

14. AGROFORESTRY FARMING PRACTICES OF SMALLHOLDERS IN LEYTE AND IMPLICATIONS FOR AGROFORESTRY SYSTEMS DESIGN

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This paper examines evidence from the Leyte Island smallholder socio-economic survey, on the agroforestry systems adopted by smallholders in terms of timber trees and other crops. A number of broad categories of agroforestry systems may be identified, in terms of smallholders growing various tree and crop species and raising livestock on the same land parcels. However, there do not appear to be any favoured and widely adopted species mixtures with particularly high performance that could be rolled-out more widely. Also, at a land-use block level, survey data provides little evidence of widely-adopted specific agroforestry systems.

INTRODUCTION

Agroforestry often allows landholders to utilize their land resources efficiently to gain maximum output and achieve an acceptable time flow of cash and products for on-farm use. A huge body of literature exists on *agroforestry systems*, for example papers in the journal of this name. Various definitions exist as to what constitutes an *agroforestry system*. As generally understood, agroforestry involves a mixture of trees and crops or livestock. For example, Helms (1998, p. 4) in *The Dictionary of Forestry* defines agroforestry as 'a land-use system that involves deliberate retention, introduction, or mixture of trees or other woody perennials in crop and animal production systems to take advantage of economic or ecological interactions among the components'. Agroforestry systems as defined by Helms are most widely practiced in developing countries.

Another form of agroforestry is *taungya*, in which timber trees and agricultural or horticultural crops are grown together. Helms (1998) defined *taungya* as simply the local name for shifting cultivation in Myanmar. However, *taungya* is sometimes used by governments as a mean of securing labour for plantation establishment at reduced cost and with increased efficiency, by engaging the local community in the early stage of plantation development (e.g. Jordon *et al.* 1992; Maung and Yamamoto 2007). According to Adekunle and Bakare (2004, p. 134), 'Agroforestry practice has become a way of livelihood to farmers in Nigeria. *Taungya* is an agroforestry practice whereby forest trees and agricultural crops are raised simultaneously on the same piece of land. It is primarily aimed at plantation establishment. ... It was introduced in Nigeria in 1927 [for] regeneration of tropical rainforests ...'.

Another use of the term agroforestry, adopted by the Rural Industries Research and Development Corporation (RIRDC) in Australia, is where timber trees and some other crop or livestock production are conducted on the same farm, but not mixed together in the same area on the farm.

Kenneth *et al.* (1990) have listed more than a dozen benefits of agroforestry, where trees and other plants or animals are managed on the same block of land. These benefits include

crop protection from sun and wind, organic matter addition, nutrient recycling, exploiting greater soil volume, providing a disease and pest barrier and erosion control.

As noted by Harrison and Harrison (2000), many examples of crop yield increase have been reported in the literature, but the species adopted 'have limitations such as restricted environments where they grow well and limited uses of their products. Hence there is merit in extending the choice available to growers in part to cater for the diverse biophysical and socio-economic environments of the Philippines' (p. 134). They further noted the potential concern with some Australian tree species being introduced to the Philippines with regard to high soil water extraction, competition for nutrients and allelopathy.

In the study reported here, the objective is to identify agroforestry systems in the sense of mixed plantings on the same parcel or block of land which are adopted, or have to potential for adoption, by Leyte smallholders. The mixture of trees with crops or livestock on the same parcel of land corresponds to the RIRDC definition, while mixtures on the same vegetation block follow the more traditional definition of Helms.

In broad terms, a number of agroforestry systems adopted by Leyte smallholders may be identified, for example: coconuts and timber trees; coconuts and other products (e.g. fruit trees, livestock); timber trees and fruit trees; and coconuts or timber trees and rice. However, what would be more useful is to identify which species of timber trees and other agricultural activities (fruit trees, crops, and vegetables) can be grown as mixtures within the same vegetation block, to gain the economic and ecological interactions identified by Helms (1998).

