmental protection. Educational programs that support livelihood decisions have been found in many other developing countries to offer the greatest opportunities (Vanclay *et al.* 2006), particularly those that incorporate an understanding of local value systems, provide technical support and work towards empowering the poor and disadvantaged through participatory decision making (Garen *et al.* 2009, McDermott and Schreckenberg 2009). Further, research is recommended in the processing and marketing of whitewood to ensure that the benefits of timber growing and processing are shared widely throughout the community. Community forestry is one option that can be explored for providing a more equitable sharing of resources between villagers (house-holders).

The need for landholders to have a better understanding of markets for whitewood came clearly out of the surveys done here. A study related to this project was implemented in 2011: assessment of the current value-chain of whitewood and exploration of opportunities for value-adding. This is research involving extensive interviews of landholders, loggers, sawmillers, and processors both on Santo and the island of Efate.

CONCLUSIONS

Possibilities exist for both the development of large-scale plantation forestry based around whitewood or smaller-scale community forests. To date, in spite of many consultancies having painted an optimistic picture of the industrial scale operations that might be developed, little has happened. This appears to be mainly due to concerns about lack of resource security under communal land ownership, as well as declining export markets in recent years.

The second possibility is community forestry, which can improve livelihoods and welfare of rural people, as well as improve conservation of natural forest systems through local participation and cooperation. Pagdee *et al.* (2006), in their meta-study of what makes community forest management successful, cited many factors with generally positive influences that are not currently present on Santo Island in Vanuatu: tenure security, clear ownership, congruence between biophysical and socioeconomic boundaries of resources, effective enforcement of rules and regulations, effective enforcement of rules and regulations, strong leadership within capable local organizations and common interests among community members. Thus, focus on improving performance in these areas may eventually enable community members to develop a viable whitewood plantation sector, in this environment where the biophysical conditions are highly suitable. It appears that primarily a lack of clear options for using and-or selling whitewood, either as standing trees, logs, or boards is a major factor impeding the development of more

community plantations. The essentially subsistence culture of rural Santo, combined with other more familiar options for earning income, that is growing food crops or kava, also may partially explain the lack of more whitewood plantations.

ACKNOWLEDGEMENTS

This research was funded by the Australian Centre for International Agricultural Research (ACIAR) grant FST 2005/089. The authors would like to express sincere gratitude to all the people who contributed their time, information and opinions during this study.

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