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Agroforestry and Forestry in Sulawesi series:

Profitability of land-use systems in South Sulawesi and Southeast Sulawesi

Arif Rahmanulloh, M. Sofiyuddin and Suyanto

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

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ICRAF Southeast Asia Regional Program
Jalan CIFOR, Situ Gede, Sindang Barang
Bogor 16115, Jawa Barat
[PO Box 161, Bogor 16001]
Indonesia

Tel: +62 251 8625415
Fax: +62 251 8625416
Email: icraf-indonesia@cgiar.org
http://www.worldagroforestrycentre.org/sea

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About the authors

Arif Rahmanulloh is a researcher under the Economic and Policy Unit (EPU) in ICRAF-SEA Regional Office specializing in Agroforestry economic and engage closely with various studies about land-use financial and economic assessments since 2007. Arif obtained his bachelor degrees on Forest Management at Gadjah Mada University.

M.Sofiyuddin is a researcher on Agroforestry Economist that familiarize with the Socio Economic methodology research such as household survey, Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) method. Yudi involves in design of survey and questionnaires, train enumerators for survey try-out and data collection, data compiling, data cleaning and data tabulation, data analyzing and interpretation.

Dr. S Suyanto has more than 15 years experience in natural resource management and institutional analysis. He has worked at the ICRAF-Southeast Asian Regional Research Programme based in Indonesia since 1994, developing a range of skills in socio-economic, natural resource economics, econometrics and institutional analysis. He conducted a study on the evolution of indigenous land tenure and tree resource management in the buffer zone of Kerinci National Seblat Park in Sumatra for his PhD dissertation. In the last five year, He managed several research projects relate on climate change, namely (1). "Efficient and Fair ways of Avoiding Carbon Emissions in Indonesia's Forest Margins: next steps in Negotiation Support Systems" (Ford Foundation Project); (2) "Sustainable livelihood options and carbon rights: a basis for efficient and fair emission reduction in the Central Kalimantan Ex-Mega Rice Project" (AUSAID Project); (3) "Fair, Efficient and Sustainable Emission Reduction from Land Use in Indonesia (FESERLUI)" – (Packard Project); (4) " Accountaibility and local level initiative to reduce emission from deforestation and degradation in Indonesia" (ALLREDDI-EU Project). He is currently leading the economic and policy analysis unit in ICRAF's Indonesia.

Abstract

This profitability assessment is an early effort to generate baseline information for the Agroforestry and Forestry in Sulawesi: Linking Knowledge with Action project (the ‘AgFor project’), for implementation in two provinces, South Sulawesi and Southeast Sulawesi. The study collected information on existing farming systems and estimated profitability for each land use. The profitability indicators used in the study are: net present value (NPV), equivalent annuity and return to labour. Our estimation shows that in South Sulawesi the most profitable land-use system using the annual equity measure was clove gardens, followed by coconut-cacao mixed-gardens and coconut-gardens. Timber-garden systems generated the highest return to labour of the other land uses, while the coconut used for sugar system generated the lowest (USD 6 per day). In Southeast Sulawesi, the most profitable land-use system using the annual equity measure was timber-gardens (teak), followed by pepper monoculture, and patchouli monoculture. Timber-gardens (teak) generated the highest return to labour of the others, while the cacao monoculture system generated the lowest (USD 10 per day).

Keywords: profitability, net present value, equivalent annuity, return to labour

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Contents

1. Introduction **1**
2. Methods **1**
Study site 1
Data collection 2
Data analysis 2
3. Results and discussions **4**
Selected main land-use systems 4
Profitability 10
Labour engagement 13
4. Conclusion **15**
References **16**

List of tables

Table 1. Macroeconomic parameters used in the study 2
Table 2. Land cover of South Sulawesi and the selected main land-use systems 5
Table 3. Selected main land-use systems in Southeast Sulawesi 7
Table 4. Productivity of selected land-use systems 9
Table 5. Profitability and return to land of land-use systems in South Sulawesi 10
Table 6. Profitability of land-use systems in Southeast Sulawesi. 12
Table 7. Labour engagement 14