AGROFORESTRY SYSTEMS IN THE PHILIPPINES

A substantial literature exists on agroforestry systems in the Philippines. Bertomeu and Roshetko (2007) conducted field trials on the pruning intensity of gmelina when alley cropped with maize, finding that increased pruning intensity increased grain yield but not enough to compensate for the cost of pruning and the reduced timber value. They recommended growing trees of less competitive species, or trees in farm niches away from crops. In contrast, Magcale-Macandog and Abucay (2007) simulated the growth performance of a eucalypt-maize agroforestry system in Clavaria, Mindanao, concluding that 'the eucalypt-maize hedgerow system provides substantial improvements to a range of biophysical and economic measures of productivity and sustainability' (p. 229).

Rañola *et al.* (2007) carried out a profitability analysis for 16 farming systems in Clavaria, Northern Mindanao, including four agroforestry systems: rubber plus mango block plantings and rice, corn and tomatoes; timber plus fruit trees multi-story and corn and tomatoes; fruit trees with hedgerows and corn; and mango block planting with rice and ampalaya. The timber trees included gmelina, bagras, mangium, mahogany and narra, while the fruit species included bananas, mangoes, rambutan, durian, lanzones, jackfruit, marang and coconuts. They concluded that 'the most profitable systems are those where high-value fruit crops (bananas) and fruit trees (mango, lanzones, durian) are integrated at high densities in the farming system' (p. 333).

In a Leyte study, Gonzal (2007) examined the economic and ecological benefits of integrating abaca (*Musa textilis*) in established monoculture fruit trees and coconuts, and mixed forest culture including rainforestation farming. Fruit species suggested include durian, lanzones, citrus, rambutan and mango. Gonzal noted that 'utilising the open space between monoculture coconuts will minimise further forest encroachment and clearing of tropical forest for abaca plantation' (p. 20).

In a current study, Mercado and others are examining the benefits and establishment requirements of elite timber-latex clones of rubber (*Hevea brasiliensis*) along with other crops including maize, bananas and pineapples in Mindanao in the Philippines (Mercado, in process).

RESEARCH METHOD

A socio-economic survey covering a sample of 81 smallholders was conducted in seven randomly selected municipalities in Leyte and Southern Leyte Provinces. The use of focus groups, the questionnaire design and development and the survey procedure, have been discussed by Severe *et al.* (2006). This paper concentrates on sections C, D and E of the survey, which relate to land-use systems.

Land-use patterns were examined at the land parcel and land (or vegetation) block within parcel level, and then for land blocks carrying timber trees.

PARCEL CHARACTERISTICS AND LANDUSE PATTERNS

The 81 respondents reported a total of 252 land parcels, an average of 3.1 per respondent. Land tenure details were reported for 246 land parcels. Some characteristics of owners and land parcels are summarized in Table 1. About 60% of the parcels were owned under title, 21% were owned tax declaration land, and only 6% were tenanted. The land was mostly acquired by inheritance or purchase. Most respondents classified their land as flat or moderately sloping. The average parcel size was 4.71 ha, but 82.5% of the parcels were 4 ha or smaller, and 67.1% were 2 ha or smaller. Most were within 10 km of a town. Slightly more than 54% classified their road to the nearest town as concrete, though some reported poor road types.

