Agroforest Syst (2017) 91:375–392
DOI 10.1007/s10457-016-9940-0

Factors influencing smallholder commercial tree planting in Isabel Province, the Solomon Islands

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Received: 12 May 2015 / Accepted: 11 April 2016 / Published online: 15 April 2016

Abstract Small-scale forestry systems provide subsistence products and income generation for smallholders, and a range of environmental services. However, smallholders often face constraints to the adoption of small-scale forestry. In the Solomon Islands, family-based plantations of commercial timber species, in particular teak, have been promoted over the last 10 years. After initially high uptake, rates of new plantings have slowed, and management of existing plantations is perceived to limit timber quality. This study assesses the factors that influence household adoption of small-scale forestry through a case study of Isabel Province, the Solomon Islands. These factors were investigated in five tree-planting villages using a mixed methods approach, in which a household survey of tree planters and non-tree planters was complemented with qualitative methods. Descriptive statistics, probit and multiple regression models, and qualitative analysis were used to generate results. The study finds that a market for existing planted timber resources, improved extension services and, in the longer-term, more livelihood-appropriate small-scale (agro)forestry systems are critical to facilitate the ongoing adoption and maintenance of small-scale plantations in Isabel Province of the Solomon Islands.

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Keywords Small-scale forestry systems · Family-based reforestation · Teak · Rural households' decision-making · Marketing of timber from small-scale plantations · Forestry extension

Introduction

Globally, the declining extent and quality of natural forests threatens the continued provision of forest goods and services (FAO 2010; Roshetko et al. 2008). In this context, the role for planted forests has received considerable attention (Carle and Holmgren 2008). Recent decades of growth in the area of planted forest have also been accompanied by a shift away from large-scale industrial forestry and increasing recognition of the importance and potential of smallholder forestry (Angelsen and Wunder 2003; Arnold 2001; Harrison et al. 2002; Snelder and Lasco 2008). Small-scale (agro)forestry systems can provide subsistence products and income generation for smallholders (Angelsen and Wunder 2003; Arnold 2001), and environmental services such as erosion control and carbon sequestration (Idol et al. 2011; Roshetko et al. 2007; van Noordwijk et al. 2008). However, smallholders often face constraints to adopting small-scale forestry, and programmes and policies to facilitate and promote adoption often have poor outcomes (Angelsen and Wunder 2003; Arnold 2001; Barney 2008; Bertomeu 2004; Obidzinski and Dermawan 2010; van Noordwijk et al. 2008).

In the Solomon Islands, family-based plantations of commercial timber species have been promoted over the last 10 years. After initially high uptake, rates of new plantings have slowed (SKM 2012), and management of existing plantations is perceived to limit the quality of timber from future harvests (Blumfield et al. 2013). However, knowledge about the factors that influence smallholder adoption and maintenance of small-scale forestry in the Solomon Islands is currently limited (though see Lyons et al. 2012; Racelis and Aswani 2011; Raymond and Wooff 2006). Such knowledge may inform development of more livelihood appropriate small-scale forestry systems (e.g. see Blumfield et al. 2012).

In developing countries in the tropics, the challenges that smallholders face in adopting tree planting have prompted a number of empirical studies to investigate the factors that influence household adoption decisions (e.g. Byron 2001; Godoy 1992; Lamb 2011; Pattanayak et al. 2003; Sabastian et al. 2014). Identifying these factors can inform the design, support and promotion of technologies and interventions appropriate to farmers' resources and livelihood strategies, and allow constraints to tree planting to be addressed.

Pattanayak et al.'s review (2003) concluded that five categories of factors influence adoption of agricultural and forestry technology: farmer preferences; resource endowments; market incentives; biophysical factors; and risk and uncertainty. Byron (2001) outlined the 'keys' for successful tree planting as comprising: secure property rights to land and tree crops, a viable production technology, capacity for crop protection, and access to markets. Empirical studies in Central and South-East Asia, South and Central America, and sub-Saharan Africa have identified a range of influential factors including: a household's labour and income; farmer knowledge, skills and attitude; household demographics; available land resources; tenure security; membership of farmer or community organisations; access to germplasm, inputs and markets; and policy incentives (e.g. see Amacher et al. 1993; Bertomeu 2004; Boulay et al. 2011; Dewees and Saxena 1997; Garen et al. 2009; Mahapatra and Mitchell 2001; Rohadi et al. 2010; Salam et al. 2000; Simmons et al. 2002).

While these studies highlight some trends with regard to factors that influence adoption of tree planting, unexpected findings within studies and contradictions between them highlight the importance of locally specific research. In the Solomon Islands, where relatively little is known about the factors that influence adoption of tree planting, it cannot be assumed that knowledge generated through studies in other geographic and cultural settings will translate to the local context.

This study contributes to filling this gap by assessing the factors that influence household adoption of commercial tree planting through a case study of Isabel Province in the Solomon Islands. Socio-economic and perceptional factors were investigated in five tree-planting villages on the northern side of Santa Isabel using a mixed methods approach, in which a household survey of tree planters and non-tree planters was supplemented with participatory rural appraisal methods, key informant interviews, informal discussions and observation. In summary, the study finds that a market for existing planted timber resources, improved extension services and, in the longer-term, more livelihood-appropriate small-scale (agro)-forestry systems are critical to the ongoing adoption and maintenance of small-scale plantations in Isabel Province of the Solomon Islands.

Methods and materials

Conceptual framework

Smallholders are typically assumed to maximise welfare, rather than profit, while minimising risk (Byron 2001; Kragten et al. 2001; Salam et al. 2000; Scherr 1995; Simmons et al. 2002). Households may adopt tree planting if they perceive that it provides net benefits, not just in isolation but also relative to other livelihood alternatives and their interactions (Byron 2001; Scherr 1995). Moreover, a household's socio-economic characteristics and perceptions influence the perceived costs and benefits of tree planting, and consequently their decisions to plant and maintain trees (Lamb 2011). Therefore, understanding the diversity of rural households and their related livelihood strategies can help ensure the success of initiatives to promote tree planting (Byron 2001; Emtage and Suh 2004; Nawir et al. 2007).

The factors that influence rural households' decision-making can be conceptualised in different ways: the agricultural household model recognises that

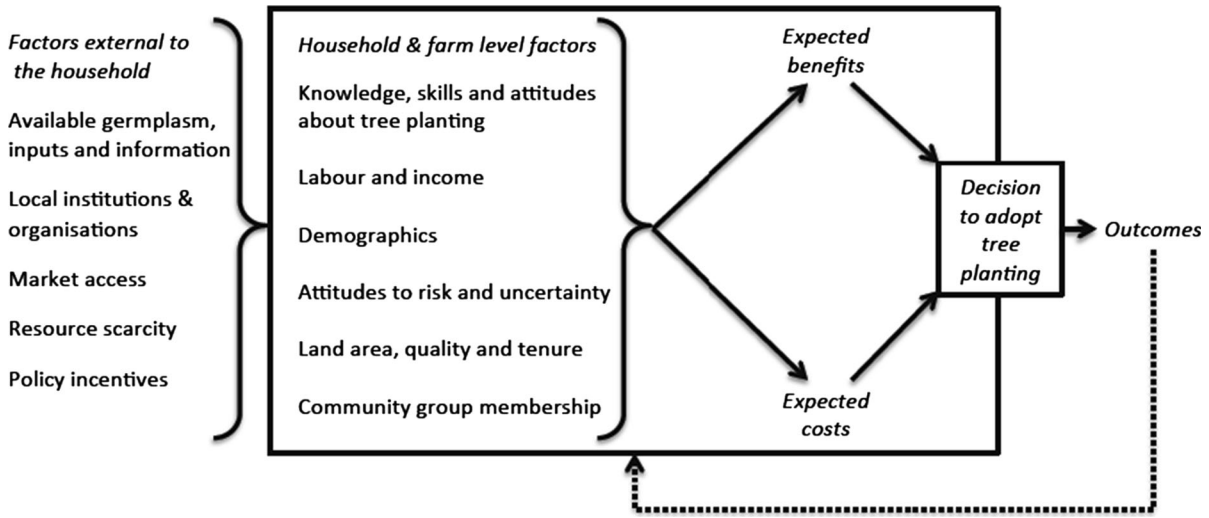

Fig. 1 Conceptual framework of how factors interact to influence household decisions to plant commercial trees. Factors external to the household and at the household and farm level influence the expected benefits and costs of tree planting relative to other livelihood options. The outcome of the adoption decision feeds back into the expected costs and benefits of tree planting

factors such as income, time, labour, production technology and risk aversion influence decisions (Ellis 1992; Mercer 2004; Taylor and Adelman 2003). The Sustainable Livelihoods Framework describes that a household's available resources, such as physical, natural, financial, social and human capital, inform their livelihood decisions (e.g. see Ellis 2000; Scoones 1998). A range of dynamic external conditions and trends (such as institutional and organisational factors, and the social context) also influence the relative costs and benefits of different livelihood options (ibid.). This and other literature (particularly Ostrom 1990) as well as empirical studies investigating factors that influence household adoption of tree planting (as outlined in Introduction section) have been drawn on to develop the conceptual framework for this study (Fig. 1).