1. Introduction

This study is an early attempt to provide baseline information for the proposed enhanced livelihood of rural areas intervention to be conducted in Sulawesi, as part of the Agroforestry and Forestry in Sulawesi: Linking Knowledge with Action project ('AgFor Sulawesi project'), by the World Agroforestry Centre (ICRAF). Assessing the profitability of existing farming systems will generate information about which farming systems are most efficient, thus able to generate more income for household farmers. Understanding farming system efficiency will also help farmers in resource allocation. They will be able to invest in the systems that provide the highest financial return, leading to improvement in their quality of livelihood. As well as profitability, it is important to understand the labour engagement of farming systems, in order to ensure suitable development intervention. Labour engagement in farming systems is linked to the demographic condition of the area. By understanding the figures of labour engagement of the existing systems, we can analyse the workforce availability for proposed development intervention.

This study aims to 1) estimate profitability of existing land use, and 2) provide figures of labour engagement in the farming systems of the study site.

2. Methods

Study site

This study took place in two provinces, South Sulawesi and Southeast Sulawesi. In South Sulawesi, we selected a mountainous area located in the districts of Bantaeng and Bulukumba, approximately 150 kms from Makassar. The area of Bulukumba district is 1154.7 km^2 and inhabited by 394 757 people in 2010 (BPS 2010). The adjacent district of Bantaeng is smaller, covering an area of 395.83 km^2 with a population of 170 057 people in 2010.

In Southeast Sulawesi we selected the districts of Konawe and Kolaka. The area of Konawe is approximately 16 480 km^2, while Kolaka is 6918.38 km^2. The population of Kolaka was 314 812 people in 2010, and Konawe was 246 798 in 2011 (BPS 2012).

Data collection

The first stage of the study was to select the land use systems for the profitability analysis. Primary data was collected using rapid rural appraisal (RRA). Data of farm budgets for each different land use were gathered (including price, production, labour and input), for the period of 2012.

The people interviewed for the purpose of the study consisted of farmers, traders and government officers. Land-use data was developed from interviewing these various sources to define the most common patterns as practiced by farmers in the study site.

We also conducted focus group discussions (FGDs) to collect comprehensive information about the main uses of land in the villages. Each FGD consisted of approximately 5–9 farmers, and we were assisted by local translators to reduce language barriers.

The study also collected data from secondary sources, such as government publications. The fieldwork for the data collection was undertaken in March 2012.

Data analysis

The data collected during the fieldwork was analysed to create farm budgets. We employed assumptions for all farm budgets consisting of exchange rates, daily wage rates and interest rates (Table 1). These farm budgets were then used to estimate the profitability indicators for return to land, net present value (NPV) and return to labour.

Table 1. Macroeconomic parameters used in the study

Parameters	
Exchange rate	IDR 9085 =USD 1
Wage rate in:	
South Sulawesi	USD 3.3/day
Southeast Sulawesi	USD 5.5/day
Private interest rate	8%/year

The wage rate for agricultural work was IDR 30 000–50 000 per day, and the exchange rate was IDR 9085 = USD 1. Real interest rates (interest rate net of inflation) were the discount factors used to value future cash flows in current terms. We suggest that a private discount rate of 8% is a lower boundary for the actual cost of capital for a smallholder owing to imperfections in capital markets in the study area. Due to the time constraints and lack of reliable time-series data, the study used single year price data (2012 prices).

Return to land

We used net present value (NPV) as one of the indicators for return to land. NPV is the most common indicator used for comparing the profit of different types of investment (in this case, different types of land use). The NPV of an investment is defined as the sum of the present values of the annual cash flows, minus the initial investment. The annual cash flows are the net benefits (revenue minus costs) generated from the investment during its lifetime. These cash flows are discounted or adjusted by incorporating the uncertainty and time value of money (Gittinger 1982).