Table 1. Characteristics of owners and land parcels

Characteristic of parcel	Frequency distribution
Tenure (n=249)	Owner 150, tax declaration 52, tenant 15, administration 8, communal 3, lease 2, titled tenant 1, other (mixed type, no answer) 18
How land obtained (n=247)	Inherited 105, purchased 94, only a tenant 15, CARP (land reform) 10, ancestral domain 5, other (mixed type, no answer) 18
Land slope (n=246)	Flat 93, gentle 10, moderate 118, steep 11, flat to gentle 2, flat to moderate 3, moderate to steep 2, other 7
Parcel size in ha (n=240)	0-5 ha 60, 0.51 to 1 ha 52, 1.01-2 ha 49, 2.01-4 ha 37, 4.01-6 ha 17, 6.01-10 ha 11, 10.01-20 ha 8, 20.01-100 ha 5, over 100 ha 1, mean area 4.71 ha
Distance to nearest town (n=238)	0 to 2.5 km 45, 2.51 to 5 km 53, 5.01 to 7.5 km 42, 7.51 to 10 km 46, 10.01 to 15 km 43, 15.01 to 20 km 9
Road type to nearest town (n=239)	Concrete 130, mainly smooth unsealed 6, mainly rough unsealed 35, trail 10, concrete and trail 20, concrete and rough unsealed 34, smooth unsealed and concrete 1, rough and trail 3

Table 2 reports land-use in terms of main crop, in order of perceived importance. For each of 245 parcel land-use responses, coconuts were as grown on 108 (44.1%) of the parcels, gmelina on 67, and mahogany on 40. One or more timber species was reported as a crop grown on 101 (41.2%) of the parcels. Rice was reported as being grown on only 37 (15.1%) of the parcels; this number would have been limited by the area of land suitable for rice and

by water unavailability. Various fruit and vegetable species were grown, though none on more than 10% of parcels. Only one respondent considered abaca as a main crop.

Table 2. Main crops and other crops reported by smallholders, by land parcel (n=245)

Crop type	Frequency as:			Total
	First main crop	Second main crop	Other main crop	
Coconut	91	14	3	108
Gmelina	59	7	1	67
Mahogany	28	12	0	40
Rice	32	4	1	37
Mango	6	2	0	8
Bananas	2	2	1	5
Vegetables	2	0	1	3
Sweet potato	1	1	0	2
Fruit trees	0	1	1	2
Bamboo	0	2	0	2
Tacudo	1	0	0	1
Abaca	1	0	0	1
Total	218	45	8	271

Respondents listed a number of 'other crops', as distinct from their main crops, the most commonly listed species being coconuts, followed by bananas (Table 3). Of the timber tree species, mahogany was most frequently mentioned, followed by gmelina. Bananas, mangoes and bamboo were relatively minor 'main crops' but significant 'other crops'. Abaca again received few mentions.

Table 3. Reported frequencies by parcel for 'other crops' grown by smallholders (n=245)

Crop type	Frequency as			Total
	First other crop	Second other crop	Less important other crop	
Coconut	38	7	5	50
Bananas	12	9	13	34
Mahogany	13	4	2	19
Mango	9	5	4	18
Bamboo	3	9	3	15
Gmelina	7	3	2	12
Rice	2	2	0	4
Abaca	3	1	0	4
Fruit trees	3	1	0	4
Sweet potato	1	1	0	2
Vegetables	0	1	0	1

Table 4 summarizes some combinations of what were reported as main crops and other crops on the land parcels. Timber and coconuts were the most common combination. Bananas were grown as another crop on the same land parcels as both timber and coconuts. In the few cases where bananas were the main crop the farmers appear to be specialist banana producers. Rice was rarely reported as being grown on the same parcels as other crops.

Table 4. Crop combination matrix (n=245) ^a

Main crop	Other crop			
	Timber (42)	Coconut (50)	Rice (4)	Bananas (31)
Timber (101)	0	43	0	16
Coconuts (108)	24	0	3	18
Rice (37)	1	3	0	3
Bananas (5)	0	0	0	0

^a Numbers in parentheses are frequencies of mentions as main and other crops.

Overall, the parcel analysis indicates that there is a wide variety of cropping systems, based in particular on coconuts, timber trees, fruit and rice. However, apart from this broad typification, it is difficult to identify commonly adopted agroforestry systems. While coconuts and timber trees are both grown on more than 40% of land parcels, these are listed together as major crops on only 67 parcels (27.3%). Similarly, both coconuts and rice are listed as major crops on only six parcels, and timber trees and rice on only four parcels.