Background: family-based reforestation in the Solomon Islands

In the Solomon Islands, large-scale industrial plantations comprise a total area of more than 25,000 ha, primarily in Western Province; limited opportunities exist to extend this area (Pauku 2009; Raymond and Wooff 2006; SKM 2012; URS 2006). There were low levels of smallholder and community plantations until the early 2000s, when the Ministry of Forestry and Research (MOFR) and the Solomon Islands Forest Management Programme 2 began to work closely with landowners to expand small-scale plantation forestry.[1] In 2003, planting peaked with the establishment of more than 2500 ha of smallholder and community plantations. Planting rates have since declined; today, the total planted area is unknown, though it is estimated to be between 6000 and 10,000 ha (Blumfield et al. 2012; SKM 2012; SIG 2014).

The MOFR has primarily promoted high-value exotic species that are relatively easy to grow for smallholder planting; in 2006, over two-thirds of village level plantations were *Tectona grandis*, and *Swietenia macrophylla, Gmelina arborea* and *Eucalyptus deglupta* comprised near equal shares of the remaining third of planted trees (Pauku 2009). Timber plantations are typically family-based although there are also examples of clan and community plantings. This paper focuses on smallholder planting of these exotic timber species, though it recognises that indigenous species are valued for both subsistence and commercial purposes, and potential exists to further develop and promote planting of some indigenous species for these purposes (e.g. see Blumfield et al. 2013).

[1] An Australian programme, which ran from 1999 until 2009 (Hughes et al. 2010).

There are concerns about the silviculture, suitability and short-term economic benefits of existing small-scale plantations (Evans 2006). While the network of rural Community-based Forestry Extension Officers (CFEOs), who work in villages to promote tree planting, is considered an effective model for extension (Gua 2008 in Lamb 2011; see Lamb 2011 also for a description of their role), there is a perceived need to strengthen these services (SKM 2012; URS 2006). Disconnection from markets and infrastructure limitations are further constraints (ACIAR 2013).

Study site: Isabel Province

Isabel province (often spelt Ysabel locally) is one of seven provinces in the Solomon Islands. It comprises the main island Santa Isabel and numerous smaller islands (see Fig. 2). The province has approximately 26,000 inhabitants and an annual population growth rate of 2.5 % (SIG 2012). Rural livelihoods are strongly subsistence based with only 18.5 % of the adult population in paid employment (SIG 2012). Households are reliant on forest resources, particularly for housing and energy (Peterson et al. 2012). Most land is under customary tenure, which is based upon matrilineal inheritance (Kabutaulaka 2005; Maetala 2008). On the main island, there are few public roads, though temporary logging roads weave throughout the many logging concessions. Most local transport is by canoe, outboard motor or on foot.

Isabel province has the second highest number of current logging operations in Solomon Islands and the provincial government receives more than 60 % of its total revenues from logging fees and taxes (Peterson et al. 2012). Landowners receive royalties equivalent to about 15 % of total log value, and the industry provides direct employment and demand for local produce. Harvest levels are likely to decline in the future with severe implications for provincial government and rural communities.

Village selection

Five villages that are accessible from the northern side of Santa Isabel Island were purposefully selected to be representative of the greater population.[2] They were sampled from villages with at least ten households that had adopted commercial tree planting, and were selected to provide variation in road access, population density, access to Buala, settlement history,[3] inland/-coastal location and logging history.

Data collection

At the provincial level, preliminary interviews with key informants built an understanding of the local context and guided development of a household survey. The survey was structured to generate data about household livelihoods, tree planting and management, socio-economic characteristics and perceptions about tree planting. It was pre-tested with seven respondents.

In the study villages, an initial focus group, participatory rural appraisal (PRA) and interviews were carried out prior to conducting the household survey, in order to gain contextual information and enable greater triangulation. The PRA methods used were community mapping and village timeline activities, which involved six to ten participants who were selected using convenience sampling. A focus group was held in each village to explore themes related to tree planting with purposefully sampled groups of women and men of a range of ages. Throughout the village-based fieldwork, qualitative data was also collected through ongoing interviews, informal discussion and observation. Follow-up interviews at provincial and national levels aided interpretation of village-level data.

Households in each study village were divided into two lists (tree planters and non-tree planters) based on information from the MOFR office in Buala and key informants in villages. Survey respondents were randomly selected from each list. Disproportionate stratified sampling was applied within villages, which is appropriate to facilitate within and between strata analysis when strata sizes are uneven (Daniel 2005). Across the five study villages, surveys were completed with 66 tree planting and 59 non-tree planting households.

This study uses the definition of a household as a social unit of people who live under the same roof, pool resources and share income, as per Ellis (1992).

[2] Specific names and locations of villages are not disclosed. The total number of villages in the area is not known.

[3] One village was settled on land belonging to another clan in the 1960s.

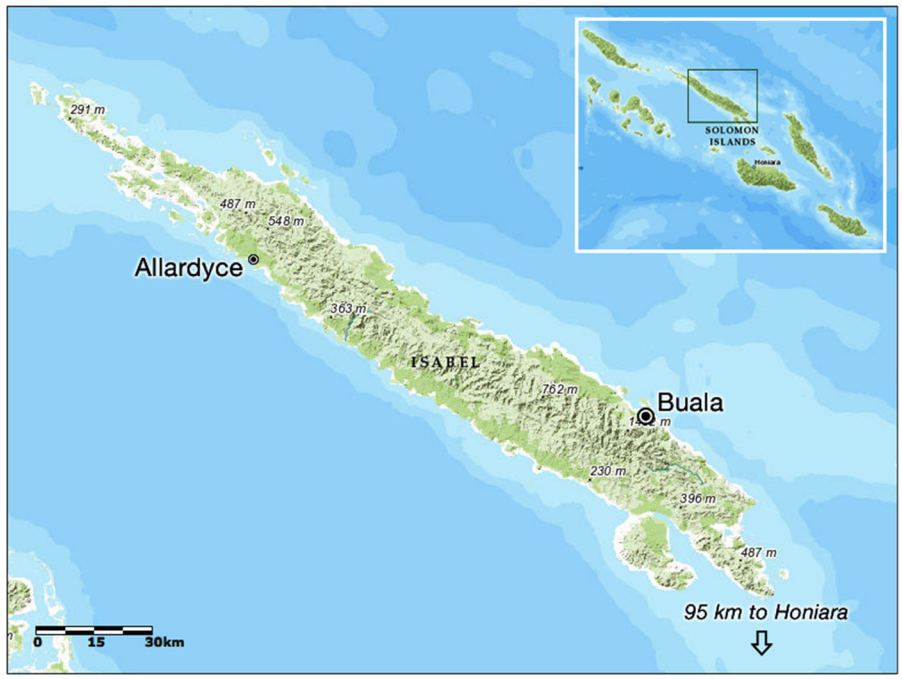

Fig. 2 Map of Isabel Province, the Solomon Islands. Buala, the provincial capital, and Allardyce are MOFR provincial stations (source ARCGIS online and own data)

For analysis, the default household head was the most senior adult male, in line with census findings that most households nominate this person as household head (SIG 2009).