NPV is one of the most robust financial evaluation tools to estimate the value of an investment. The formula to calculate the NPV is as follows:

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

Where B_t is benefit at year t, C_t is cost at year t, t is time denoting year and i is discount rate.

NPV in this study is calculated at private price. NPV at private price shows private profitability, as a measure of profitability and as a production incentive. The investment for one specific land use is labeled profitable if the NPV is higher than 0. The higher the NPV, the higher the profitability of that investment.

Equivalent annuity

Since each land-use system has a different cycle, we used equivalent annuity to make the comparison between land-use systems possible. The formula is described as follows:

$$C = \frac{r(NPV)}{1-(1+r)^{-n}}$$

$$C = Equivalent\ Annuity\ Cash\ Flow$$
$$NPV = Net\ Present\ Value$$
$$r = rate\ per\ period$$
$$n = number\ of\ periods$$

The equivalent annuity expresses the NPV as an annualized cash flow by dividing it by the present value of the annuity factor. Due to the character of the definition itself, it is generally argued that using NPV or its equivalent annuity is the same (Luciano 2001).

Return to labour

The measure of return to labour is approached by adjusting the wage rate until the NPV reaches 0. This proxy can be used since the calculation converts the surplus to a wage rate (Vosti et al. 2000). The value of return to labour indicates the attractiveness of the system: if the return to labour is higher than the average wage rate, then it is attractive for people to work in the system. In comparison, if the value is lower than the daily work return (wage rate), then people tend to choose other opportunities rather than this system.

3. Results and discussions

Selected main land-use systems

South Sulawesi

The land-use system identification for this profitability assessment was selected based on FGDs about livelihood, conducted in each village. The FGDs identified the main uses of land that were managed by villagers to generate the majority of their income. The result was 11 land-use systems for assessment in this study (Table 2).

Table 2. Land cover of South Sulawesi and the selected main land-use systems

Category	Land-use type	Products	Scale of operation (ha)	Location (village)
Crops	Maize	Maize	0.5-1	Bonto Cinde
Mixed-garden	Candlenut garden	Candlenut, maize	1	Bonto Cinde
	Kapok garden	Kapok, maize	1	Bonto Cinde
	Coffee garden	Coffee, maize	1	Kayuloe
	Coconut sugar garden	Coconut sugar	1	Tugondeng
	Coconut-cacao garden	Coconut, cacao	1	Tugondeng
	Cacao-coffee garden	Cacao, coffee, fruit	1	Campaga
	Cacao-coffee-clove garden	Cacao, coffee, clove, fruit	1	Campaga
Timber-garden	Gmelina garden	Gmelina	0.5-1	Karassing
	Sengon-gemelina garden	Sengon, gmelina	0.5-1	Karassing
Monoculture	Clove garden	Clove	1	Barong Rappoa

The study noted that maize cultivation was widely practiced in the village of Bonto Cinde in the Bantaeng district. Farmers cultivated maize intensively, even in the area with hilly topography. Looking at the landscape, it is clear that maize cultivation dominates the agricultural activities in this area. Most maize crops were managed by adding fertilizer of up to 600 kg per area, in a year. Farmers used hybrid seeds in order to harvest two or three times a year. Each harvest produced approximately 5000 kgs of maize. Other land-use types in this mountainous area were spotted candlenut (*Aleurites moluccana*), and kapok (*Ceiba pentandra*), which grew in lower areas. According to farmers, recent trends have seen candlenut trees felled and replaced with maize.

Farmers are required to wait until the productive period of the candlenut tree, which takes around three years. The tree fruits only once a year, when thousands of candlenuts fall from the trees, for several weeks. Each day farmers and their families collected the fallen fruit and transported it home. Some farmers processed the candlenuts manually, involving breaking the hard coats of the nuts one by one.

