TABLE 4.13 Labor use in cinnamon fields by age of trees and laborers' gender

Age of Trees	Number of Sample Plots	Men	Women	Total
			(person-days/hectare)	
		57.3	51.9	109.2
		(85)	(78)	(82)
3	21	20.6	25.4	46.0
		(67)	(58)	(62)
5	29	15.1	5.5	20.7
		(58)	(85)	(65)
	30	17.6	17.4	35.0
		(27)	(9)	(18)

SOURCE: Intensive survey.

NOTE: Numbers in parentheses are proportions of family labor. For simplicity, only labor data for tree of selected ages are shown.

by gender; women worked primarily in weeding and harvesting, whereas men were engaged mostly in land preparation. The proportion of hired labor seasonally migrating from neighboring areas was approximately two-thirds, primarily because the selected villages are endowed with much more fertile paddy fields than neighboring areas. The large reliance on hired labor also indicates that the labor market is well developed in this area.

Table 4.13 shows labor use per hectare in cinnamon fields by laborers' gender and age of trees. It is clear that in cinnamon fields, too, men and women worked more or less equally. Labor use per hectare is particularly high in the first year owing to heavy labor requirements for land preparation and planting of both cinnamon and annual crops. From the second year, labor requirements tend to decline as the proportion of fields planted to food crops and weeding requirements declined. Family labor is used mostly in the first three years, whereas hired labor is heavily employed for such simple tasks such as weeding in later stages of tree growth.

Using average wages to impute family labor costs, we examined estimates of revenue, total cost, and the residual profit of rice production by land tenure institution, including the costs of current inputs (such as seeds and chemical fertilizer) and capital services (water buffaloes for land preparation, trucks for hauling, and mechanical threshing). The costs of current inputs and capital accounted for only a small portion of total cost,[22] whereas labor accounted for about 50 percent. This is not surprising given the labor-intensive paddy cultivation system employed in the study area. It is observed that not only gross rev-

22. We also imputed the cost of family-owned buffalo and threshing machines, even though they were relatively minor cost items.

ıue but also the cost of each item and the residual profit were quite similar nong different land tenure institutions. Borrowed land, which exhibits lower ılues of revenue, total cost, and profit, is an exception to this pattern. These ɔservations suggest that, despite differences among the prevailing tenure initutions, these institutional differences do not have a significant influence on ıe efficiency of paddy production. This may be explained partly by the fact that though the lack of tenure security may affect long-term investment incentives, ce is an annual crop, and the simple gravity irrigation system requires little inɛstment to establish or maintain. It may also be the case that practices that ould degrade land, which in principle would arise under the rotation system jointly owned plots, were effectively prevented by mutual enforcement echanisms operating in the joint ownership arrangements within extended milies.

The potential value of production, labor costs, current input costs (mostly ıemical fertilizer for annual crops), and the potential profit of cinnamon fields e shown by age of trees in Table 4.14. For young cinnamon plots, data are ıown by plantation or regrowth. Plantation after clearance of different types fields (old cinnamon field, bush-fallow field, or forest) was combined because the limited number of observations and the similarity of costs of clearance

ABLE 4.14 Potential value, production costs, and potential profit of upland ltivation by age of cinnamon trees

ge	Potential Value[a] (1)	Labor Cost[b] (2)	Cost of Current Inputs (3)	Total Cost (2) + (3)	Potential Profit (1) − (2) − (3)
ears)			(1,000 rupiah)		
(Plantation)	457	649	126	775	−318
(Regrowth)	553	328	66	394	158
(Plantation)	214	134	2	135	79
(Regrowth)	154	282	11	293	−140
(Plantation)	38	256	8	264	−226
(Regrowth)	82	198	9	206	−124
	1,071	209	2	211	860
	2,441	119	2	121	2,319
	4,096	98	0	98	3,995
	6,408	64	19	83	6,325
	9,271	83	0	83	9,189

JRCE: Intensive survey.

ctual revenue from food production for age 1 to 3 years and the value of cinnamon trees esti- ted by traders for age 4 years and above. Only data for trees of selected ages are shown.

ıputed cost of family labor by the prevailing wages plus cost of hired labor.

among the three cases. The total cost was substantially higher and the value of production lower in planted fields than in coppiced fields in the first year primarily because of the cost of clearing fields before planting. In the second year, however, the total cost became higher and revenue smaller in coppiced fields because of the larger labor requirements for weeding due to the omission of slash-and-burn operation. The difference in production cost, as well as the residual profit, became smaller by the third year. For the productive fields with trees aged four years and above, differences between planting and coppicing were negligible. The potential value of production and potential profit increase monotonically with the age of trees. Note that production and cost data in the very old fields must be interpreted with caution; since cinnamon trees are generally felled between 8 and 10 years of age, data for older trees probably are subject to selection bias.