A household was defined as a 'tree planter' if they had planted exotic timber species for commercial production/income generation. Exotic timber species were *Tectona grandis* (Teak), *Swietenia macrophylla* (Mahogany) and *Eucalyptus deglupta* (Eucalyptus) for which the MoFR provides seeds (and occasionally seedlings). Households that planted less than five trees were categorised as non-tree planters.

The sampled households were approached and provided background information about the study and the survey. The survey was conducted with the agreed respondent(s) or a time made to return. The survey typically took 30–40 min and was conducted in Pijin, unless the respondent(s) preferred to use their local language, in which case an interpreter was used.

It was hypothesised that socio-economic characteristics and perceptions of tree planting would differ between households that did and did not plant commercial timber species. This data was collected through the household survey for later quantitative analysis (Table 1). The table includes these factors, the indicators used to assess these factors and their hypothesised relationship with tree planting. Qualitative data was also gathered about many of these factors.

Qualitative data was also gathered about other factors that the literature highlights in relation to household perceptions including: knowledge, skills and attitudes about tree planting; experience in tree planting; attitudes to risk and uncertainty; information and perceptions about market access; access to germplasm and production technology; and perceptions of existing policy incentives. Data was also collected on the village and provincial contexts.

Data analysis

Using survey data, descriptive statistics and regression analysis were generated in Stata.[4] Income data was transformed to income per number of adult equivalents in the household (OECD 2005).[5] Responses to specific survey questions about perceptions of tree

[4] Unweighted and weighted descriptive statistics and regressions were generated and contrasted (as per Solon et al. 2013). Unweighted results are primarily presented, though implications of weighting are discussed where they are considered to affect interpretation of the results.

[5] 1 per first adult, 0.7 for every additional adult and 0.5 per child.

Table 1 Summary of literature and hypothesised relationship between household characteristics and adoption of tree planting

Factors	Sources	Indicator used in this study	Expected relationship
Labour	Pattanayak et al. 2003*	Working age household members/total household size	(−)
Income	Dewees and Saxena 1997; Emtage et al. 2007; Kallio et al. 2011; Pattanayak et al. 2003; Sabastian et al. 2014; Sandewall et al. 2010	Income percentile	(+)
Off-farm income	Bertomeu 2004 (for average to large farms); Boulay et al. 2011; Godoy 1992; Thacher et al. 1997	Salary as most important household income	(+)
Assets	Kallio et al. 2011; Mahapatra and Mitchell 2001; Pattanayak et al. 2003	An iron roof on main house	(+)
Age	Pattanayak et al. 2003; Schuren and Snelder 2008	Age of household head	(+)
Gender	Pattanayak et al. 2003	Female household head	(−)
Education	Pattanayak et al. 2003	Number of years completed by HH head	(+)
Resource scarcity	Salam et al. 2000; Santos Martín et al. 2011	Perceived availability of timber species	(+)
Access to extension	Mercer 2004; Salam et al. 2000; Schuren and Snelder 2008; Thacher et al. 1997	Awareness of forestry extension programme	(+)
Participation in community organisation	Kallio et al. 2011; Mahapatra and Mitchell 2001	Member of a community group	(+)
Tenure security	Boulay et al. 2011; Byron 2001; Godoy 1992; Santos Martín et al. 2011	Perceived security of land tenure	(+)
Land availability	Bertomeu 2004; Boulay et al. 2011; Dewees and Saxena 1997; Emtage and Suh 2004; Kallio et al. 2011; Salam et al. 2000; Santos Martín et al. 2011; Sabastian et al. 2014	Perceived availability of and access to land	(+)
Village or location	Bertomeu 2004; Schuren and Snelder 2008; Walters et al. 1999	Dummy variables for village of residence	(+)

* Pattanyak et al. (2003) is a literature review. It is listed here when the review found that studies that examined this factor most commonly found it was significant in the indicated direction

planting were coded by categories in order to analyse the prevalence and nature of different perceptions. Using NVivo, qualitative data gathered through PRA, focus groups, interviews and observation was also coded by categories, in order to analyse household and village-level themes (Maxwell 2008).

Probit and multiple regression

The relationship between household socio-economic characteristics and adoption of commercial tree planting was explored through a two-stage regression analysis. In the first stage, a household's decision to plant trees was investigated with the probit binary choice model. A household's assumed choice of whether or not to plant trees is reflected in a response variable that can take only values 0 and 1. This response is assumed to depend on identifiable characteristics (x) within the household. All sampled households were included in this model.

In the second stage, a multiple regression was conducted. The dependent variable was the number of planted commercial timber trees, corrected for number of households involved in family plantations. This number was log transformed to create a more normally distributed outcome. Only tree planting households were included in this model. The same independent variables used in the probit model were adopted. Dummy variables with highly skewed distribution (less than five in one group) were excluded.

A household that planted under unique circumstances and was considered to unduly influence the results was excluded from the models.

Results

Tree planting and management

Of all households across the five study villages, an estimated 58 % had established commercial timber plantations. The proportion of tree planters in each village ranged from approximately 29–88 % of households. A Chi square test shows this difference is highly significant ($p = 0.000$). Overall, 32 % of households in the study villages were sampled (an estimated 40 % of tree planters and 27 % of non-tree planters). Of the selected tree planting households, 45 (68.2 %) established plantations as individual households and 22 (33.3 %) planted with extended family (one household had both a household and a family plantation). Family plantations involved between two and four households. In one village, members of a clan had established a two hectare teak plantation; maintenance had all but ceased once funds to pay labour were depleted.

Households planted 397 trees on average. Total trees planted ranged from 19 up to 2200 trees. On average, family plantations contained 578 trees compared to 306 in household plantations ($p = 0.0542$). When plantation size was corrected for number of households in a family plantation,[6] 28 (42 %) tree planting households planted less than 100 trees (median = 166; mean = 287) (Fig. 3). With this correction applied, family plantations were slightly smaller on average than household plantations, though this difference was not statistically significant. Between villages, the number of trees planted per household varied, ranging from 129 to 447 trees per household. A W test, which took unequal variance into account, was significant ($p = 0.0214$).

The majority of tree planting households (58; 88 %) established their plantations in 2003 or 2004; 53 (91 %) of these households had not planted any more timber trees since this time. A small number of households established or extended their first plantation between 2005 and 2013. Households with existing plantations were responsible for all planting in 2013 (i.e. no new households started planting).

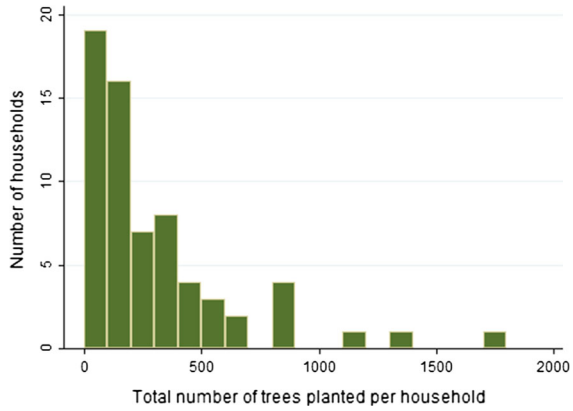

Fig. 3 Number of trees planted per household

Plantations were primarily established on clan-owned land allocated to families for cultivation. Households had most commonly obtained their right to land through the customary system of matrilineal inheritance. In addition, a number had secured their land with a *kastom* feast[7] or had been allowed use rights by village leaders.

Teak comprised 86 %, mahogany 12 % and eucalyptus 2 % of the planted trees. Households with two or more plantations had shifted from teak in their first plantation to mahogany in later plantation(s). Trees were typically planted in garden fallow/secondary forest and rarely in logged over clan land, which was typically further from the village than family gardens. Some households had initially intercropped teak seedlings with kumara (*Ipomoea batata)* and others had stands of betel nut *(Areca catechu)* or naturally regenerating indigenous species inside their plantation. Mahogany stands were predominantly established under coconut. Some households had planted trees in areas poorly suited for gardens, due to swampy terrain or distance from the village. Rumours about the negative impact of teak on soil and waterways, which had emerged around 2003, had influenced some households' decisions about whether or where to plant teak.

[6] The correction involved dividing the number of trees planted by number of households involved.