In the lower area of Bonto Cinde, some farmers managed kapok gardens. We met with the head of the farmers group to collect information about the cultivation of kapok. Generally, farmers planted kapok with maize on the same land. They managed maize for the first two years, while the kapok garden provided enough open space to allow sunlight to reach the maize plants.

Farmers recognized that the kapok tree is fast-growing with low requirements for input. Fertilizer was used for the maize during the first two years, as well as other chemical herbicides. Kapok farmers began to harvest during the third year, with an average yield of 0.5 kg for each tree. Some of the farmers sold kapok unprocessed in sacks, and some processed it to produce a flexible thin bed of material, that was then shipped to Surabaya.

Complex mixed-garden systems were found in Campaga. This type of land use refers to multispecies of trees planted in the same area. Common tree species managed by farmers include cacao, coffee, clove (*Syzygium aromaticum*) and types of fruit trees. This type of land use reflects the change in farmers' preferences in choosing tree species. Prior to 1992, their land was planted with annual crops such as maize or shrubs, then in 1992 they began to cultivate cacao. Several years later, they heard about Arabica coffee and planted it between the cacao trees. However, they experienced low production of cacao and in 2009 they experimented with planting clove trees instead. Some fruit trees were also planted in smaller numbers, such as durian (*Durio* sp) and rambutan (*Nephelium lappaceum*).

Farmers in Campaga each applied approximately 400 kg of chemical fertilizer per year for their mixed-gardens. They also applied manure at the beginning of both cacao and coffee planting. Approximately 4 L of chemical herbicide was sprayed each year to remove unwanted vegetation. Other farming activities undertaken by farmers in this system included pruning, manual weeding, harvesting and the drying of coffee beans. The coffee-related activities were the most labour intensive, using approximately 86% of the total labour.

Mixed-gardens of different tree compositions were found around Tugondeng, where in 1 hectare of land, farmers usually cultivated 143 coconut trees mixed with 1000 cacao trees. Farmers regularly applied fertilizer of up to 480 kg each year for both coconut and cacao trees. Instead of routinely applying fertilizer, farmers also conducted manual weeding and spraying of other chemicals. Cacao pruning was undertaken each year during the productive period. Under this type of land management, a hectare of land produced an average of approximately 27 000 units of coconut fruit each year, and 946 kg of dried cacao beans.

In this area we also found farmers who utilized the coconut tree to make sugar. We noted this type of land use was very highly labour intensive. Twice a day farmers were required to tap the juice (a clear liquid contained within the coconut flower, locally called 'nira'), in the morning and the evening. They collected the coconut nira with a bucket or plastic bottle which they then placed into a pan. Each day they cooked this liquid on a fuelwood cooking stove in a simple wooden hut located in the garden area. From every 30–35 coconut trees, 10 kg of coconut sugar was produced each week. It is estimated that their annual sugar production requires 44 m^3 of fuelwood for each hectare of plantation.

Timber-gardens were found in Karassing, which is located close to Tugondeng. In this area, farmers utilized their land with homegardens, by planting fast growing trees such as sengon and gmelina. According to farmers, they started to plant trees when the government distributed free seedlings in 1990. After the first harvesting, more farmers were attracted to plant sengon and gmelina. During fieldwork, we found a farmer who was expanding his timber-garden to include teak.

Clove gardens were mostly found in upper Bantaeng and Bulukumba. In these areas, the landscape was dominated by trees, primarily productive clove trees. Farmers usually managed 200 clove trees per each hectare of land. Each year they conducted manual weeding to clean the ground of shrubs and dried leaves. The harvesting was undertaken every two years by hiring specialized harvesting labour. According to farmers, at the beginning of the harvesting years each tree can produce approximately 2 kg of cloves. The production then increases to 30 kg per tree when the tree reaches seven years.

