Land, Trees, and Women

Evolution of Land Tenure Institutions in Western Ghana and Sumatra

Agnes R. Quisumbing
Keijiro Otsuka
with
S. Suyanto
J. B. Aidoo
E. Payongayong

RESEARCH REPORT 121

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
WASHINGTON, D.C.

ISBN 0-89629-122-7

Library of Congress Cataloging-in-Publication Data

Land, trees, and women : evolution of land tenure institutions in western Ghana and Sumatra / Agnes R. Quisumbing . . . [et al.].
p. cm — (Research report ; 121)
Includes bibliographical references.
ISBN 0-89629-122-7
1. Land tenure—Ghana. 2. Land use, Rural—Ghana. 3. Agroforestry—Ghana. 4. Women and land use planning—Ghana. 5. Right of property—Ghana. 6. Land tenure—Indonesia—Sumatra. 7. Land use, Rural—Indonesia—Sumatra. I. Quisumbing, Ma. Agnes R. (Maria Agnes R.). II. International Food Policy Research Institute. III. Research report (International Food Policy Research Institute); 121.

HD1022.Z63 L36 2001
333.3'23'08209598—dc21

2001055540

Contents

Tables

Figures

Foreword

This research report examines three questions that are central to IFPRI research: How do property-rights institutions affect efficiency and equity? How are resources allocated within households? Why does this matter from a policy perspective? As part of a larger multicountry study on property rights to land and trees, this study focuses on the evolution from customary land tenure with communal ownership toward individualized rights, and how this shift affects women and men differently.

Changes in property-rights institutions have the potential to affect the distribution of resources among and within households. While individualization of land-tenure institutions has been shown to improve management efficiency in many settings, concerns have been raised about the equity implications of such changes. In particular, it is often argued that individualization of land tenure leads to the deterioration of women's customary property rights to land.

This study's key contribution is its multilevel econometric analysis of efficiency and equity issues. Using a combination of community, village, and household surveys in Western Ghana and Sumatra, two areas with traditional matrilineal inheritance systems, the authors and their collaborators analyze the effectiveness of village-, household-, and parcel-level property-rights institutions and arrangements.

This study challenges the conventional wisdom that communal tenure systems do not provide adequate incentives for permanent improvements in land. In fact, whether on private or on communally owned land, agroforestry has a positive, indirect effect on equity. This is because agroforestry is more profitable than food crops in poor marginal areas, so systems that encourage their development also contribute to reducing the welfare gap between the relatively wealthy and the poor rural population.

Agroforestry systems can also be consistent with gender equity. In Ghana and Sumatra, there are no significant gender differences in the efficiency of managing cropped fields. Land inheritance systems in these areas are evolving to provide incentives consistent with the relative intensity of male and female labor in various crops. The increase in demand for female labor in cocoa has led to stronger land rights for women in Ghana, while the labor requirements in agroforestry have strengthened land rights for men in matrilineal Sumatra. In both cases, land tenure systems have evolved toward increased efficiency and equity.

To promote gender equity while providing incentives for efficient natural resource management, any program that changes the distribution of property rights must be checked for overt or implicit barriers to women's obtaining rights. Implementation of titling programs, in particular, must pay special attention to women's rights. Technology development and trans-

fer programs must also consider the needs of women farmers, who have often been neglected by male-dominated extension systems. Finally, concern about women's land rights should not blind policymakers to the importance of investing in the education of both girls and boys. Increasing women's educational attainment will increase their opportunities in the nonfarm sector, contribute to smaller family sizes, and reduce population pressure on scarce forest resources.