[7] A traditional way to seal or confirm the transfer of land (see Maetala 2008).

Table 2 Descriptive statistics of household characteristics, including p-values for tests of equality of mean/proportion between tree planters (TP) and non-tree planters (NTP)

Variable	All (SE)	TP (SE)	NTP (SE)	p value
Sample size (n)	125	66	59	–
Age of household head [mean years]	44.4	47.5	41.0	0.0025***
	(1.07)	(1.28)	(1.68)	
Gender of household head [proportion female]	0.03	0.03	0.03	0.9092
	(0.02)	(0.02)	(0.02)	
Education [mean years]	8.66	8.33	9.03	0.1944
	(0.27)	(0.39)	(0.36)	
Dependents [count]	2.98	3.30	2.63	0.0262**
	(0.15)	(0.22)	(0.20)	
Working ratio [mean (adults/household size)]	0.48	0.45	0.50	0.1609
	(0.02)	(0.02)	(0.02)	
Income [mean percentile]	–	0.48	0.53	0.2697
	(0.02)	(0.04)	(0.04)	
Off-farm income [% w/salary as primary income]	0.11	0.08	0.15	0.1742
	(0.03)	(0.03)	(0.05)	
Iron roof [% with]	0.35	0.47	0.22	0.0036***
	(0.04)	(0.06)	(0.05)	
Tenure security [% perceived secure]	0.86	0.95	0.76	0.0018***
	(0.03)	(0.02)	(0.05)	
Land availability [% perceiving constraint]	0.18	0.08	0.31	0.0010***
	(0.03)	(0.03)	(0.06)	
Community groups [% active in community group]	0.78	0.85	0.71	0.0639*
	(0.03)	(0.04)	(0.05)	
Awareness of extension [% w/some or little awareness]	0.56	0.64	0.47	0.0698*
	(0.04)	(0.06)	(0.07)	
	0.59	0.56	0.62	0.4500

SE standard error

Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Household socio-economic characteristics and adoption of tree planting

The mean/proportion and standard error values for characteristics of the sample households (all, tree planters (TP) and non-tree planters (NTP)) are listed in Table 2 together with results of two-way tests for equality of means/proportions of tree planting and non-tree planting households.

Tree planters were significantly older than non-tree planters ($p < 0.01$) and had more dependent members in their household ($p < 0.05$). They were more likely to have an iron roof, an important asset that is indicative of a permanent house, than non-tree planters ($p < 0.01$). Tree planters were more likely to perceive their right to land to be secure ($p < 0.001$) and not to perceive land availability as a constraint ($p < 0.001$). Tree planters were more likely to be a member of a community group (predominantly church groups) ($p < 0.1$) and to be aware of extension programmes ($p < 0.05$).[8]

Of these variables, a number demonstrated statistically significant variation between villages. One-way ANOVA tests find that income, iron roof, land and extension levels exhibit highly significant variation between villages ($p < 0.0001$). Households with off-farm income and perceived tenure security (both $p < 0.05$) and number of dependents also varied significantly ($p < 0.1$) between villages.[9]

The result of the probit analysis reveals a statistically significant positive relationship between the age

[8] If weighted, participation in community groups was no longer statistically significant, and number of dependents was less significant ($p < 0.1$).

[9] With weighted statistics, off-farm income was no longer significant, and tenure security became more highly significant ($p = 0.0001$).

Table 3 Results of probit analysis of factors influencing adoption of tree planting

Independent variables	Coefficient Unweighted	SE Unweighted	p > [t] Unweighted	p > [t] Weighted	p > [t] Weighted w/ village dummy
Age of household head	0.0265017	0.0110943	0.017**	0.083*	0.015**
Working ratio	−1.200267	0.6430379	0.062*	–	–
Tenure security	0.7120555	0.399918	0.075*	0.067*	–
Land availability	−0.9947445	0.3409775	0.004***	0.005***	0.014**
Awareness of extension	0.4618076	0.2609858	0.077*	0.056*	0.072*
$Village_B$					0.064*
$Village_C$					0.551
$Village_D$					0.000***
$Village_E$					0.690
Intercept	−1.286878	0.5981844	0.038**	0.056*	0.042**
Model statistics					
Chi^2			30.16	20.77	54.55
Prob > Chi^2			0.0000***	0.0009***	0.0000***
Classification accuracy (unweighted model)					71.77 %
Post-estimation goodness of fit test of observed vs. expected responses (unweighted model) (p)					0.4752
Sample size (n)					124

Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

of household head and adoption of tree planting (Table 3). Households with a lower proportion of working age members were significantly more likely to plant trees in the unweighted model only. Perceived tenure insecurity was negatively related with tree planting in the weighted and unweighted models, though was no longer significant in the model with a dummy for village of residence, which likely reflects that perceived tenure insecurity is considerably more prevalent in the settler village. In all models, there is a negative relationship between perceived land constraints and adoption of commercial tree planting, though this is less significant when tested with a dummy for village of residence, which likely reflects the higher prevalence of these constraints in the village nearest the provincial centre. Awareness of extension was positively related with tree planting in all models.

The model with the village dummy showed that there are highly significant differences in the proportion of households in each village that plant trees ($p = 0.000$).

The result of the multiple regression on factors that influence the intensity of household adoption (number of trees planted) illustrates that household income per adult equivalent unit and awareness of extension are both significantly positively related to plantation size in all models ($p < 0.01$) (Table 4). Awareness of extension is less significant when a village dummy is included, which suggests some of the significance of this variable in the other models is due to differences between villages. The weighted model also reveals a significant positive relationship between working ratio and plantation size ($p < 0.1$).

The model with a village dummy showed that village of residence had no effect on number of trees planted ($p = 0.4019$). Further tests reveal that the assumptions of homoscedasticity and normal distribution of residuals are fulfilled, which suggests that the model is relatively robust.

Household perceptions of tree planting

83 % of households with plantations stated that they had planted exotic timber species for income. One-fifth of households stated that they also planted to provide future benefit for their children. Nearly one-fifth of households mentioned the MOFR's promotion of tree planting as an important reason for planting. Just over ten per cent of tree planters stated they had planted to follow others in the community. While it

Table 4 Results of multiple regression of number of trees planted

Independent variables	Coefficient Unweighted	SE Unweighted	p > [t] Unweighted	p > [t] Weighted	p > [t] Weighted w/ village dummy
Income percentile	1.250403	0.4228514	0.004***	0.008***	0.05***
Awareness of extension	0.8074188	0.2527265	0.002***	0.004***	0.010**
Working ratio	–	–	–	0.082*	–
$Village_B$	–	–	–	–	0.616
$Village_C$	–	–	–	–	0.557
$Village_D$	–	–	–	–	0.361
$Village_E$	–	–	–	–	0.284
Intercept	3.925703	0.2776518	0.000***	0.000***	0.000***
Model statistics					
R^2			0.2459	0.2908	0.3168
Prob > F			0.0002***	0.0001***	0.0008***
N					65

Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

was not the sole motivation of any household for planting trees, over one-quarter of respondents stated that the subsistence use value of planted trees influenced their decision to plant.

A perceived advantage of tree planting was the reduced workload as trees matured. Plantations were widely perceived to require less maintenance once the canopy closed. Some households liked that they could use thinnings or prunings, e.g. for construction or firewood. A number of households had positive perceptions of the requirements of mahogany relative to teak. It was perceived to: require less labour than teak as land didn't need to be cleared to plant it; help keep coconut plantations clean inside; and need less pruning than teak. Households in the village with perceived land constraints also found mahogany to be a more viable option than teak, as it didn't require households to forgo existing land use or land cover, such as coconut plantations or forest cover.

For tree planting households, access to materials for maintenance was the most commonly reported challenge (Table 5). One quarter of tree planters were concerned about the health of their trees, which may also reflect a lack of access to information and inputs to prevent, understand and/or manage the health issues. Additionally, one-fifth of tree planters separately cited lack of access to information and extension as a challenge. A widespread narrative on the negative local impacts of teak on soil and waterways may also reflect a lack of access to accurate information; this was also cited by a number of non-tree planters (see Table 6).