Southeast Sulawesi

Seven major land-use systems in Konawe and Kolaka districts, Southeast Sulawesi province, were selected for profitability analysis (Table 3). We discovered that patchouli, pepper, sago and cacao were commonly found in monoculture systems. We also noted mixed-gardens included combinations of cacao-coconut and cacao-patchouli systems. All land-use systems were managed by smallholders, and ranged from 0.25 ha to 1 ha.

Table 3. Selected main land-use systems in Southeast Sulawesi

Category	Land-use type	Products	Scale of operation (ha)	Location (village)
Crops	Patchouli	Patchouli	0.25-1	Anggawo, Lamunde, Tinondo
Mixed-garden	Cacao-coconut garden	Cacao, coconut	1	Taosu
	Cacao-patchouli garden	Cacao, patchouli	1	Anggawo, Tinondo
Timber-garden	Teak garden	Teak	0.5-1	Anggawo
Monoculture	Sago	Sago	0.5-1	Simbune
	Pepper	Pepper	0.5-1	Lawonua
	Cacao garden	Cacao	1	Asipako, Tasahea, Taosu

In Southeast Sulawesi province, almost the entire area is dominated by cacao plantations. Cacao cultivation started in the 1970s, when various government programs encouraged tree planting in order to improve the production of exportable commodities. In the last 20 years, the area of cacao cultivation in Southeast Sulawesi has increased from 55 000 ha in 1990, to 230 000 ha in 2010 (Dirjenbun 1990–2010), with an average productivity of 966.01 kg/ha (KPPU 2009).

The productivity of cacao varies depending on the pattern of cultivation. Recent cacao productivity has declined, due to a number of issues such as the quality of seeds, pests and disease, and the plant requiring rejuvenation due to age. Decreasing productivity and pest attacks have caused farmers to start looking for other easily cultivated and more profitable crops.

In some areas where farmers had cultivated coconuts as their main income, they had begun to plant cacao under the coconut stands to generate more revenue. In order to utilize the land and increase profits, farmers had also begun to plant patchouli on the cacao plantations.

Farmers had started very recently cultivating patchouli. They were interested to cultivate this crop after seeing the success of farmers in other districts with it, such as in Northern Kolaka district. Their preference for patchouli was mostly due to the ease of cultivation, as patchouli can be harvested six months after planting, and then harvested every four months.

We also noted pepper as one of the significant commodities in Southeast Sulawesi, a crop that has increased in growth since 1990. Based on 2010 data from the total area of 12 193 hectares, more than 60% of the pepper plantation area is located in Konawe and Kolaka (BPS 2011). The cultivation of pepper in Southeast Sulawesi uses traditional methods, including farmers using gamal trees as climbing poles. According to farmers, the productivity of these crops was decreased due to pest attack.

Sago palm is widely grown in Southeast Sulawesi, encompassing vast areas in several districts, and has long been used as a staple food. The sago palm plantation area has reached approximately 5282 hectares (BPS 2011). People interviewed explained that historically sago was brought by migrants from Maluku Island to Southeast Sulawesi, where it was planted and then adapted to the new environment, before eventually spreading throughout the province. However, the current sago plantation area is declining due to excessive harvesting, lack of planting, and also settlement development.

In Konawe district, several villages in Lambuya and Uepai subdistricts are located directly adjacent to the forest. These villages have timber-based systems which range from around 0.5 ha to 1 ha. Teak planting in Southeast Sulawesi began in 2003–2005, as part of the implementation of a government reforestation program. During that period local government distributed free seedlings to be planted on private lands.

Summarized land-use productivity of selected land-uses both in South Sulawesi and Southeast Sulawesi is shown at Table 4.