Per Pinstrup-Andersen
Director General

Acknowledgments

This research was supported by the United Kingdom Department for International Development, the Government of Japan, and the United States Agency for International Development Office of Women in Development, Grant Number FAO-0100-G-00-5020-00, on "Strengthening Development Policy through Gender Analysis: An Integrated Multicountry Research Program." We would like to acknowledge the cooperation of the Institute for Land Management and Development, University of Science and Technology, Kumasi, Ghana, the Nairobi and Southeast Asia offices of the International Centre for Research on Agroforestry, and Jambi University in Jambi Province, Sumatra. These institutions provided us not only with administrative support in the field, but also with teams of dedicated survey interviewers. We would like to thank the interviewers and field staff for introducing us to the complexities of rural institutions in their respective countries, and especially for allowing us to interact closely with the people in our study sites. Indeed, without them, the field work would have been impossible. We are indebted to our colleagues and collaborators, Frank Place and Thomas Tomich, from whose work we draw heavily. We received helpful comments on early versions of this manuscript from George Benneh, Howarth Bouis, David Edmunds, Marcel Fafchamps, Lawrence Haddad, Yujiro Hayami, Peter Hazell, Alain de Janvry, Carol Levin, John Maluccio, Ruth Meinzen-Dick, Jean-Philippe Platteau, Elisabeth Sadoulet, Towa Tachibana, two anonymous reviewers, and the members of the Gender and Development listserve. Finally, we thank the women and men of our survey villages for their patience in answering questions that go to the root of concepts of property and family. We hope that this work will contribute to better lives in the rural and marginal areas of Western Ghana and Sumatra. All errors and omissions are ours.

Summary

Widespread deforestation in many developing countries has contributed to ecological deterioration, particularly in marginal areas. Agroforestry has the potential to halt this decline and improve the livelihoods of poor inhabitants of these areas. Yet agroforestry depends on people's rights to plant and use trees, rights established by prevailing systems of land and tree tenure. Without clear property rights, there are few incentives to invest in trees because future benefits would not accrue to those who manage them. Understanding land tenure institutions and their effect upon agroforestry practices is therefore critical in improving natural resource management and reducing poverty. While individualization of land tenure institutions encourages the adoption of agroforestry, there is a concern that women may lose out in this process. In many parts of the world, women's rights to land are weaker than men's, and it is often argued that the shift from customary to individualized tenure may weaken them further.

Land, Trees, and Women examines the evolution of customary land tenure institutions in areas of Western Ghana and Western Sumatra where traditional matrilineal inheritance systems have been changing. Though the cultural, natural, and policy environments of the two regions differ, most of the study sites are within agriculturally marginal, less favored areas with a high incidence of poverty. Communities with contrasting land tenure institutions, farming systems, and natural resources were included in the study.

The study has three objectives: (1) to quantify the effects of various land tenure institutions on the efficiency of agroforestry and cropland management and on investments; (2) to identify factors affecting the evolution of customary land tenure institutions; and (3) to assess the implications of land tenure institutions for gender equity and the preservation of the natural resource base. Several different, but complementary, methodologies were employed to analyze evolutionary change from the community or village level down to the level of the individual and the plot. Three sets of analyses were used. The first was an extensive study of communities located over wide areas, with a range of natural, socioeconomic, and policy environments. The second was an intensive study of households in selected communities, where differing land tenure institutions and farming systems coexist. The third was a study of intrahousehold and gender issues, based on a detailed retrospective survey of land inheritance and educational investment in individuals within households.

The study found that population pressure is the major factor accounting for the decrease in forestland. Under the communal tenure system, population pressure has led to the privatization of land rights, the clearing of forest areas, and the erosion of traditional land acquisition methods. Since the effort of clearing forests is rewarded by strong individual land rights, reversing

the trend of deforestation will not be simple. Also, there is no strong statistical evidence to support popular arguments that customary land tenure in Ghana and Sumatra discourages commercial agroforestry. Indeed, commercial trees have been planted under communal ownership systems as widely and actively as under the private ownership systems. Even where land rights are relatively weak, the expectation of strengthened individual land rights stimulates tree planting. However, once trees are planted, the communal land ownership system is converted de facto to private ownership. Agroforestry systems, whether on privately or on communally owned land, have a positive, indirect effect on equity because agroforestry is more profitable than food crops in marginal areas where poverty levels are high. To improve the efficiency of natural resource management, promote gender equity, and disseminate best agroforestry practices, public policies should harness the profit incentives that underlie institutional change in land ownership systems. Three issues must be addressed; they are described in the following sections.

