TRADITIONAL VERSUS INTENSIVE COCONUT PRODUCTION IN NORTH SULAWESI

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Summary

The purpose of the study is to assess the efficiency of coconut farming based on the existing farming systems, monoculture versus intercropping; the existing varieties, tall versus hybrid, the existing technology, traditional versus intensive, and on agro-climatic zones, coastal versus mountainous, of North Sulawesi. The government is considering whether to enact policies that favor coconut farmers by subsidizing chemical fertilizers and credit. The purpose of providing input subsidies is to induce or encourage coconut farmers to implement intensive production technology.

The study concludes that intensification has a significant negative impact on farmer incomes. The recommendation that subsidies be used to stimulate the adoption of more intensive technology cannot be implemented. An alternative solution to make the package profitable is to add value by processing coconut products in other forms (e.g., coconut oil, coconut).

I. INTRODUCTION

1.1. Background And Issues

Coconut is the major tree crop in North Sulawesi. In 2001, the total area of coconut palm in that province was 255,573 hectares. The area of productive trees was 181,903 hectares (71.2 %). Most coconut palms are categorized as old trees, and the average annual yield was 1.1 ton of copra per hectare (North Sulawesi In Figures, 2001). Coconut farming is characterized by a large number of farm households with small landholdings (less than 2 hectares). Most coconut farmers use traditional technology without modern inputs, such as chemical fertilizers.

The average yield of coconut farming, 1.1 tons of copra per hectare per year, is much lower than the potential productivities of the tall coconut variety, 2 – 3.5 tons of copra per hectare per year, and of the hybrid coconut variety, 3 – 5 tons of copra per hectare per year. The provincial center of coconut research has developed new technologies for intensifying and intercropping coconut farming. Their research results conclude that fertilizing and intercropping in coconut farming will increase coconut output and double farmer incomes (Tarigans and Mahmud, 1997).

The government would like to enact policy to assist coconut farmers. One suggested policy was to support coconut farmers, via fertilizer and credit subsidies. But these input subsidies almost surely would be used for other crops as well. Before price policies are changed or new technologies are introduced for coconut farming, it is desirable to assess whether an input-intensive system would be profitable for the farmers and the province.

1.2. Purpose of the Study

The purpose of the study is to assess the efficiency of coconut farming in North Sulawesi, based on existing planting patterns (monoculture versus intercropping), varieties (tall versus hybrid), technologies (traditional versus intensive), and agro-climatic zones (coastal versus mountainous). This study will also assess whether an input-intensive system of coconut farming would be profitable. The purpose of providing input subsidies by government is to encourage coconut farmers to implement intensive technology in coconut farming, by using chemical fertilizers and intensive crop care. But subsidies to induce innovation only make sense if the new technologies are profitable for the farmers and efficient for the province.

II. METHODOLOGY

2.1. Data and Data Sources

The information used for this study includes secondary and primary data. The secondary data were obtained from the provincial office of the Central Bureau of Statistics, the Center of Coconut Research, the tree crop smallholder development project of North Sulawesi, and the provincial offices of trade and industrial affairs and of estate/plantation affairs. Primary data were collected through field surveys in six districts of Minahasa, the central area of coconut production in North Sulawesi. The data were collected to obtain physical input-output coefficients of coconut farming as well as costs in private and in social prices.

2.2. Assumptions

An important outcome of this study is the lack of divergences, except a small interest rate divergence. Consequently, the results for private and social profits are nearly identical.

a. Outputs

The main outputs of coconut farming are copra (for coconut oil) and two secondary outputs, shell and fiber. These two secondary products are commonly used as fire material in making copra. Coconut shell is also traded on local markets. Some coconut shell is burned by farmers to make charcoal, and some coconut fiber is selected to make handicraft products of coir fiber.