PARCEL AND BLOCK ANALYSIS OF TREE SPECIES GROWN

While the above data are derived from a question confined to land parcels, details were also sought on a *parcel and block* basis, for blocks (distinct units within land parcels) carrying tree species. The frequencies for timber species are higher than those reported above, where separate blocks carrying trees are defined within a land parcel. Gmelina was clearly the most widely grown timber species, followed by mahogany (Table 5). No other tree species is reported as a main crop on more than 5% of land parcels.

Table 5. Trees as main crops on each land parcel (n=200)

Tree species	Frequency of first listing	Frequency of second or later listing	Relative frequency (%)
Gmelina	112	3	55.8
Mahogany	69	5	35.9
Mangium	10	0	4.4
Bagras	3	0	1.5
Auri	2	1	1.5
Bamboo	2	0	1.0
Bangkal	1	0	0.5
Mango	1	0	0.5
Total	200	7	

As indicated in Table 6, gmelina, mahogany and mangium are most frequently planted in compact blocks within land parcels, and there is only a small proportion of border plantings (mainly of gmelina). Notably, only about 51% of the gmelina plantings are in compact blocks, whereas compact blocks are the rule for mahogany and mangium (73% and 100% of the sample, respectively).

Table 6. Contingency table of species versus planting layout, for main species (n=198)^a

Planting layout	Species			Total	Relative frequency (%)
	Gmelina	Mahogany	Mangium		
Compact block	59 (51.3)	54 (73.0)	9 (100)	122	61.6
Intercropped	25 (21.7)	16 (21.6)	0 (0)	41	20.7
Fenceline planting	18 (15.7)	2 (2.7)	0 (0)	20	10.1
Other, not stated	13 (11.3)	2 (2.7)	0 (0)	15	7.6
Total	115	74	9 (0)	198	100.0

^a Numbers in parentheses are percentages.

Table 7 lists the 'other' tree species and crops grown and livestock grazed, in 207 blocks carrying trees, reported by respondents. Coconuts clearly lead the list. The main tree species (gmelina, mahogany and mangium) have few mentions under 'other' trees grown. Among the other timber trees, the native tree species of ipil-ipil and antipolo are the most popular, and bamboo is also notable. Bananas and mangoes are the most popular fruit species, and carabao is the most widely found large livestock species. In that no individual species has a high frequency, no widely practiced agroforestry systems in terms of species mix are apparent.

Table 7. Other trees and plants grown, and livestock grazed, in tree blocks

Tree, crop or livestock species ^a	Frequency of mentions	Tree, crop or livestock species	Frequency of mentions
Coconut	63	Jackfruit	5
Gmelina	1	Talisay ^b	3
Mahogany	5	Durian	1
Mangium	2	Pineapple	1
Ipil-ipil	12	Tamarind	1
Antipolo	10	Fruit trees	2
Bagalonga	3	Cacao	1
Anislag	4	Cassava	1
Narra	4	Carabao	9
Bamboo	8	Cattle	5
Banana	9	Goats	2
Mango	7		

^a Strictly speaking, tree species should not have been mentioned in response to this question.

^b Talisay (*Terminalia catappa*) is an almond-like medicinal plant.

CROP, LIVESTOCK AND NON-FARM INCOMES

Table 8 summarizes respondents' earnings from cropping over the year preceding the survey, for those completing this part of the questionnaire. Sixty eight respondents (84.0% of the sample) produced copra, all selling their product. Thirty five respondents (43.2%) reported growing rice, but only half sold palay (unhusked) rice, on average selling about three quarters of their harvest. Abaca generated the next highest level of revenue, all being sold. On average, about half of the mango and camote crop was sold, and about one third of the banana and cassava production.