Table 4. Productivity of selected land-use systems

Site	Land use	Main products	Averaged Productivity		Labour use (ps-day/ha/yr)	Fertilizer (kg/ha/yr)
			Production	Unit		
South Sulawesi	Candlenut garden	Candlenut	1,890	kg/ha/yr	666	-
	Coffee garden	Coffee	778	kg/ha/yr	28	155
	Crops	Maize	10,000	kg/ha/yr	86	800
	Kapok garden	Kapok	5,096	kg/ha/yr	103	-
	Timber-garden	Sengon Gmelina*	870	tree/ha	26	-
	Mixed-garden	Cacao	857	kg/ha/yr	111	533
		Coffee	313	kg/ha/yr		
	Timber-garden	Gmelina*	935	tree/ha	29	-
	Mixed-garden	Cacao	857	kg/ha/yr	142	400
		Coffee	268	kg/ha/yr		
		Clove	182	kg/ha/yr		
	Coconut	Sugar	13,237	kg/ha/yr	1006	254
	Mixed-garden	Coconut	10,922	kg/ha/yr	111	531
		Cacao	946	kg/ha/yr		
	Clove garden	Clove	381	kg/ha/yr	82	-

Southeast Sulawesi	Monoculture garden	Cacao	778	kg/ha/yr	83	500
	Mixed-garden	Cacao	748	kg/ha/yr	89	508
		Patchouli	12,500	kg/ha/yr		
	Monoculture garden	Sago*	240	kg/ha/yr	117	-
	Mixed-garden	Cacao	704	kg/ha/yr	105	500
		Coconut	6,267	unit/ha/yr		
	Monoculture garden	Pepper	674	kg/ha/yr	227	105
	Timber-garden	Teak*	450	tree/ha	29	-
	Crops	Patchouli	12,500	kg/ha/yr	115	100

** at the end of period (harvesting).*

Profitability

Table 5 shows the results of profitability assessment in the mountainous area of Bantaeng and Bulukumba, South Sulawesi. There were 11 land uses identified and assessed during the fieldwork. The table also indicates different periods of estimation. Mixed-garden and clove garden systems employ a period of 30 years, while the timber-based system employs a shorter period.

Table 5. Profitability and return to land of land-use systems in South Sulawesi

Type of land use	**Main product**	**1 cycle period (year)**	**Return to land ($/ha)**	
			At 1 cycle period	**Equal per year**
Crops	Maize	1	953	953
Kapok garden	Kapok	30	10,506	933
Kemiri garden	Kemiri	30	5,380	478
Coffee garden	Coffee bean (arabica)	30	5,946	518
Timber-garden	Sengon, gmelina	9	6,766	1,074
Timber-garden	Gmelina	8	7,629	1,317
Mixed-garden	Cocoa, coffee, fruits	30	10,188	888
Mixed-garden	Coconut, cacao	30	20,355	1,774
Coconut	Sugar	30	19,872	1,732
Mixed-garden	Cocoa, coffee, fruits, clove	30	17,136	1,492
Clove garden	Clove	30	36,459	3,239

Looking at the annual equity, the result shows that the most profitable land-use system is clove garden, followed by complex mixed-garden consisting of coconut and cacao. Clove that was cultivated in a monoculture system performed as the most profitable.

Farmers in Campaga also planted clove within their mixed-gardens three years ago but as yet they have been unproductive. Instead, they have had to provide more labour during the unproductive period.

The lowest profitability land use is shown as coffee gardens in Kayuloe. This system has no commercial products except for coffee beans. Farmers only planted Arabica coffee mixed with shading trees that have no economic value. In this system, farmers had allocated lower input (without even fertilizer application) leading to low production of Arabica beans. Coffee farmers also experienced a recent drop in the price of Arabica beans: in March 2012, they received a coffee price as low as IDR 10 000 per kg. The low production of coffee beans could be improved by rejuvenation and increasing the amount of input.

Our estimation of candlenut gardens shows that the system generates a low return to land. As observed during the fieldwork, we found that many candlenut gardens were increasingly replaced with other crops, such as maize. The domination of such crops replacing trees may increase environmental risks in the area. Improving farm management by introducing mixed systems such as agroforestry, would reduce the environmental risks without a significant loss to economic return.