In this study, the observed prices of copra, shell, and fiber are taken as reasonable indicators of the social prices of these products because neither market failures nor distorting policies were identified after careful observation. Copra is traded internationally and enters into international trade in the absence of trade distorting policy, since the government of Indonesia relaxed the market of coconut and other generated products through deregulation policy in 1991. Coconut shell and coconut fiber are nontradable goods and thus have no international prices. The observed price of corn is taken as a reasonable indicator of the social price of that intercropped product because neither market failures nor distorting policies are identified in the output market of corn. Corn was neither subsidized nor protected in 2001.

b. Fertilizers

The major types of chemical fertilizers used in coconut farming were urea, TSP, and KCL. These inputs are internationally tradable and enter into international trade in the absence of trade-distorting policies. Fertilizers were neither taxed nor subsidized in 2001. For these tradable inputs, the social prices thus were observed to be the same as the actual market prices.

c. Labor

The actual wage rate is taken as a reasonable indicator of the social price of unskilled labor because neither market failures nor distorting policies were identified in the labor market. Information about employment opportunities is widely available, and a considerable amount of seasonal and multi-year migration of unskilled laborers occurs. Government policy to set a provincial minimum wage rate is only enforced in modern sectors and is ignored by unskilled labor in agriculture.

d. Interest Rates

In this study, the social interest rate is estimated to be 27.5 percent, which includes a rate of return to investment of 17 percent and inflation for the region of 10.5 percent. The observed interest rate offered by the owners of capital in the area of study was 30 percent.

e. Shelter

In making copra, each farmer has to build a fireplace and a kiln above the fireplace and then a shelter to protect from rain, wind, and sun radiation. There are three kinds of building construction. The first type, permanent construction, used mostly tradable components, such as cement and an iron-and-zinc roof. The second type, semi-permanent, consisted of tradable and nontradable components in equal amounts. The third type, non-permanent construction, used only nontradable components. The buildings for copra processing, observed in this study, were mostly non-permanent. The capital cost recovery factor (CRF) was used to estimate the social price of buildings.

f. Equipment

A small amount of equipment is used for land cultivating, land clearing, and copra processing. All of the equipment is produced and traded locally. No divergences were observed, so the social prices of equipment are assumed to be the same as the private prices.

g. Land

Land has been excluded in measures of domestic factor costs. It was not possible to obtain an estimate of the social profitability of the best alternative crop on land planted to coconut. The construction of the PAM thus had to proceed without consideration of land costs, and domestic factor costs included only labor and capital costs. The profits are defined to include returns to land and managerial skill.

2.4. Method of Analysis

The Policy Analysis Matrix (PAM) was used to analyze the efficiency of coconut farming in North Sulawesi. The PAM approach is a system of double-entry bookkeeping. This method measures the efficiency of existing coconut farming systems and the impact of policy on competitiveness and farm-level profits. The results can be used to identify whether coconut production systems – categorized by varieties, technology, and agro-climatic zones – are competitive.

The PAM analysis begins with the calculation of existing levels of private (actual market) and social (efficiency) revenues, costs, and profits. This calculation reveals the extent to which actual profit is generated by policy transfers rather than by underlying economic efficiency. Changes in yields and inputs resulting from policy can then be gauged by an examination of how they alter the private and social profits of current technologies.

The policy analysis matrix is a product of two accounting identities – one defining profitability as the difference between revenues and costs, and the other measuring the effect of divergences (distorting policies and market failure) as the difference between observed parameters and parameters that would exist if the divergences are removed. By filling in the elements of the PAM for coconut farming systems, one can measure both the extent of transfers occasioned by the set of policies acting on the system and the inherent economic efficiency of the system (Table 1).

Table 1. Policy Analysis Matrix

	Revenues	Costs		Profits
		Tradable Inputs	Domestic Factors	
Private Prices	A	B	C	D[1]
Social Prices	E	F	G	H[2]
Divergences	I[3]	J[4]	K[5]	L[6]

[1]Private profits, D, equal A minus B minus C.

[2]Social profits, H, equal E minus F minus G.

[3]Output transfers, I, equal A minus E.

[4]Input transfers, J, equal B minus F.

[5]Factor transfers, K, equal C minus G.

[6]Net transfers, L, equal D minus H; they also equal I minus J minus K.

III. COCONUT PRODUCTION SYSTEMS

3.1. Agro-climatic Zones

Coconut palms can grow in various environments, although certain ecological conditions limit its growth. According to Darwis (1986), limiting ecological factors include rainfall, altitude, swamp area, and soils. Several agro-climatic factors thus affect productivity:

a. Climate including altitude, rainfall, temperature, relative humidity, wind, sun radiation, and day length (as it relates to sun radiation);

b. Soil including physical and chemical factors and soil type; and

c. Land including coastal, dry, and swamplands.