Property Rights Institutions and Policies

Property rights institutions are moving toward providing proper incentives for efficient natural resource management. Though improved management will take place when there is a closer match between those who control and those who use resources, direct intervention in gender-based property rights policy has proven to be extremely difficult. Any program or legal framework that assigns rights to resources must be evaluated for barriers to women's participation. In addition, the twin forces of commercialization and individualization of land rights should lead to a more widespread demand for titling over time by smallholder farmers. Thus, land-titling programs will be feasible once communal land tenure institutions become sufficiently individualized. Yet such programs are costly and there is always the danger that the rich and the political elite will seize large areas of titled land. Efforts to strengthen women's land rights through legal reform must go hand in hand with education of women, which will enable them to assert and defend their rights.

Development and Dissemination of Agroforestry Technologies

Since there are strong incentives to manage agroforestry plots on sloping lands under communal ownership, improving profitability of agroforestry systems, whether through dissemination of improved germplasm or through better cultivation practices, is needed. In developing technology transfer programs, care must be taken to include women farmers, who have traditionally been neglected by male-dominated extension systems, and who may prefer to plant different tree species than men.

Market Development and Other Policy Issues

Market development is critical in generating the degree of intensification required to enable rural people to lift themselves from poverty without undermining their resources. Increased rural road construction is key to such development. While the expansion of roads may hasten deforestation by enhancing the profitability of timber harvesting, it will also accelerate the development of agroforestry where primary forests have already been cleared.

The establishment of equitable, profitable, and sustainable agroforestry systems can contribute significantly to the reduction of poverty in marginal areas, help prevent soil erosion, and create tree biomass. Moreover, profitable agroforestry can help strengthen individual land rights. Thus, the development of agroforestry is conducive to efficiency and equity from both private and social viewpoints.

Finally, investing in the education of both sons and daughters should be part of a long-term solution to rural poverty and environmental sustainability. Increasing women's educational attainment will not only increase their opportunities in the non-farm sector, it will also contribute to smaller family sizes and reduced population pressure on scarce forest resources.

CHAPTER 1

Issues and Motivation for Policy Analysis

This comparative study of customary land tenure institutions in western Ghana and western Sumatra is part of a larger multi-country study on property rights to land and trees (Otsuka and Place 2001). Its main purpose is to explore the causes and consequences of the choice of land tenure institutions in the management of land and trees, with special emphasis on agroforestry.[1] Specifically, the study provides information on the effectiveness of village, household, and even parcel-level property rights institutions and arrangements. Unlike the other studies, however, its specific focus is the gender-differentiated impact of the evolution of customary land tenure towards individualized rights.

Since gender is the main focus of the study, we selected two areas where traditional matrilineal inheritance systems have undergone evolutionary changes. Interestingly enough, the matrilineal systems in each of the study areas are very different. Under the Akan matrilineal system in Ghana, land is transferred from the deceased man to his brother or nephew (sister's son) in accordance with the decision of the extended family or matriclan. Although kinship is reckoned through the uterine line, transmission of land is through males, and women have relatively weak land rights. In matrilineal Sumatra, on the other hand, descent and inheritance, as exemplified by the Minangkabau, occur through the female line, and women have strong land rights, especially to paddy land. Sumatran society, similar to other Southeast Asian societies, also has a strong egalitarian ethic and a relative absence of gender discrimination, in contrast to western Ghana. It is no surprise that the process of individualization of land tenure institutions is quite different in these two markedly different matrilineal cultures.