The replacement of candlenut trees with maize possibly took place during the boom period in maize cultivation 5–10 years ago. During this period, farmers received prices of maize that were much higher than the current price of 1600 per kg. This could contribute to the continued preferences by farmers for maize. Another factor to consider is that income is generated more often from maize, which is harvested twice a year. In comparison, candlenut trees only produce once a year and involves high resources of labour in the fruit collection and post-harvest processing.

The result of the profitability assessment for Southeast Sulawesi province shows that all land uses are positive, indicating that they are profitable. Estimates of NPV using the annual equity are presented in Table 6.

Table 6. Profitability of land-use systems in Southeast Sulawesi.

Type of land use	Main product	Period (year)	Return to land (USD/ha)	
			At 1 cycle period	Equal per year
Monoculture garden	Cacao	20	3732	374
Mixed-garden	Cacao, patchouli	20	4489	450
Monoculture garden	Sago	15	4208	485
Mixed-garden	Cacao, coconut	20	5588	560
Monoculture garden	Pepper	20	22 936	2299
Timber-garden	Teak	20	25 201	2567
Crops	Patchouli	1	1938	1938

For all land-use systems, patchouli is the most profitable. Undeniably, patchouli is an easy crop to be cultivated. Production requires very little input but can produce a large output. With a spacing of only 50cm x 50cm, the number of plants per ha reaches 2000 trees. Of this amount more than 10 ton of leaves and stems can be harvested. In the study site it was found that farmers were able to easily access collectors (middlemen) as well as businesspeople running distilleries. Although prices for patchouli fluctuate, within only six months farmers are able to produce crops, with harvesting taking place every 3–4 months. Due to the capacity of this product, for one year of cultivation, the net profit could reach USD 1938 per ha.

Other land-use systems with high profitability are teak gardens and pepper cultivation. As is well known, to fulfill the raw material requirements for the Indonesian domestic wood industry, people turned to private forest. Increasing domestic demand for wood has caused the price of teak to continue to rise. Although return to land can reach USD 2567, farmers are required to wait for 15–20 years to be able to harvest timber from the teak gardens.

Similarly, pepper prices continue to rise during the last four years—from IDR 40 000 in 2008, to IDR 65 000 in 2011. With productivity of 670 kg per ha, return to land of pepper reaches USD 2299 per year. The low productivity of pepper was due to farmers not following the recommended management, as well as lack of capital. However with the increases in price, the planting of pepper has been quite profitable.

As described previously, cacao plantation is the dominant crop in Southeast Sulawesi. However, our profitability assessment results show that the system generated a 20-year period of NPV as low as USD 374. This low return of cacao could be explained by the fact that productivity of cacao cultivation is already declining due to the old age of the plants. To increase profit, plant rejuvenation and improvements to the patterns of cultivation is required. This low profit has caused farmers to begin to look for alternative crops or other plants to be planted along with the cacao. We calculated the profitability of cacao-coconut mixed-gardens as able to reach a return of USD 560.

The increase in demand for patchouli has resulted in farmers planting patchouli among cacao trees. This study employs a scenario of mixed systems of patchouli planted with 20-year old cacao. This is in accordance with what is taking place in the field. The profitability for this system only increases the return to USD 450. More studies are required to identify the implications upon production yield under a mixed system of patchouli and cacao.

Return to land of sago monoculture reached USD 485, which is slightly higher than cacao. Sago palm can only be harvested at an average age of ten years, hence assessing the productivity was not optimal as farmers have not yet undertaken intensive cultivation. However, while the profitability has a low value, sago palm has a social and culturally important role in Southeast Sulawesi.

Labour engagement

An interesting figure of labour engagement is demonstrated in Table 7. As return to labour is another indicator of profitability for labour, the higher return to labour of a land use means a higher level of attractiveness to farmers for engagement. In both study sites, the assessment results showed that return to labour of each land-use system was higher than the daily wage range.