In addition, one-third of tree planters perceived market uncertainty and nearly 30 % perceived the long rotation period as challenges that limited incentives to maintain trees. Households expressed that the upfront labour requirements were high, and that although the requirement declined over time, the ongoing multiple demands for household labour, including short-term income generation, constrained the allocation of labour to maintaining planted trees.

The non-planting households most commonly stated that they did not plant trees because they had limited labour resources and significant existing family, community and church commitments (Table 6). More than one-third of non-tree planters stated that their need to focus on short-term income generation and the long lag from planting to harvest of tree limited their incentive to plant trees. The perceived uncertainty about the market for existing trees deterred nearly one-third of households from planting trees. Some households had some interest in tree planting but perceived that access to seed, and to a lesser extent information, was a barrier.

Discussion

This study finds that a number of factors influence household adoption of small-scale commercial

Table 5 Challenges about tree planting for tree planting households (n = 66)

Challenge	No. of times stated*	% of respondents
Access to materials for pruning and thinning	23	34.8
Uncertainty about market/buyer	22	33.3
Long rotation/long time until economic return	19	28.8
Unhealthy trees (insects/fungus/wind/swampy areas)	17	25.8
Busy with other work and commitments/focus on short-term income generating activities	14	21.2
Labour demands/maintenance of young trees	13	19.7
Access to information and extension (seeds, nursery, pruning, thinning, market information)	12	18.2
Teak spoils soil and dries up water\	10	15.2
No policy incentive (subsidy)	5	7.6
Uses good agricultural land	4	6.1
Distance to plantation (time and/or cost of transport)	4	6.1
None	4	6.1
Exotic species poorly suited to local climate and environment\	2	3.0
Deteriorating road for harvest	1	1.5
Total responses	150	

* Respondents could state more than one challenge

Table 6 Barriers to tree planting for non-tree planting households (n = 59)

Challenge		No. of times stated*	% of respondents
1	Busy/labour	23	39.0
2	Long time until harvest/focus on short term generating activities	20	33.9
3	Uncertainty about market/buyer	19	32.2
4	Difficulty in accessing seed	15	25.4
5	Land availability/suitability	14	23.7
6	Right to land	13	22.0
7	Teak spoils soil and dries up water	8	13.6
8	Information about nurserying and planting	6	10.2
9	Was living away when everyone planted/too late now	6	10.2
10	Old/sick	4	6.8
11	No policy incentive (subsidy)	4	6.8
12	New household	2	3.4
13	Prefer not to plant exotic species	2	3.4
	Total	135	

* Respondents could state more than one challenge

timber plantations. The key themes that emerged were: market uncertainty; the availability of inputs and information; and household socio-economic characteristics. These are discussed below, together with their implications for policy and policy implementation.

Market access: demonstrating a market for existing plantations

The study suggests that perceived market uncertainty significantly influences current development of small-scale forestry in Isabel Province. While households are

primarily interested to establish small-scale plantations to generate future income, the perception that a market for timber from existing plantations is uncertain or non-existent deters many from planting trees under current conditions and also discourages tree planters from maintaining their plantations. In this study, it was common that households had not thinned or pruned their plantations to the recommended standard, an issue also noted in other studies (e.g. see Holding Anyonge and Roshetko 2003; Perdana et al. 2012).

Developing markets, whether local and/or export, for existing planted timber resources in Isabel province is critical to overcoming current scepticism about tree planting as a livelihood option. Although final harvest of most plantations established in the 2003 and 2004 is still some years away, many plantations are reaching an age suitable for commercial thinning. Finding buyers for both thinnings and final harvest at prices acceptable to the tree planters is likely to be a challenge as it requires a solution appropriate to the quality and quantity of timber, and the remote and scattered locations of the producers. As part of an overall market strategy, there may be a role and need for government or other supporting institutions to support smallholders to overcome these challenges.

Building smallholders' knowledge about the market for their timber and market exchanges may help empower and build capacity to participate in the market (Perdana et al. 2012). A more realistic understanding of rotation length, market requirements, marketing costs and price may also help develop more informed participation in tree planting as a livelihood option.

More intensive silvicultural management would produce better quality timber capable of fetching a higher market price. Poor silvicultural management may reflect limited understanding of good silvicultural practice (Kallio et al. 2012), as well as poor market links and a lack of price incentive for a long-term crop (Roshetko et al. 2013). This is consistent with the notion that rural households, particularly those with a strong subsistence orientation and/or low incomes, are sensitive to market uncertainty (e.g. see Ellis 1992; Mahapatra and Mitchell 2001; Mendola 2005). Exposure to silvicultural demonstration and information can increase adoption of silvicultural practice and increased sharing of information between farmers (Roshetko et al. 2013).

There may also be a role for government and supporting institutions to consider mechanisms to increase the bargaining power of individuals and communities (Angelsen and Wunder 2003; Perdana et al. 2012; also see Blumfield and Wallace 2011). For a remote and scattered timber resource, a collective approach to marketing has the potential to improve the economies of scale, thereby improving efficiency and reducing transaction costs, as well as improving quality control and access to information and equipment (Perdana et al. 2012). In this regard, it will be valuable to critically monitor the piloting of timber producer associations that are currently being conducted in other provinces (B. Ngiloaia, MOFR, 10 April 2014, pers. communication), as well as other work to explore the potential of collective marketing (ACIAR 2013).

Extension services: access to germplasm, inputs and information

While smallholders may have traditional knowledge about indigenous species, to successfully plant and manage exotic species they are likely to require germplasm and inputs, new knowledge and skills (Lamb 2011). This was the first rotation growing exotic commercial timber species for all households in this study. Access to germplasm, inputs and information was identified as a key constraint to adoption and maintenance; this finding echoes studies in other regions (see Roshetko et al. 2008).

Access to seed was also widely identified as a constraint to tree planting. A project to make germplasm accessible for households in 2003 and 2004 likely explains the high proportion of tree planting households in one of the studied villages. Both within villages and at the MOFR office in Buala, availability of seed was sporadic at the time of study. From a government perspective, there is a recognised tension between making seed accessible and ensuring this limited resource is not wasted (SIG 2013). Developing more local sources of germplasm may improve reliability and accessibility of supply. Solutions must take into account local travel and infrastructure limitations. Also, there may be opportunities to consider species and planting arrangements that require less upfront labour/preparation of land, how germplasm is made available (as seed or seedlings), and the information or

training required for smallholders to successfully nursery and transplant timber species.

The positive relationship between awareness of extension services and adoption of tree planting is consistent with other studies (Mercer 2004; Salam et al. 2000; Schuren and Snelder 2008; Thacher et al. 1997). Awareness of extension was also strongly positively correlated with plantation size. Although these correlations do not imply causation, low awareness of extension services is likely to limit current household adoption and maintenance to some extent. The common perception that access to germplasm, information and materials for maintenance were key challenges further supports the conclusion that access to extension services needs to be strengthened if adoption rates and maintenance are to improve.

Although the village-based model that underpins the roles of CFEOs in the Solomon Islands has recognised potential (Gua 2008 in Lamb 2011), staff face challenges in providing effective extension. In practice, forestry officers had limited resources to enable travel and engagement beyond their neighbouring villages. Households often associated the MOFR more with the logging industry than reforestation and had a strong perception of corruption in the former. These factors affected perceptions about the presence and quality of extension services and, in particular, their reliability and integrity as a source of information and support. The persistence of rumours about the negative environmental effects of teak[10] (despite MOFR efforts to rebut them) highlights the challenge in providing information through government services that is counter to information from local institutions, in particular the church; this finding echoes those of Racelis and Aswani (2011) and Riddell (2012).

These findings suggest that better access to germplasm, inputs and information from the provincial down to the household level is required to improve adoption and maintenance of plantations. At the provincial and national levels, this demands a long-term, coordinated approach to providing services that address identified needs in a timely manner. This study suggests that developing accessible sources of quality germplasm should be a top priority. Further to this, Community-based Forestry Extension Officers require greater resources and support to frequent villages across their district, and provide information that is appropriate to smallholders. Given the greater presence of agricultural officers in the field and the relationship between small-scale forestry plantations, particularly agroforestry systems, and agriculture, the role for greater collaboration between Forestry and Agriculture ministries could be considered (also noted in Pauku 2009).