Econometric Analysis

In this section, we estimate the revenue or potential value, total cost, and actual or potential residual profit functions separately for paddy, young cinnamon, and productive cinnamon fields by the ordinary least squares regression method. The specification of estimated functions is based on the basic methodology developed in Chapter 2 (see equation [4]). Dependent variables are expressed as values per hectare. Since the residual profits are negative in some cases, we used a linear specification. In this specification, the estimation of one of the three functions is redundant except for the direct demonstration of the significance of the estimated coefficients. We assume that land tenure institutions, represented by modes of acquisition, are predetermined for each household. In order to take into account the effect of household specific factors, we applied the random effects model for the estimation pertaining to the productive cinnamon.[23] We have 140 parcels for this analysis, after excluding parcels of those households cultivating only one parcel.

Means of explanatory variables, other than land tenure variables, are shown by type of field in Table 4.15. The majority of sample fields were acquired more than 10 years ago. Both young and productive cinnamon fields were located far from residential areas. Household characteristics represented by paddy and cinnamon area owned, endowment of male and female family workers, and age and schooling of the male household head were not substantially different across different types of fields.

23. We did not apply the household-level fixed or random effects model to the statistical analysis of young cinnamon fields because only a small number of households cultivated two or more parcels. We show only the results of random effects estimation for the productive cinnamon because the Hausman test shows that household-level unobservables are not significant, indicating that random effects is the preferred specification. The Breusch-Pagan test also indicates the importance of random effects.

TABLE 4.15 Means of explanatory variables for plot-level analysis on lowland rice and upland crop production by type of field

	Paddy Land	Young Cinnamon	Productive Cinnamon
Year of land acquisition	1983	1986	1983
Walking time (minutes)	24.3	76.6	86.3
Altitude (m)	n.a.	1,058	1,082
Slope (degree)	n.a.	10.16	11.66
Owned paddy area (ha)[a]	1.05	0.95	1.21
Owned cinnamon area (ha)	4.01	4.68	6.00
Number of male workers[b]	1.16	1.14	1.11
Number of female workers[b]	1.27	1.24	1.26
Age of head	43.3	40.3	42.9
Schooling of head (years)	8.0	7.1	8.1

SOURCE: Intensive survey.

NOTE: "n.a." refers to "not analyzed."

[a]Including areas under joint family ownership.

[b]Number of male or female family members between 16 and 60 years of age.

Estimation results of gross value of output, total cost, and the residual profit functions for paddy production are shown in Table 4.16, in which joint family ownership is used as the base for comparison of land tenure effects. The fits of the regressions are poor, as reflected in low values of R^2. None of the coefficients of the three land tenure dummies is significant in any of the three functions, which supports our hypothesis that the prevailing land tenure institutions do not affect farm management efficiency. These results are consistent with earlier findings by Place and Hazell (1993) that land tenure institutions do not affect crop yields in customary land areas of selected Sub-Saharan countries.

The two tenancy variables are not significant either, which is consistent with the general finding that land tenancy contracts do not distort work incentives in Asia (Hayami and Otsuka 1993). Moreover, there also is no strong evidence that resource endowments of households significantly affect profitability of paddy production, even though owned paddy areas and the number of male family workers affect gross revenue and total costs. The overall findings are consistent with hypothesis 5, that factor markets, including land rental and hired labor markets, function well so as to equalize factor ratios among different fields.

Table 4.17 presents the estimation results for young cinnamon fields. Since production differed with the age of trees and previous land cover (Table 4.14), we used two dummies for tree age and three interaction terms between tree age and regrowth dummies. As might be expected, the dummy variables have

TABLE 4.16 Determinants of gross value of output, total cost, and residual profit of rice production

	Gross Value of Output	Total Cost	Residual Profit
Intercept	2001.0		
	(5.42)		
Rainfed dummy	−8.77		
	(−0.05)		
Walking time	−1.02		
	(−0.34)		
Age of head	0.70		
	(0.11)		
Schooling of head	−3.31		
	(−0.19)		
Owned paddy area	−178.2*		
	(−2.45)		
Owned cinnamon area	28.2		
	(1.45)		
Number of male workers	152.6*		
	(1.75)		
Number of female workers	41.1		
	(0.41)		
Single family	−7.88		
	(−0.43)		
Private	225.5		
	(0.82)		
Borrowing	−389.0		
	(−1.46)		
Share tenancy	−260.5		
	(−1.29)		
Fixed-rent tenancy	−32.5		
	(−0.14)		
R-squared	0.109		

NOTE: Dependent variables are expressed as values per hectare. Numbers in parentheses are *t*-statistics.