The methodology for analyzing the evolution of land tenure institutions and its efficiency implications is based upon a synthesis of the evolutionary model of farming systems developed by Boserup (1965), Ruthenberg (1980), Pingali, Bigot, and Binswanger (1987), and McIntire, Bourzat, and Pingali (1992); a theory of property rights developed by Demsetz (1967) and Alchian and Demsetz (1973); and a theory of induced innovation developed by Hayami and Ruttan (1985) and Hayami (1997). The first two models can be considered as applications of the induced innovation model. Boserup's study is concerned with the evolution of farming

[1] The other countries in the larger study are Malawi, Uganda, Vietnam, Nepal, and Japan.

systems from land-using shifting cultivation to land-saving intensive farming when population increases over time, whereas Alchian and Demsetz's study focuses on the evolution of property rights institutions from loosely administered open access to private ownership when natural resources become scarce. The analysis of gender differences in land rights, however, draws from theories of intergenerational transfers (Becker and Tomes 1986; Behrman, Pollak, and Taubman 1982) and models of intrahousehold allocation (see Haddad, Hoddinott, and Alderman 1997 for a review). These different but complementary methodologies enable us to analyze evolutionary change at many levels—from the community or village level down to the level of the individual and the plot. Linking changes in property rights institutions and other social institutions for the transmission of wealth across generations is an innovation in studies of this kind. Unlike previous studies that have only theorized about the possible direction of change, we are able to carry out rigorous statistical testing of hypotheses for different units of observation.

The quantification of information is important in informing the debate on the impact of individualization of land tenure systems on women. This issue, although controversial, has rarely been informed by systematic tests of hypotheses at different levels. Conventional wisdom tends to view the process of individualization as a product of colonization or commercialization, rather than as the product of evolutionary processes. If individualization were only the product of colonization, it would be easy to ascribe it to an external intervention or an exogenous shock defined by historical events. However, viewing individualization of land rights as part of an evolutionary process or as an institutional innovation would enable researchers and policymakers to understand better the tradeoffs—for example, between efficiency and equity—involved in this process. Moreover, by identifying the factors that affect the evolution of land tenure institutions at the village and household levels, this study helps to identify critical points for policy intervention. Finally, the comparison between two types of matrilineal systems in two continents enabled us to include a variety of property rights institutions and dynamics, basic agroecological conditions, and natural resource management strategies. Without this comparison, it would have been easy to arrive at simplistic conclusions about the effects of the individualization of land rights on gender.

Research Objectives

This study has three basic research objectives.

The first objective is to explore quantitatively the effects of various land tenure institutions on investments in and the efficiency of agroforestry and cropland management. Despite the widely recognized importance of land tenure institutions in the management of natural resources, the extent and ways in which the former affect the latter are not well understood, especially outside of agriculture. To the extent possible, this study attempts to assess quantitatively the efficiency of natural resource management. Note that the term "efficiency" is used broadly throughout this study to encompass technical or production efficiency, the allocative efficiency of variable inputs, and the efficiency of investments from the viewpoint of local communities and households. Regional, national, or global externalities associated with natural resource management are not explicitly analyzed.

The second objective of this study is to identify major factors affecting the evolution of customary land tenure institutions. Customary or communal land tenure institutions are dynamic. Recent research suggests that the system of communal or family land rights on cultivated agricultural fields tends to evolve toward greater privatization with population growth and increasing commercialization in many parts of Sub-Saharan Africa (Bruce and Migot-Adholla 1994). Very little rigorous statistical analysis, however, has been attempted.

If land tenure institutions evolve toward their social optimum with population growth

and the commercialization of agriculture, there will be little need for policy interventions in land rights systems. On the other hand, if inappropriate land rights institutions tend to persist, or if they move in the wrong direction, effective policy options must be sought.

The third objective of this study is to assess the implications of land tenure institutions for equity, particularly with respect to gender, and for the natural resource base. Most of the study sites lie within agriculturally marginal, less favored, or low-potential areas, where the incidence of poverty is generally high. The ultimate purpose of this study is to seek effective ways to reduce poverty by increasing the efficiency of land use and management in such areas based on a proper understanding of the nature and role of land tenure institutions. The study will also analyze how changes in land tenure institutions affect women's status, and how women's status, the wealth of farm households reflected in farm size, and the gender composition of family labor affect investment in trees and the management efficiency of perennial and annual crop farming. Finally, it will consider how changes in land tenure institutions affect the natural resource base and environmental benefits through their effects on the management of land and trees.