Household socio-economic characteristics

This study finds that households' socio-economic characteristics and perceptions influence their adoption of small-scale forestry. This is consistent with a number of other studies (e.g. Emtage and Suh 2004; Kallio 2013; Mahapatra and Mitchell 2001; Salam et al. 2000; Sabastian et al. 2014; Simmons et al. 2002).

Households commonly experienced multiple competing demands on their labour resources due to family, church and community commitments, and perceived that this constrained their adoption and maintenance of trees. However, there was no clear relationship between household working ratio and adoption of tree planting, which aligns with the idea that tree planting can be a flexible, low input livelihood option (Bertomeu 2006). Many households looked favourably on the lower workload of mature trees; also the emerging preference to plant mahogany under coconut was primarily due to perceived lower upfront and ongoing labour requirements, which further highlights how labour considerations inform decision-making. This has been highlighted elsewhere, e.g. Bertomeu et al. (2011) report that smallholder timber farmers in the Philippines switch to species that are self-pruning as a means of reducing labor costs.

In contrast with many studies (Dewees and Saxena 1997; Emtage et al. 2007; Kallio et al. 2011; Pattanayak et al. 2003; Sandewall et al. 2010), this study found no clear relationship between adoption of tree planting and income. Also counter to other studies (Bertomeu 2004; Boulay et al. 2011; Godoy 1992; Thacher et al. 1997), off-farm income did not have a clear influence on either adoption or intensity of tree planting in this study. However, income was strongly

[10] A number of studies have reported that smallholder teak systems enhance soil fertility, rehabilitate land and shorten fallow periods (Midgley et al. 2007; Osemeobo 1989; Roshetko et al. 2013).

positively related with number of trees planted. This suggests that, although tree planting may have a relatively low cost of entry, particularly under the right conditions (i.e. accessible information and germplasm), the higher costs of maintaining larger numbers of trees may prohibit lower income households from establishing and maintaining larger plantations. The potential for poorer households to be excluded from the livelihood benefits of plantation forestry has been noted elsewhere (Newby et al. 2014).

The long lag until harvest was widely perceived as limiting household incentives to allocate labour to establish and maintain timber plantations. This is consistent with findings of other studies (Dewees and Saxena 1997; Lintangah et al. 2010). Development and promotion of agroforestry planting arrangements that incorporate timber species with crops with a shorter rotation could help address this challenge in small-scale forestry. Intercropping can provide a short-term income source from annual crops, improve tree establishment and growth, and encourage more active plantation management. Intercropping does not need to be limited to the establishment phase; mature trees can also be intercropped (Roshetko et al. 2013). In the Solomon Islands context there is potential to develop the use of multiple indigenous species to complement small-scale forestry plantations (Pauku 2009).

Secure land tenure is a basic enabling condition for the development of smallholder forestry (Roshetko et al. 2008. Across all study villages, with the exception of the settler village, there were generally high levels of perceived tenure security. Tree planters were more likely to describe their tenure as secure, which supports findings from other studies that perceived tenure insecurity limits a household's incentive to plant trees (e.g. see Boulay et al. 2011; Byron 2001; Godoy 1992; Santos Martín et al. 2011). However, the positive relationship between adoption and perceived tenure security was not highly statistically significant, and a lot of the significance of this variable came from the greater prevalence of perceived tenure insecurity in the settler community, which had the lowest proportion of tree planters across all five villages.

Generally speaking, Isabel province is characterised by low population density and an abundance of land (SIG 2001). Correspondingly, a relatively low proportion of households perceived land availability to constrain adoption of tree planting; the village nearest the provincial centre, where village density was highest, had the greatest perceived land constraints. Perceived land constraints were negatively correlated with adoption of tree planting, which reflects the findings of other studies (Bertomeu 2004; Boulay et al. 2011; Dewees and Saxena 1997; Emtage 2004; Kallio et al. 2011; Salam et al. 2000; Santos Martín et al. 2011).

Households with a younger household head were significantly less likely to be tree planters, which is likely to reflect that a majority of plantations were established between 2003 and 2005. Limited tree planting in the intervening years may reflect lower awareness of tree planting and greater difficulty accessing seed and information now relative to the 'teak fever' years, when the Australian-led Forest Management Programme was heavily involved in reforestation. This trend may also reflect booms in new agricultural cash crops that have been observed in the Solomon Islands in recent years (Jansen et al. 2006). Many households also cited that, given perceived market uncertainty, they preferred to observe market developments before planting trees. Some studies suggest that household life cycle stage may influence land use decisions, with younger households more likely to focus on faster-producing sources of income generation (Perz and Walker 2002), and older households having a lower cash orientation, a higher focus on leaving something for their children and a preference for less intensive labour (Schuren and Snelder 2008); household perceptions indicated some generational differences in motivations in this regard (e.g. preference of younger households to work in logging), though this finding was not conclusive.

The literature suggests that farmer participation in community organisations can positively influence the adoption of tree planting (Byron 2001; Kallio et al. 2011; Mahapatra and Mitchell 2001). However, in this study, there is only a weak positive correlation between participation in community organisations and tree planting. Across the study villages, organisations with greatest membership were church groups, followed by small savings groups and income generation projects. None of these had a focus on enabling or supporting adoption of tree planting.

Despite this, the existing institutional landscape offers some insight into potential to improve the coordination and accessibility of information and

inputs for small-scale forestry at the village or district level. Firstly, savings groups and income generation projects were often, at least initially, developed with external organisations or partners. This reflects Pender and Scherr's (1999) finding that external organisations have some potential to catalyse local organisational development. Initiatives that were perceived to support improved income generation (e.g. fishing cooperative with a freezer) or saving opportunities (e.g. savings clubs) were typically favourable looked upon, though were not without organisational challenges. This is consistent with the view that households are often more likely to collectively organise if they perceive benefits to be tangible and outweigh the costs (Byron 2001). Finally, as noted elsewhere (see Racelis and Aswani 2011; Riddell 2012), church and village institutions and leaders have considerable influence within villages, and their support and cooperation is likely to be critical for local organisational development.

Conclusion

The paper has assessed the factors that influence household adoption of small-scale forestry through a case study of Isabel Province, the Solomon Islands. These factors were investigated through a mixed methods approach, in which a household survey of tree planters and non-tree planters was complemented with qualitative methods.

The study illustrates that developing markets for the timber resource in existing plantations is critical to the continued development of smallholder plantation forestry in the Solomon Islands. Smallholders alone have limited capacity to address the barriers to their participation in the market, such as their low bargaining power, lack of market information and high transactions costs. Addressing these barriers to market participation should be a short-term priority for government and other supportive institutions.

The longer-term success of the smallholder forestry sector requires strengthened extension services that can effectively reach remote and scattered village locations, and cater to the diverse livelihood platforms of households. This requires strategies to ensure that germplasm, information and inputs are locally accessible, and to develop and promote tree species and planting arrangements that take into account not only biophysical considerations, but also households' objectives (both economic and subsistence) and the constraints that they face (such as labour and the need for short- or medium-term economic return). In particular, agroforestry species and planting arrangements may hold potential to meet multiple objectives and provide return over shorter timeframes. Opportunities may exist to develop locally relevant models of smallholder organisation that aim to improve coordination and accessibility of information and inputs with regard to tree planting and agroforestry at the village or district level.

Acknowledgments The research benefitted from the advice and comments from Dr. Tim Blumfield, Dr. Frédérique Reverchon and Larren Gomese of the ACIAR project, *Enhancing economic opportunities offered by community and smallholder forestry in the Solomon Islands.* Moreover, the support received from staff of the Solomon Islands' Ministry of Forestry and Research and the Diocese of Isabel, particularly Bishop Richard Naramana, is greatly acknowledged. Any errors though are the sole responsibility of the authors.

Funding Financial support for the research was received from Major General J.F. Classen Foundation, Miss Ellen Backe and Margaret Munn Tovborg Jensen's Foundation; PLAN-Danmark; Jubilæumsfondet ved Science, Copenhagen University; Agricultural Development grant, Copenhagen University.