These environmental factors interact with one another to affect plant growth and production.

a. Altitude

The higher the elevation, the lower the temperature. In North Sulawesi, coconut plants can grow well up to an elevation of 900 meters. But altitude affects coconut production and oil content. Trees that grow at elevations above 500 meters produce a thin endosperm and low oil content.

b. Rainfall

Coconut plants need frequent rainfall all year round. Coconut palms require a suitable annual rainfall ranging from 1200 to 2500 mm/year (Thampan in Darwis, 1986). Monthly rainfall also plays a key role in determining coconut growth and production. According to Darwis (1986), the monthly rainfall should be at least 130 mm. Data derived from Mapanget meteorological station (North Sulawesi) showed that monthly rainfall is in a range of 140 – 480 mm.

3.2. Coconut Palm Distribution

Coconut trees are widely distributed in Minahasa Regency. They grow in coastal areas from elevations at sea level to mountainous areas at elevations more than 600 meters above sea level. But their optimal growth occurs in elevations of 0 to 600 meters above sea level.

Altitude significantly influences the production and growth of coconut palms in the Minahasa region. In this study, two agro-ecological zones are distinguished – the coastal area (less than 200 meters above sea level), represented by Tombasian and Tenga Districts, and the mountainous area (more than 400 meters above sea level), represented by North Bitung and Tombatu Districts.

3.3. Farming Systems

Coconut palms are mostly cultivated on smallholder plantations. About 93 % of the total coconut plantation area of 255,573 hectares of North Sulawesi is farmed by smallholders. The rest is owned by private companies. Most farmers have less than 2 hectares of land. They plant 100 productive trees per hectare that produce 0.9 to 1.3 tons of copra (Waney, 1997).

There are two coconut cropping systems in North Sulawesi – monoculture and intercropping. Those farmers who have big plantations mostly practice monoculture, while small-scale farmers intercrop coconut with corn, dry land paddy, chillies, ginger, papaya, or vanilla.

Coconut farming systems in North Sulawesi are either traditional or intensive. Traditional farmers cultivate a tall coconut variety with less intensive crop care and without using modern inputs such as fertilizers. Intensive farming is used by farmers who plant shorter, hybrid varieties.

3.4. Coconut Varieties

In North Sulawesi, traditional, tall varieties are cultivated on 95% of coconut plantation area. The most common tall varieties are Tenga Tall and Mapanget Tall. Hybrid varieties are planted on only 5% of coconut land. The most popular hybrid coconut varieties for smallholders are PB 121 and KHINA-1. Hybrid coconut varieties were first widely introduced in 1978 by the Smallholder Coconut Development Project (SCDP).

3.5. Harvesting and Processing

The gestation period for the tall variety coconut palms is 6-7 years, whereas that for hybrid varieties is 4-5 years. Most farmers harvest 3-4 times a year. Some farmers harvest hybrid coconut trees 5 times annually. Harvesting is carried out by climbing the trees or by using bamboo ladders on the shorter hybrid trees.

The production of copra, from harvesting to processing, is sometimes carried out by daily wage laborers but usually is done by contracted laborers. The contracted laborers commonly are paid shares when the copra is sold. The laborers' share ranged between a fifth and a half.

Typically, the process of making copra occurs on the farms. The process begins by peeling the coconut fruit, using traditional tools called lewang. The peeled coconut is then cut and placed on top of a kiln where it is roasted until mature and dry (when the coconut meat color is brownish). The meat, called copra hari-hari, is next peeled out of the coconut shell (the water content is up to 15 percent). The copra hari-hari is sun-dried until the water content is reduced to 5 percent. The dry copra, called copra gudang, is sold to traders who transport it to warehouses.

IV. EMPIRICAL RESULTS

4.1. Monoculture Coconut Systems

A. Yields

The empirical survey data show that there are differences in coconut farming yields based on agro-climatic zone and technology in North Sulawesi (Table 2). Coastal plantations have yields that are about one-fifth higher than yields in mountainous regions. Coconut trees produce better at lower elevations. Intensive technologies have yields that are about two-fifths higher than yields with traditional technologies. The intensive technologies use more fertilization and better crop care. But higher yields do not necessarily bring more profitable results.