*.05 level

**.01 level

significant coefficients in several cases. As a result, R^2 statistics generally are high. Yet neither land and labor endowment variables nor the share tenancy dummy is significant, rendering added support to the hypothesis that factor markets work well. Furthermore, none of the land tenure variables except borrowing is significant, which supports the hypothesis that the customary land tenure institutions provide sufficient tenure security comparable to private ownership.

	Gross Value of Output	Total Cost	Residual Profit
Intercept	731.88	1484.98	
	(1.16)	(2.26)	
Second-year dummy (2D)	−308.49*	−415.52*	
	(−1.83)	(−2.37)	
Third-year dummy (3D)	−563.86**	−461.58**	
	(−3.45)	(−2.71)	
Regrowth dummy × 1D[a]	118.66	−308.47*	
	(0.85)	(−2.11)	
Regrowth dummy × 2D[a]	−86.91	−64.93	
	(−0.50)	(−0.36)	
Regrowth dummy × 3D[a]	118.95	−128.27	
	(0.72)	(−0.74)	
Walking time	−0.90	−0.95	
	(−1.13)	(−1.14)	
Slope	4.05	−1.64	
	(0.68)	(−0.26)	
Altitude	−0.047	−0.51	
	(−0.09)	(−0.93)	
Age of head	2.77	−3.33	
	(0.63)	(−0.72)	
Schooling of head	−6.98	−17.95	
	(−0.58)	(−1.44)	
Owned paddy area	−43.14	−58.28	
	(−0.85)	(−1.10)	
Owned cinnamon area	−15.35	5.37	
	(−1.12)	(0.38)	
Number of male workers	−38.66	−5.43	
	(−0.65)	(−0.09)	
Number of female workers	59.10	151.44*	
	(0.83)	(2.04)	
Private—purchase	−159.83	−100.507	
	(−1.43)	(−0.86)	
Private—clearance	−219.06	−23.12	
	(−1.40)	(−0.14)	
Share tenancy	−87.28	−57.02	
	(−0.64)	(−0.40)	
Borrowing	−337.32**	−36.52	
	(−2.91)	(−0.30)	
R-squared	0.536	0.411	

NOTE: Dependent variables are expressed as values per hectare. Numbers in parentheses are *t*-statistics.

[a]Interaction term between dummy for regrowth of trees and dummy for first year (1D), second year (2D), or third year (3D) of cultivation.

*.05 level

**.01 level

Regarding borrowed land, which does not conform to the general pattern, it may well be that land that is lent is of inferior quality. This is consistent with the observation that revenue from borrowed land was significantly lower even though production costs are comparable to costs under single family ownership.

Finally, Table 4.18 presents results for productive cinnamon fields using the random household effects model.[24] In this model, we used nine tree age dummies and four variables related to land quality, namely, slope, altitude, and two dummy variables representing the previous land cover. Partly reflecting the fact that the age of trees is largely uniform in the same field unless the field is very old, most coefficients of tree age dummies are not only positive, as may be expected, but also highly significant. Altitude has negative and significant effects on the potential value and profit, which is consistent with the common perception of farmers in this area that trees grow less well and water content of bark tends to be higher at higher altitudes within the Kerinci Valley. The area of land cleared from forest has a weakly significant positive effect on the potential value.

It is remarkable to find that neither the factor endowment variables nor private land tenure, share tenancy, and borrowing dummies have significant effects on potential value, total cost, and potential profit. The former result indicates that factor markets work well in customary land areas of Sumatra. The latter result strongly supports our hypothesis formulated in Chapter 2 that customary land tenure institutions have been sufficiently individualized to ensure tenure security.

Estimation of Internal Rates of Return

In order to assess the profitability of investments in cinnamon trees, we computed the internal rate of return by land tenure type under the assumption of an eight-year interval between major cinnamon harvests based on the estimated profit functions shown in Tables 4.17 and 4.18. In computing net profits, we assume that bush-fallow land is cleared in the first growth cycle and that cinnamon trees are regrown three times thereafter, which was reported to be the common practice by farmers.[25] We used the average values of variables pertaining to plot and household characteristics and their estimated coefficients, and the coefficients of tree ages and land tenure dummies. Results for profit function estimates for young cinnamon trees were used to derive cash flows for the first three years. The cost function estimates for productive trees were used for cash flows from fourth to seventh years. Finally, the profit function result for pro-

24. Considering the possibility of selection bias arising from the fact that some cinnamon trees were harvested after the eighth year, we reestimated all three functions by excluding those fields whose trees were nine years of age and older. Both the magnitude and significance of the remaining variables, however, remain largely unchanged.