References

ACIAR (2013) Teak value chain review. Pacific Agribusiness Research & Development Initiative, Adelaide

Amacher G, Hyde W, Rafiq M (1993) Local adoption of new forestry technologies: an example from Pakistan's Northwest Frontier Province. World Dev 21(3):445–453. doi:10.1016/0305-750X(93)90156-4

Angelsen A, Wunder S (2003) Exploring the forest—poverty link: key concepts, issues and research implications. CIFOR Occassional Paper (No. 40). CIFOR, Jakarta

Arnold JEM (2001) Forestry, poverty and aid. CIFOR occasional paper No. 33, vol 62. CIFOR, Bogor. http://www.cifor.org/publications/pdf_files/OccPapers/OP-033.pdf. Accessed 14 Feb 2015

Barney K (2008) Local vulnerability, project risk, and intractable debt: the politics of smallholder eucalyptus promotion in Salavane Province, Southern Laos. In: Snelder DJ, Lasco RD (eds) Smallholder tree growing for rural development and environmental services. Springer Science+Business Media, Leiden, pp 263–286

Bertomeu M (2004) Smallholder timber production on sloping lands in the Philippines: a systems approach. Doctoral dissertation, Escuela Técnica Superior de Ingenieros de Montes, Universidad de Madrid

Bertomeu M (2006) Financial evaluation of smallholder timber-based agroforestry systems in Claveria, Northern

Mindanao, the Philippines. Small-Scale For Econ Manag Policy 5(1):57–82
Bertomeu M, Roshetko JM, Rahayu S (2011) Optimum pruning strategies for reducing crop suppression in a gmelina–maize smallholder agroforestry system in Claveria, Philippines. Agrofor Syst 83:167–180
Blumfield T, Wallace H (2011) Development of a market mechanism for teak and other high value timber in the Western Province of the Solomon Islands. Pacific Agribusiness Research for Development Initiative (PARDI), Brisbane
Blumfield T, Moveni R, Lyons K (2012) Project Proposal. Enhancing economic opportunities offered by community and smallholder forestry in the Solomon Islands. FST-2012-043. ACIAR, Brisbane
Blumfield T, Bacon G, Lyons K, Walters P, Tutua S, Moveni R (2013) Improving silvicultural and economic outcomes for community timber plantations in Solomon Islands by interplanting with Flueggea flexuosa and other Pacific agroforestry species. Final report. FST/2007/020. ACIAR, Canberra
Boulay A, Tacconi L, Kanowski P (2011) Drivers of adoption of eucalypt tree farming by smallholders in Thailand. Agrofor Syst 84(2):179–189
Byron N (2001) Keys to smallholder forestry. For Trees Livelihoods 11(4):279–294. doi:10.1080/14728028.2001.9752396
Carle BJ, Holmgren P (2008) Wood from planted forests: a global outlook 2005–2030. For Prod J 58(12):6–18
Daniel J (2005) Sampling essentials: practical guidelines for making sampling choices. Sage Publications, Los Angeles, pp 125–174
Dewees PA, Saxena NC (1997) Tree planting and household land and labour allocation: case studies from Kenya and India. In: Arnold M, Dewees PA (eds) Farms, trees and farmers: responses to agricultural intensification. Earthscan, London
Ellis F (1992) Peasant economics: farm households and agrarian development. Cambridge University Press, Cambridge
Ellis F (2000) The determinants of rural livelihood diversification in developing countries. J Agric Econ 51(2):289–302
Emtage NF (2004) An investigation of the social and economic factors affecting the development of small-scale forestry by rural households in Leyte Province, Philippines: a typology of rural households in relation to small-scale forestry. Doctoral dissertation, University of Queensland
Emtage N, Suh J (2004) Socio-economic factors affecting smallholder tree planting and management intentions in Leyte Province, Philippines. Small-Scale For Econ Manag Policy 3(2):257–270
Emtage N, Herbohn J, Harrison S (2007) Rural household diversity and the implications for small-scale forestry development in Leyte Province, the Philippines. In International Conference on Poverty Reduction and Forests, Bangkok, September 2007 (pp. 1–23)
Evans BR (2006) Solomon Islands smallholder agriculture study solomon islands smallholder agriculture study. Volume 5 literature review: a brief national assessment of the agriculture sector. AusAID,Canberra, Australia
FAO (2010) Global forest resources assessment 2010: Main Report. FAO Forestry Paper 163. Food and Agriculture Organisation of the United Nations, Rome
Garen EJ, Saltonstall K, Slusser JL, Mathias S, Ashton MS, Hall JS (2009) An evaluation of farmers' experiences planting native trees in rural Panama: implications for reforestation with native species in agricultural landscapes. Agrofor Syst 76(1):219–236. doi:10.1007/s10457-009-9203-4
Godoy RA (1992) Determinants of smallholder commercial tree cultivation. World Dev 20(5):713–725. doi:10.1016/0305-750X(92)90147-N
Harrison S, Herbohn J, Niskanen A (2002) Non-industrial, smallholder, small-scale and family forestry: what's in a name? Small-Scale For 1(1):1–11
Holding Anyonge C, Roshetko JM (2003) Farm-level timber production: orienting farms towards the market. Unasylva 212(54):48–56
Hughes T, Crawford P, Sutch H, Tacconi L (2010) SI forest management project II (FMP2). Independent Completion Report (ICR)
Idol T, Haggar J, Cox L (2011) Ecosystem services from smallholder forestry and agroforestry in the tropics. In: Campbell WB, Lopes Ortiz S (eds) Integrating agriculture, conservation and ecotourism: examples from the field. Springer, New York, doi:10.1007/978-94-007-1309-3_5
Jansen T, Mullen B, Pollard A, Maemouri R, Watoto C, Iramu E (2006) Solomon Islands smallholder agriculture study solomon islands smallholder agriculture study. Volume 2: Subsistence production, livestock and social analysis. AusAID, Canberra
Kabutaulaka TT (2005) Rumble in the jungle: land, culture and (un)sustainable logging in Solomon Islands. In: Hooper A (ed) Culture and sustainable development in the Pacific. ANU E Press and Asia Pacific Press, Australian National University, Canberra, pp 88–97
Kallio M (2013) Factors influencing farmers' tree planting and management activity in four case studies in Indonesia. Doctoral thesis, University of Helsinki
Kallio MH, Kanninen M, Rohadi D (2011) Farmers' tree planting activity in Indonesia—case studies in the Provinces of Central Java, Riau, and South Kalimantan. For Trees Livelihoods 20(2–3):191–209. doi:10.1080/14728028.2011.9756706
Kallio MH, Kanninen M, Krisnawati H (2012) Smallholder teak plantations in two villages in Central Java: silvicultural activity and stand performance. For Trees Livelihoods 21(3):158–175
Kragten M, Tomich TP, Vosti S, Gockowski J (2001) Evaluating land use systems from a socio-economic perspective. ASB Lecture Note 8, International Centre for Research in Agroforestry, Bogor, pp 3–6
Lamb D (2011) Regreening the Bare Hills: tropical forest restoration in the Asia-Pacific region. Springer, Brisbane
Lintangah W, Mojiol AR, Kodoh J (2010) An assessment of tree plantation activity among smallholders in the District of Ranau, Sabah. Mod Appl Sci 4(9):58–65
Lyons K, Walters P, Riddell E, Burch PD, Boer H (2012) Agroforestry and its social impacts social science research final report—2012 (pp. 1–31)
Maetala R (2008). Matrilineal land tenure systems in Solomon Islands: the cases of Guadalcanal, Makira and Isabel Provinces. In E. Huffer (ed.) Land and women: the matrilineal factor. The cases of the Republic of the Marshall Islands,