Table 2. Yields of Traditional versus Intensive Monoculture Tall Coconut Farming Based on Agro-Climatic Zone of North Sulawesi

	Annual Yields		
	Copra **(kg/ha)**	**Shell (pieces/ha)**	**Fiber (pieces/ha)**
Coastal:			
Traditional	1,425	7,125	7,125
Intensive	1,995	9,975	9,975
Mountainous:			
Traditional	1,176	5,880	5,880
Intensive	1,647	8,235	8,235

B. Revenues

The annual revenue in the coastal area amounted to Rp 2,777,875 per hectare per year, whereas in the mountainous area the annual revenue was only Rp 2,293,200 per hectare. Because both regions face the same output prices, this difference reflects the lower yields in the higher elevations. With intensification, the revenue in the coastal area increased to Rp 3,889,375 per hectare per year and in the mountainous area to Rp 3,210,775 per hectare per year. This increase entirely reflected the 40 percent higher yields associated with intensification.

The observed output prices were Rp 1,750 per kg for copra, Rp 25 per piece for shell, and Rp 15 per piece for fiber. The estimated private and social revenues were identical, since the actual prices of coconut farming products – copra, shell, and fiber – were the same as the social prices of those products. Because neither market failures nor distorting policies were identified in the output market, divergences on revenues were zero.

C. PAM Results

PAM matrices were constructed for four coconut farming systems in North Sulawesi, based on two agro-climatic zones (coastal and mountainous) and two technologies (traditional and intensive). The results are reported in Table 3.

Table 3. The Policy Analysis Matrix of Traditional Versus Intensive Monoculture Tall Coconut Farming Based On The Two Agro-Climatic Zones Of North Sulawesi

	REVENUES	COSTS		PROFITS
		INPUT	FACTOR	

Table 3. The Policy Analysis Matrix of Traditional Versus Intensive Monoculture Tall Coconut Farming Based On The Two Agro-Climatic Zones Of North Sulawesi

		REVENUES	COSTS		PROFITS
			INPUT	FACTOR	
COASTAL	Traditional:				
	Private	2,777,875	0	1,686,410	1,091,465
	Social	2,777,875	0	1,634,948	1,142,928
	Divergences	0	0	51,462	(51,463)
	Intensive:				
	Private	3,889,375	770,000	2,970,930	148,445
	Social	3,889,375	770,000	2,879,958	239,418
	Divergences	0	0	90,973	(90,973)
MOUNTAINOUS	Traditional:				
	Private	2,293,200	0	1,570,580	722,620
	Social	2,293,200	0	1,521,345	771,855
	Divergences	0	0	49,235	(49,235)
	Intensive:				
	Private	3,210,775	770,000	2,807,390	(366,615)
	Social	3,210,775	770,000	2,719,563	(278,788)
	Divergences	0	0	87,828	(87,828)

The estimated total costs in the coastal area are slightly higher than those in the mountainous area, because yields and thus harvesting and post-harvest costs are higher at lower elevations. However, the major increases in costs of production occur in the change from the traditional systems to the intensive systems. The intensive technologies require much higher inputs of chemical fertilizers, labor, and working capital. The application of chemical fertilizers, 400 kg per hectare per year, costs Rp 770,000. Intensification demands greater labor inputs for land clearing, fertilization, harvesting, and post-harvest activities. The total labor cost increase is Rp 810,400 in the coastal area and Rp 773,700 in the mountainous area. The need for working capital to finance chemical fertilizers and labor used in intensive coconut farming is also increased. Small divergences in the credit market increased the private cost of capital.

For unskilled labor, the actual wage rate, Rp 20,000 per man-day, was taken as a reasonable indicator of the social price of unskilled labor because neither market failures nor distorting policies were identified in the labor market. The factor transfer for capital is negative, since the estimated social interest rate of 27.5 percent (social rate of return to investment of 17 percent plus inflation for the region of 10.5 percent) is 2.5

percent below the actual interest rate (30 percent) paid by coconut farmers. The capital market is the only source of divergences in the factor markets.