25. The estimated internal rates of return were almost unchanged when we assume that trees were harvested every 10 years.

TABLE 4.18 Determinants of potential value, total cost, and potential profit functions for productive cinnamon fields: Household random effects

	Potential Value	Total Cost	Potential Profit
Intercept			
Age 5 dummy			
Age 6 dummy			
Age 7 dummy			
Age 8 dummy			
Age 9 dummy			
Age 10 dummy			
Age 11 dummy			
Age 12 dummy			
Age 13 dummy			
Slope			
Altitude			
Dummy for forest before			
Dummy for bush-fallow before			
Walking time			
Private—purchase			
Private—clearance			
Share tenancy			
Borrowing			
R-squared			

NOTE: Dependent variables are expressed as values per hectare. Numbers in parentheses are *t*-statistics.

*.05 level

**.01 level

ductive cinnamon was the basis for the estimate of profit from the main harvest in the eighth year.

The estimates of internal rates of return are 42 percent for single family ownership, 29 percent for private ownership through purchase, and 31 percent for private ownership through clearance of forest. Note that these estimates are not significantly different, as none of the land tenure dummies was significant in the regression analyses of profits and cost on both young and productive cinnamon fields. The estimated returns are quite high, which indicates that cinnamon is quite profitable.[26] The high profitability of cinnamon production is consistent not only with the expansion of cinnamon areas in Kerinci but also with the transformation of the customary land tenure system toward individualization, which is conducive to investment in trees. Very similar results were obtained from the companion case study of rubber agroforestry in Sumatra (Suyanto, Tomich, and Otsuka 2001).

These high rates of return on investment may be explained in part by the lack of access to credit because of the credit market imperfection, which in turn may be explained partly by the absence of collateral value of land due to the lack of land titles, as argued by Feder et al. (1988). In any event, since these high rates of return are found under private ownership as well as traditional tenure systems, they cannot be attributed to any deficiency of customary land tenure institutions.

Land Tenure and Land Distribution

The evolution of customary land tenure institutions toward individualized ownership may lead to inequitable distribution of landholding. In order to quantify the relative importance of the various land components under different land tenure institutions in accounting for the overall inequality of land distribution, we apply a decomposition analysis of the Gini measure of landholding inequality as developed by Fei, Ranis, and Kuo (1978) and Pyatt, Chen, and Fei (1980) for household data.

The Gini decomposition formula is given by $G(Y) = \Sigma s_i \, PG(Y_i)$, where $G(Y)$ equals the Gini ratio of total operational landholdings, Y_i equals landholding of i-th tenure type, s_i equals average share of i-th type of land, and $PG(Y_i)$ equals the pseudo-Gini of landholding inequality. If $PG(Y_i)$ is greater (smaller) than $G(Y)$, distribution of i-th type of landholding is less (more) equitable than the average, thereby contributing to the expansion (contraction) of inequality in the overall landholding distribution (see Appendix of Chapter 3 for further details). Computation results are shown in Table 4.19.

26. It is estimated that during the period from 1981 to 1996 the real domestic price of cinnamon increased by 7 percent per year. If farmers expect an increasing trend in the cinnamon price, the estimated internal rates of return may still underestimate farmers' expected returns.

TABLE 4.19 Overall Gini ratio of operational landholding and contribution by land component

	Land Share	Pseudo-Gini Ratio
Single family—matrilineal		−0.362
Single family—egalitarian and patrilineal		0.373
Private—forest clearance		0.565
Private purchase		0.472
Renting		0.171
Overall		0.382

SOURCE: Intensive survey.

The negative pseudo-Gini coefficient of landholding under the matrilineal-type single family ownership implies that the distribution of this type of land is negatively correlated with the distribution of other types of land. Since the income share of this type of land is negligibly small, its impact on the overall Gini coefficient is small. As might be expected, the pseudo-Gini ratio of single family land acquired by egalitarian and patrilineal land inheritance is smaller than the overall Gini ratio, implying that this type of land is relatively equally distributed. The pseudo-Gini of the acquired forestland is a major component of landholding that contributed to the inequitable distribution of land. As we have seen from Table 4.7, households endowed with larger paddy fields and large number of male family workers acquired more forestland, which seems to have resulted in the inequitable distribution of landholding. Privately purchased land is another inequality-increasing component of land distribution. Yet it is remarkable to find that the pseudo-Gini ratio of land renting is exceedingly small, which implies that land rental transactions contributed to the reduction of inequality. As a result, the overall Gini ratio is not widely different from the Gini ratio of single family ownership with egalitarian inheritance.