In South Sulawesi, it is difficult to pinpoint the actual labour wage. This is due to some farming activities (such as land preparation) undertaken communally, with no cash provided to pay for the labour involved. The actual labour wage was commonly found in harvesting activities such clove, coffee, timber and kapok. This study used 30 000 IDR per day (3.3 USD per day) as one of the assumptions in all land-use systems in South Sulawesi. This value was raised when we asked the farmers to assess it, and it is lower than harvesting fees.

Table 7. Labour engagement

Type of land use in South Sulawesi	Return to labour ($ per day)
Crops maize	14
Kapok garden	15
Kemiri garden	4
Coffee garden	19
Timber-garden sengon gmelina	40
Timber-garden gmelina	45
Mixed-garden cocoa coffee	12
Mixed-garden coconut cocoa	22
Coconut sugar	6
Mixed-garden cocoa coffee clove	16
Clove garden	40

Type of land use in Southeast Sulawesi	Return to labour ($ per day)
Cacao	10
Mixed-garden cacao-patchouli	11
Mixed-garden cacao-coconut	11
Sago	11
Pepper	16
Patchouli	27
Teak garden	67

We noted that the coconut sugar system was the most labour-intensive. Although the system generates high NPV, the labour usage of this system altered the return to labour figure to the lowest level. Each year, in a hectare of coconut plantation used for sugar, they require approximately the labour of 1000 ps-day (people a day).

This figure confirms why in the field there was a contract based-system in managing coconut gardens for sugar. Under this system, farmers were able to rent 30–35 coconut trees costing IDR 50 000–100 000 for each coconut tree for a year. This rental system is commonly practiced with 30–35 trees to a household farmer.

In Southeast Sulawesi, all selected land-use systems performed return to labour above the daily wage rate of USD 5.5 per day. Teak monoculture had the highest return to labour. In fact, planted teak does not require a large amount of labour, as maintenance activities are performed only annually, and a large workforce is only required in the early years of planting.

4. Conclusion

In South Sulawesi there are several main land uses identified in the study area, ranging from crops (maize), simple mixed-gardens (candlenut, kapok, coffee, coconut-cacao and coconut sugar), complex mixed-gardens (cacao-coffee and cacao-coffee-clove), timber-gardens and monoculture systems (clove). The most profitable land-use system based on the annual equity measure is clove gardens, followed by coconut-cacao mixed gardens, and coconut gardens. Timber gardens generate the highest return to labour (USD 45 per day) of the other land uses, while the coconut for sugar system shows the lowest (USD 6 per day).

In Southeast Sulawesi, the land uses identified in the study area range from monoculture systems (cacao, patchouli, sago and pepper), simple mixed-gardens (cacao-patchouli and cacao-coconut), and timber-gardens. The most profitable land-use system based on the annual equity measure is timber garden (teak), followed by pepper monoculture, and patchouli monoculture. Timber-gardens of teak generate the highest return to labour (USD 67 per day) of the other land uses, while the cacao monoculture system generates the lowest (USD 10 per day).

We highlight some land-use systems that could be improved to increase economic return, as well as reducing environmental risks. Assisting farmers to manage mixed-gardens would reduce the environmental risks caused by the practice of crop planting that dominates in the mountainous areas. Incentives should be provided for focusing on tree-planting instead of on crops such as maize. Another assistance option is to assist farmers to access better germplasm such as cacao and coffee. Coffee farmers were experiencing unproductive periods and this system should be rejuvenated. The cacao farmers also need assistance in reducing pests and disease.

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United Nations Avenue, Gigiri • PO Box 30677 • Nairobi, 00100 • Kenya
Telephone: +254 20 7224000 or via USA +1 650 833 6645
Fax: +254 20 7224001 or via USA +1 650 833 6646
Southeast Asia Regional Program - Sindang Barang, Bogor 16115
PO Box 161 Bogor 16001, Indonesia
Ph: +62 251 8625415 - Fax: +62 251 8625416
www.worldagroforestry.org/sea