The traditional monoculture coconut farming systems were by far the most profitable coconut systems in North Sulawesi. In the coastal area, the average annual private profit was Rp 1,091,465 per hectare and social profit amounted to Rp 1,142,928 per hectare. These profit levels were smaller in the mountainous areas, about two-thirds of those in the coastal regions, reflecting the lower yields attainable there.

The intensification technologies were extremely disappointing and much less successful than the traditional technologies. The profits actually received by farmers in the coastal area declined by 86 percent, from Rp 1,091,465 to Rp 148,445, whereas in the mountainous area the profits were negative. The enormous decline in profits was caused by the more than doubling of costs associated with intensification. With intensification, the social profits declined 75 percent in the coastal area and 136 percent in the mountainous area.

These results demonstrate that higher yields do not result in greater profits if the costs of inputs in the new technology are too high. Farmers will not adopt new technologies that decrease their profits. The government could, in principle, subsidize input costs to make the new technologies privately profitable. But that policy decision would be an inefficient waste of public resources. Hence, there is no need to examine the effects of various levels of subsidies on inputs. Such subsidies would increase private profits but would not change social profits.

4.2. Intercropping Coconut Systems

A. Yields

By intercropping tall coconut farming with corn, in the coastal area the annual amount of copra produced increased 26 percent (from 1,425 kg per hectare to 1,800 kg per hectare), whereas in the mountainous area it increased 19 percent (from 1,176 kg per hectare to 1,400 kg per hectare). The corn yield was 2,200 kg per hectare in the coastal area and 2,000 kg per hectare in the mountainous area (Table 5).

Table 5. Yields of Traditional versus Intensive Intercropping Tall Coconut Farming Based on the Two Agro-Climatic Zones of North Sulawesi.

	Annual Yields			
	Corn (kg/ha)	Copra (kg/ha)	Shell (#/ha)	Fiber (#/ha)
Coastal:				
Traditional	2,200	1,800	9,000	9,000
Intensive	3,800	2,520	12,600	12,600
Mountainous:				
Traditional	2,000	1,400	7,000	7,000
Intensive	3,600	1,785	8,925	8,925

B. PAM Results

.Table 6. The Policy Analysis Matrix of Traditional Versus Intensive Intercropping Tall Coconut Farming Based On The Two Agro-Climatic Zones Of North Sulawesi

		REVENUES	COSTS		PROFITS
			INPUT	FACTOR	
COASTAL	Traditional:				
	Private	5,710,000	39,600	3,861,960	1,808,440
	Social	5,710,000	39,600	3,763,060	1,907,340
	Divergences	0	0	98,900	(98,900)
	Intensive:				
	Private	8,714,750	1,454,600	6,127,260	1,132,140
	Social	8,714,750	1,415,000	5,957,585	1,341,415
	Divergences	0	39,600	169,675	(209,275)
MOUNTAINOUS	Traditional:				
	Private	4,730,000	39,600	3,258,960	1,431,440
	Social	4,730,000	39,600	3,316,810	1,373,590
	Divergences	0	0	(57,850)	(57,850)
	Intensive:				
	Private	7,080,750	1,454,600	5,615,060	11,090
	Social	7,080,750	1,415,000	5,455,235	210,515
	Divergences	0	39,600	159,825	(199,425)

Consistent with the increased amount of coconut produced and the additional corn produced by intercropping with corn, the revenues from the intercropped systems were higher than those from the monoculture systems. In the coastal area, the revenue from coconut amounted to Rp 3,510,000 and from corn to Rp 2,200,000. In the mountainous area, the revenue from coconut was Rp 2,730,000 and from corn was Rp 2,000,000. As in the monoculture systems, the estimated private and social revenues are identical, because neither market failures nor distorting policies were identified in the output market. The sole divergence resulted from the observed interest rate exceeding the social interest rate by 2.5% per annum.

The PAM results for the intercropped coconut systems present a pattern that is similar to that reported above for the monoculture systems. The traditional systems in the coastal zone had the highest private and social profits. Efforts to introduce intensification would greatly reduce both private and social profits. With intensification, the private profits (actually received by farmers) in the coastal area decline by 37 percent (from Rp 1,808,440 to Rp 1,132,140) and in the mountainous area by 99 percent (from Rp 1,283,440 to Rp 11,090). Similarly, the social profits fall by 32 percent and 88 percent. However, the critical result is that intercropping systems produce much higher profits than do monoculture systems. For example, the social profits in the traditional coastal system improved by two-thirds with the introduction of intercropping.