Table 8. Production, disposition, and prices and revenue from main crops

Production or sales variable	Crop							
	Copra (kg)	Rice (palay)	Camote (60 kg bag)	Cassava (60 kg bag)	Banana (piece)	Abaca (kg)	Pineapple (piece)	Mango (piece)
Number producing crop	68	35	11	6	29	6	9	6
Number selling crop	68	17	7	4	20	6	4	4
Total quantity harvested	256,554	6673.5	72.5	129	233,495	2350	6805	2719
Average proportion sold per producer (%)	98.28	37.61	49.47	33.83	31.93	100	23.44	58.83
Average proportion sold per seller (%)	98.28	77.44	77.74	50.75	46.3	100	52.75	88.25
Average price (PhP)	13.22	501.91	308.57	85.00	0.68	13.33	14.63	22.00
Average revenue per seller (PhP)	49,877	197,029	3196	2741	7939	5221	24,889	14,955
Average revenue over all sample farms (PhP)	41,152	32,023	214.71	68.70	907.57	5106.20	648.35	651.72

The annual crop income over the whole sample averaged PhP76,053, the main contributions being from copra and rice. Of the 68 respondents growing copra, 38 grew no rice, presumably lacking suitable land. Of the 35 growing rice, six grew no copra. This suggests that farmers who are able to grow rice also produce copra. Other crops reported, of lower importance for on-farm food production and sales, were cacao, peanuts, and papaya, ampalaya, star apple, jackfruit, lanzones, rambutan and other fruit species.

Table 9 reports details provided on livestock owned, and revenue from livestock sales. Pigs and chickens were the most widely reported livestock species raised, and used for food on-farm. Twenty farmers slaughtered a total of 140 pigs, and sold 449 head at an average price of PhP3079. Thirty three farmers (40.7% of the total sample) had a total of 163 pigs on hand, and three of these reported having a total of 26 piglets on hand. Pigs were the greatest livestock revenue earner, followed by cattle. The annual livestock income over the whole sample averaged PhP24,787, more than two-thirds of which was from sale of pigs. In regard to other livestock, five owners had a total of 168 ducks on hand, although no duck sales were reported. One respondent reported having sheep, and one reported having horses.

Table 9. Livestock numbers, sales, prices and revenue^a

Production or disposition variable	Livestock species				
	Cattle	Carabao	Pigs	Goats	Chickens
Number of current owners	16	8	33	7	35
Number slaughtering animals ^a	7	na	20	2	32
Number slaughtered	12	na	140	4	525
Number of sellers	6	5	23	1	6
Number sold	42	11	449	2	268
Mean price ^b	10,337	15,250	3079	650	82.5
Stock on hand	515	79	163	20	570
Mean income over sample	5359.93	2070.99	17,067.54	16.05	272.96

^a 'na' means not available because not asked, but number very small.

^b The mean price is an average over the prices obtained per seller, where some respondents sold more than one head of a particular species.

Off-farm Income

Table 10 summarizes the off-farm income sources of respondents. Many of the respondents had some form of non-farm income, the most important sources being income from professions and from 'other' sources (including non-professional work, sari-sari store, driving, tuba gathering, and charcoal making). Twenty one percent received domestic remittances, but amounts were small, and only about one in 10 reported remittances from overseas. Only one respondent reported working for pay on another farm. Twelve respondents indicated they produce charcoal from coconut shells, but only one from timber.

Table 10. Sources and amounts of off-farm income

Number and income type	Remittances (domestic)	Remittances (international)	Work on other farms	Fishing	Income from professions	Income from other sources
Number reporting income	17	8	1	5	38	40
Total income (PhP)	22,758	302,000	6000	318,600	4,949,676	5,046,118
Average income per respondent (PhP)	1339	37,750	6000	63,720	130,255	126,153

EVIDENCE OF AGROFORESTRY SYSTEMS FROM DATA ON INDIVIDUAL BLOCKS

The data for individual blocks provided limited evidence of mixed-species plantations or adoption of agroforestry systems in the sense of combining timber trees with other crops. An example is provided in Table 11, which reports various characteristics of Block 1 of Parcel 1 for all sample respondents. Most respondents reported only a single species (usually gmelina or mahogany), and a high stand density. Most plantings were of compact blocks. No planting had taken place in the last five years, and only 17.1% had planted in the last 10 years. Practically no detail was provided on intercropping, although coconuts and grazing with carabao were mentioned. The pattern was similar across all blocks, although less detail was provided than for Block 1, and some mention was made of fruit trees.