Thus, contrary to popular belief, there is no strong evidence that the evolution of customary land tenure institutions toward individualized ownership significantly widened the inequality of operational landholding.

Summary for Intensive Study

The intensive household study provided added support for our hypothesis that traditional land tenure institutions in customary land areas have evolved over time toward more individualized ownership. Otherwise, it would be difficult to interpret the absence of the significant effects of the modes of land acquisition on the efficiency of production. Farm management efficiency under single family ownership is comparable to that under private ownership in both lowland paddy and upland cinnamon production. The efficient management of cinna-

mon fields under single family ownership is particularly noteworthy, as this suggests that sufficiently strong incentives to invest in management of agroforestry exist under this newly emerging ownership system. Furthermore, the estimated internal rates of return to investment in cinnamon trees support the hypothesis that investment in cinnamon trees has high payoffs. This explains why uncultivated bush-fallow land has largely disappeared and has been replaced by more intensive use of land through tree planting in our study sites. It is highly likely that the conversion of bush-fallow land to cinnamon fields was facilitated by the individualization of customary land tenure systems.

We also have obtained evidence that land rental and labor markets allocate resources efficiently among households endowed with different proportions of land and labor. Tenure security established under the prevailing land tenure institutions is likely to have contributed to the formation of effectively functioning land markets because security of ownership is a prerequisite for efficient land market transactions. Furthermore, renting is found to contribute to the equitable distribution of operational landholdings.

In sum, the evolution of customary tenure institutions and factor markets seems effective in achieving an efficient allocation of resources and investments in agroforestry in an equitable manner.

Policy Implications

At present, property rights in land are well recognized and respected among community members, so that there does not seem to be much room for improving investment incentives by strengthening individual rights within indigenous communities. However, we do not mean to suggest that a land-titling program is unnecessary to enhance management efficiency further in the long run. Because of the lack of official titles, land cannot be used as collateral for credit from formal financial institutions. But, as others have recognized for the case of Sub-Saharan Africa (Feder and Noronha 1987; Migot-Adholla et al. 1991), there also are important questions about the administrative feasibility and cost-effectiveness of formal land titling. The cost will be particularly high or even prohibitive if land is owned jointly and land title is to be given only to a single person or household. An important observation is that such cost may not be excessively high for upland fields in Sumatra owing to clear individualization of land rights. The expansion of formal credit institutions into these relatively remote areas and the establishment of official land title will become increasingly important as further intensification of the land use is required. Unusually high internal rates of return to investment in cinnamon agroforestry may attest to the significant imperfection of credit markets in our sites.

The finding that equally efficient incentives exist for investment in and management of agroforestry among different land tenure institutions has important implications for both equity and efficiency from the social point of view.

First of all, we have to recognize that rural people in hilly and mountainous areas, such as our study sites, are generally very poor and that in such areas agroforestry has a comparative advantage over food production. In order to reduce the incidence of poverty, it is recommended that profitable agroforestry systems should be established, given that the efficient land tenure institutions are in place. Investments in research of new technologies and their extension, investment in social infrastructures, and improvement of marketing systems are examples of measures to enhance the profitability of agroforestry. Due consideration, however, must be paid to the fact that relatively wealthier farmers tend to develop agroforestry more actively.

The development of agroforestry on sloped fields will contribute to the reduction in soil erosion, siltation, flooding, and other negative externalities and the improvement in tree biomass. Such contribution justifies the support for the development of agroforestry from the social point of view.

However, it is unrealistic to expect local communities to supply sufficient substitutes for natural forests' many ecological and environmental services, including abatement of negative environmental externalities of land use change (for example, smoke that impedes aviation and harms public health) and global public goods (for example, carbon sequestration and biodiversity conservation). The analysis in this chapter shows, however, that natural forests are largely open access under the communal land tenure institutions, and, hence, they have been exploited by the desire of local farmers to acquire cultivation fields. No effective mechanism exists to compensate these farmers directly for production and investment opportunities forgone in favor of natural forest conservation. The search for workable, incentive-compatible institutional mechanisms that can clarify, monitor, enforce, and compensate for a more socially optimal mix of agricultural production and environmental services deserves high priority. Our hope is that insights from this research on the dynamics of indigenous land tenure institutions can contribute to constructive approaches to address these complex natural resource policy issues.

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