4.3. Monoculture Hybrid Coconut Farming

A. Yields

The copra yields achieved with hybrid coconut varieties are 50 percent higher than those with traditional varieties (Table 8). These higher yields result from more productive seeds and the effects of coconut farming intensification through fertilization and improved crop care.

Table 8. Yields of Traditional versus Intensive Monoculture Hybrid Coconut Farming Based on Agro-Climatic Zone of North Sulawesi

	Annual Yield		
	Shell (pieces/ha)	Fiber (pieces/ha	Copra (kg/ha)
Coastal :			
Traditional	1,518	9,108	9,108
Intensive	2,277	13,662	13,662
Mountainous :			
Traditional	1,287	7,722	7,722
Intensive	1,931	11,586	11,586

C. PAM Results

Consistent with the increased amount of production through intensification, the estimated total revenues were also increased by 50 percent (Table 9). The prices of shell and fiber for hybrid coconut are lower than those for tall coconut, because the size of hybrid coconuts is smaller than of tall coconuts.

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Table 9. The Policy Analysis Matrix of Traditional Versus Intensive Monoculture Hybrid Coconut Farming Based On The Two Agro-Climatic Zones Of North Sulawesi

	REVENUES	COSTS		PROFITS
		INPUT	FACTOR	

Table 9. The Policy Analysis Matrix of Traditional Versus Intensive Monoculture Hybrid Coconut Farming Based On The Two Agro-Climatic Zones Of North Sulawesi

		REVENUES	COSTS		PROFITS
			INPUT	FACTOR	
COASTAL	**Traditional**:				
	Private	2,793,120	0	1,880,760	912,360
	Social	2,793,120	0	1,825,560	967,560
	Divergences	0	0	55,200	(55,200)
	Intensive:				
	Private	4,189,680	770,000	3,518,880	(99,200)
	Social	4,189,680	770,000	3,417,370	2,310
	Divergences	0	0	101,510	(101,510)
MOUNTAINOUS	Traditional:				
	Private	2,368,080	0	1,779,880	588,200
	Social	2,368,080	0	1,726,620	641,460
	Divergences	0	0	53,260	53,260
	Intensive:				
	Private	3,553,040	770,000	3,336,880	(553,840)
	Social	3,553,040	770,000	3,238,870	(455,830
	Divergences	0	0	98,010	(98,010)

Through intensification with hybrid varieties, both private and social costs increased by 87% in the coastal area and by 88% in the mountainous area. As before, these cost rises were made up of additional fertilizer, labor, and working capital costs. Because these large cost increases greatly exceeded the 50% increases in revenues, profits declined sharply with intensified hybridization. The introduction of hybrid varieties also resulted in lower private and social profits compared with the planting of traditional varieties. For example, the social profit of the traditional coastal system, North Sulawesi's most profitable coconut system, was 15 percent less with hybrid seeds than with traditional ones.

V. CONCLUSIONS

Coconut farming intensification, using chemical fertilizers and intensive crop care, could increase coconut yields by 40 percent for the traditional tall variety and by 50 percent for the hybrid variety. But increases in yields are not necessarily good for either the farmers or the province. Unfortunately, the costs of coconut production (for fertilizer, labor, and working capital) under intensification rose by nearly 90 percent – much more than the increases in revenues. As a result, both private profits (actually received by farmers) and social profits (measuring the efficiency of resource use in the province) were significantly lower for the intensified systems than for the traditional systems.

Intensification would increase coconut production in the region, but it would have a significant negative impact on coconut farmers' and provincial income. Farmers can be expected to reject technologies that will reduce their incomes. The provincial government should resist the temptation to subsidize input costs in the inefficient new technologies, because such subsidies would be wasteful and could not be targeted to those uses. Researchers thus need to develop other technological packages that would be privately and socially profitable. Additional market and product research might also be done to increase value added from coconut products such as coconut oil, coconut charcoal, and fiber products.