Table 11. Some characteristics of Parcel 1, Block 1

Characteristic	Value or frequency distribution
Number of tree species reported	One: 77; more than one: 1
First tree species listed (n=81)	Gmelina 40; mahogany 34; mangium 4; none 3
Mean block size (m ²) (n=64)	0.85 ha
Mean number of trees (n=62)	1156
Planting layout (n=77)	Compact block 52, intercropped 15, boundary planting 2, other 8
Planting year (n=77)	2004 or later: 0; 1999 or later: 13; 1994 or later: 48; 1983 or later: 75; 1973 or later: 76

LAND USES ON TREE BLOCKS

Blocks planted to trees were identified where present in the timber inventory survey, and the same sampling framework was adopted in the socio-economic survey. The definition adopted for a tree block was that the minimum area be 0.1 ha and the minimum number of

trees be 100. Respondents were asked to list other species on these tree blocks, and responses are summarized in Table 12.

Table 12. Other land-use activities on tree blocks (n=352)

Species	Frequency	Species	Frequency
No other land use	252	Talisay	3
Coconut	65	Bagalonga	3
Ipil-ipil	14	Molave	3
Banana	11	Lanzones	3
Antipolo	10	Goats	2
Carabao	9	Guava	2
Mahogany	6	Bayanti	2
Anislag	6	Abaca	1
Mango	5	Pineapple	1
Jackfruit	5	Sheep	1
Tibig	5	Gmelina	1
Cattle	5	Cacao	1
Narra	4		

Of 352 tree blocks, no other trees or plants grown or livestock raised were reported on 252 blocks. Coconuts were reported on nearly two-thirds of the other blocks. Relatively small numbers of tree blocks contained other timber or fruit tree species (more than one tree species). Carabao were grazed on nine tree blocks, and cattle on five. Overall, apart from the trees and coconuts combination, no clear pattern of agroforestry system is evident.

From observations, fruit trees including pineapples are sometimes grown under tree crops for a limited time before canopy closure, but in that no recent plantings were observed, this activity would be missed in the survey data. This analysis also excludes the wide variety of vegetable species grown on small areas on household blocks where some fruit or timber trees are often present. Notably, the micro definition of a tree block (at least 0.1 ha and 100 trees) would limit the presence of multiple species.

CONCLUDING COMMENTS

Some broad classes of agroforestry can readily be identified in Leyte, even by casual driving through the countryside. Rice is widely grown on relatively flat coastal areas, backed by coconuts and bananas on slopes, with roadside plantings of gmelina. The challenge in this study was to use a survey approach to obtain more in-depth insights into agroforestry systems.

It is clear that Leyte smallholders rely almost exclusively on two timber species, with gmelina dominating mahogany. There would appear to be a resurgence in coconut production, following the recovery of the copra price, with little recent planting of timber trees. A wide variety of tropical fruit species are grown, but bananas and mangoes appear to be the main commercial species. Fruit trees are typically a secondary crop on farms growing coconuts and timber trees. Surprisingly few landholders are growing abaca crops.

On a farm and land parcel basis, there is broad mix of crop and livestock activities being conducted, but there is little evidence of mixed activities within blocks. Growing multiple species at the farm and parcel level provides income stability, increased self-sufficiency and some complementarities between species, but does not take full advantage of the economic and ecological benefits raised by Helms (1989) and Kenneth *et al.* (1990). Alley cropping

appears not to be widely practiced in Leyte. There appears to be scope for further development of within-block species mixtures, as are being trialled in Mindanao.

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