Solomon Islands and Vanuatu. Suva. Pacific Islands Forum Secretariat, Fiji
Mahapatra AK, Mitchell CP (2001) Classifying tree planters and non planters in a subsistence farming system using a discriminant analytical approach. Agrofor Syst 52:41–52
Maxwell JA (2008) Designing a Qualitative Study. In: Bickman L, Rog D (eds) The handbook of applied social research methods, 2nd edn. Sage Publications, Thousand Oaks, pp 214–253
Mendola M (2005) Farm Households Production Theories: a review of "institutional" and "behavioural" responses (No. 1), vol 21450. Università degli Studi di Milano Dipartimento di Economia Politica e Aziendale Via, Milano
Mercer DE (2004) Adoption of agroforestry innovations in the tropics: a review. Agrofor Syst 61–62(1–3):311–328. doi:10.1023/B:AGFO.0000029007.85754.70
Midgley S, Blyth M, Mounlamai K, Midgley D, Brown A (2007) Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64
Nawir AA, Murniati LR, Rumboko L (2007) Forest rehabilitation in Indonesia: Where to after more than three decades? Jakarta: Center for International Forestry Research. http://www.cifor.cgiar.org/rehab
Newby J, Cramb R, Sakanphet S (2014) Forest transitions and rural livelihoods: multiple pathways of smallholder teak expansion in Laos. Land 3:482–503
Obidzinski K, Dermawan A (2010) Smallholder timber plantation development in Indonesia: what is preventing progress? Int For Rev 12(4):339–348
OECD (2005) What are equivalence scales? OECD Project on Income Distribution and Poverty, pp 1–2. www.oecd.org/social/inequality.htm Accessed 14 Feb 2015
Osemeobo GJ (1989) An impact and performance evaluation of smallholder participation in tree planting, Nigeria. Agric Syst 29(2):117–138
Ostrom E (1990) Governing the commons: the evolution of institutions for collective action. Cambridge University Press, Cambridge
Pattanayak SK, Mercer DE, Sills E, Yang J (2003) Taking stock of agroforestry adoption studies. Agrofor Syst 57:173–186
Pauku RL (2009) Solomon Islands Forestry Outlook (No. APFSOS II/WP/2009/31). Food and Agriculture Organisation of the United Nations, Bangkok
Perdana A, Roshetko JM, Kurniawan I (2012) Forces of competition: smallholding teak producers in Indonesia. Int Forest Rev 14(2):238–248
Pender J, Scherr SJ (1999) Organisational development and natural resource management: evidence from central Honduras (EPTD Discussion Paper No. 49). International Food Policy Research Institute, Washington DC
Perz SG, Walker RT (2002) Household life cycles and secondary forest cover among small farm colonists in the Amazon. World Dev 30(6):1009–1027
Peterson N, Hamilton R, Pita J, Atu W, James R (2012) Ridges to reefs development plan for Isabel Province, Solomon Islands. Report No 1/12. The Nature Conservancy, Indo-Pacific Division
Racelis AE, Aswani S (2011) Hopes and disenchantments of religious community forestry in the Western Solomon Islands. Ecol Environ Anthropol 6(1):26–38
Raymond DH, Wooff WG (2006) Small-scale forest plantations are the key to the future of the Solomon Islands forest industry. Int For Rev 8(2):222–228. doi:10.1505/ifor.8.2.222
Riddell E (2012) Competing claims: perceptions, disjunctures and programme efficacy in the Solomon Islands. Master's dissertation, University of Queensland
Rohadi BD, Kallio M, Krisnawati H, Manalu P (2010) Economic incentives and household perceptions on smallholder timber plantations: lessons from case studies in Indonesia. Montpellier conference 24–26 March 2010
Roshetko JM, Lasco RD, Delos Angeles MD (2007) Smallholder agroforestry systems for carbon storage. Mitig Adapt Strat Glob Change 12:219–242
Roshetko JM, Snelder DJ, Lasco RD, van Noordwijk M (2008) future challenge: a paradigm shift in the forestry sector. In: Snelder DJ, Lasco RD (eds) Smallholder tree growing for rural development and environmental services. Springer Science+Business Media, Leiden, pp 453–485
Roshetko JM, Rohadi D, Perdana A, Sabastian G, Nuryartono N, Pramono AA, Widyani N, Manalu P, Fauzi MA, Sumardamto P, Kusumowardhani N (2013) Teak agroforestry systems for livelihood enhancement, industrial timber production, and environmental rehabilitation. For Trees Livelihoods 22(4):241–256. doi:10.1080/14728028.2013.855150
Sabastian G, Kanowski P, Race D, Williams E, Roshetko JM (2014) Household and farm attributes affecting adoption of smallholder timber management practices by tree growers in Gunungkidul region, Indonesia. Agrofor Syst 88:257–268. doi:10.1007/s10457-014-9673-x
Salam MA, Noguchi T, Koike M (2000) Understanding why farmers plant trees in the homestead agroforestry in Bangladesh. Agrofor Syst 50:77–93
Sandewall M, Ohlsson B, Sandewall RK, Sy Viet L (2010) The expansion of farm-based plantation forestry in Vietnam. Ambio 39(8):567–579. doi:10.1007/s13280-010-0089-1
Santos Martín F, Bertomeu M, Noordwijk M, Navarro R (2011) Understanding forest transition in the Philippines: main farm-level factors influencing smallholder's capacity and intention to plant native timber trees. Small-Scale For 11(1):47–60. doi:10.1007/s11842-011-9166-y
Scherr SJ (1995) Economic factors in farmer adoption of agroforestry: patterns observed in Western Kenya. World Dev 23(5):787–804
Schuren SHG, Snelder DJ (2008) Tree growing on farms in Northeast Luzon (The Philippines): smallholders' motivations and other determinants for adopting. In: Snelder DJ, Lasco RD (eds) Smallholder tree growing for rural development and environmental services. Springer Science+Business Media, Leiden, pp 75–97
Scoones I (1998) Sustainable rural livelihoods: a framework for analysis. IDS working paper (No. 72)
Simmons CS, Walker RT, Wood CH (2002) Tree planting by small producers in the tropics: a comparative study of Brazil and Panama. Agrofor Syst 56:89–105

SKM (2012) Solomon Islands National Forest Resources Assessment: 2011 Update. Sinclair Knight Merz, Melbourne

Snelder DJ, Lasco RD (2008) Smallholder Tree Growing in South and Southeast Asia. In: Snelder DJ, Lasco RD (eds) Smallholder Tree Growing for Rural Development and Environmental Services. Springer Science+Business Media, Leiden, pp 3–33

Solomon Islands Government (SIG) (2001) Isabel Province Development Profile. Solomon Islands Government, Ministry of Provincial Government and Rural Development, with technical assistance from UNDP/UNOPS Solomon Islands Development Administration & Participatory Planning Programme (SIDAPP)

Solomon Islands Government (SIG) (2009) 2009 Population and housing census. National report, vol 2. Solomon Islands National Statistical Office, Ministry of Finance and Treasury, Honiara

Solomon Islands Government (SIG) (2012) Report on 2009 population and housing census. Basic tables and census description. Solomon Islands National Statistical Office. Ministry of Finance and Treasury, Honiara. http://www.mof.gov.sb/Libraries/Statistics/2011_06_-_Report_on_2009_Population_Housing_Census.sflb.ashx Accessed 15 Feb 2015

Solomon Islands Government (SIG) (2013) Forest development and reforestation division: program activities. Solomon Islands Government, Ministry of Forestry and Research

Solomon Islands Government (SIG) (2014) Forestry extension officer village workshop training manual. National Forestry Plantation Development Program, Solomon Islands Government, Honiara

Solon G, Haider SJ, Wooldridge J (2013) What are we weighting for? (No. 18859), Cambridge. http://www.nber.org/papers/w18859.pdf Accessed 15 Feb 2015

Taylor JE, Adelman I (2003) Agricultural household models: genesis, evolution, and extensions. Rev Econ Household 1(1):33–58

Thacher T, Lee DR, Schelhas JW (1997) Farmer participation in reforestation incentive programs in Costa Rica. Agrofor Syst 35:269–289

URS (2006) National Forest Resource Assessment Update 2006. Solomon Islands Forestry Management Project II. URS Sustainable Development. Prepared for AusAID, Canberra

Van Noordwijk M, Roshetko JM, Murniati Angeles, Suyanto MD, Fay C, Tomich TP (2008) Farmer tree planting barriers to sustainable forest management. In: Snelder DJ, Lasco RD (eds) Smallholder tree growing for rural development and environmental services. Springer Science+Business Media, Leiden, pp 429–451

Walters BB, Cadelina A, Cardano A, Visitacion E (1999) Community history and rural development: why some farmers participate more readily than others. Agric Syst 59:3–7