Links between Land Tenure, Agroforestry, and Gender: A Review

Although communal tenure systems tend to grant different rights to different persons for a single plot of land, more private and individualized tenure systems concentrate exclusive and absolute rights to a plot of land to a single individual. Individualization of land tenure systems is inevitable as population pressure increases. It is important to examine its impact on efficiency and equity—particularly gender equity. In most customary regimes, women gain access to land indirectly through male relatives, which makes their land rights under communal tenure weaker than men's. Many have suggested that, as tenure is privatized, that position becomes even weaker (Fortmann 1981; Agarwal 1994; Lastarria-Cornhiel 1997). Modern legal reforms attempting to formalize customary tenure systems have often contributed to the erosion of women's customary rights (see Rocheleau 1988 for a review). In other cases, the erosion has been imposed on ethnic minorities by colonial powers or by national governments.

Despite the importance of this issue, very few studies systematically identify the conditions under which women gain or lose as communal systems are privatized. Indeed, it is only relatively recently that gender roles in agriculture have been analyzed, starting with Boserup's work on farming systems (1970), and the literature on gender differences in land and tree tenure is much more recent (Fortmann 1988; Rocheleau 1988; Rocheleau and Edmunds 1997). However, it may be unwise to generalize that women have always lost out in the process of privatization. Rocheleau (1988) points out that there are examples of women gaining more secure rights to land after privatization, as in the recognition of women's ownership of commercial tree crop plots (usually cocoa) in Nigeria and Ghana (Afonja 1981). Moreover, some recent land reform programs, such as those in Cuba and Nicaragua, have explicit provisions for women as beneficiaries (Deere 1985). Without information regarding the underlying distribution of property rights between men and women, it is difficult to ascertain the impact of the privatization of communal tenure on the gender distribution of property rights.

The Critical Role of Property Rights in Agroforestry

Property rights institutions and land tenure systems govern the use and allocation of forestlands, woodlands, rangelands, and croplands. These land tenure systems range from communal ownership of land to state ownership, common property, and private ownership. Overlapping these systems of land tenure are separate, though often complementary, systems regarding property rights

on trees. The overlap between land tenure and tree tenure becomes especially important in the context of agroforestry, which is the incorporation of trees into a farming system (Bruce and Fortmann 1989).

Individual land rights under the communal system are restricted. Although the usufruct right of individual members of the community is usually well established, the rights to transfer, including sales and leasing, are vested in the extended family, clan, or community. Individual land rights are generally more restricted under state ownership, where nobody has clear rights to use the state-owned land, unless the state grants clear property rights to individuals, such as through a leasehold arrangement.

Agroforestry, in turn, depends on people's rights to plant and use trees, rights that depend on the prevailing systems of land tenure and tree tenure (Fortmann 1988). Tree tenure consists of the rights to own or inherit, the right to plant, the right to use, and the right of disposal. Although tree tenure systems do not always coincide with land tenure systems, each affects the other (Fortmann 1988: 21). Traditionally, systems of customary tenure have recognized rights of use of the products of managed trees that are independent of usufruct rights to use the land (Fortmann 1987). However, as customary tenure holdings become more individualized, distinctions between land tenure and tree tenure may decline (Warner 1995). Where land tenure is communal and tree rights are strong, tree planters are advantaged in their rights to trees; where private rights to land are strong, the strength of one's rights to trees may well depend on the strength of one's rights to land (Fortmann 1988: 21–22).

Incentives to preserve natural resources and to invest in trees and other land improvements for future benefits will be thwarted without clear property rights—whether individual, family, or group ownership—simply because future benefits will not accrue to those who manage them (Mendelsohn 1994). Therefore, as populations grow and markets penetrate into rural areas and, hence, land becomes more scarce, the communal and state ownership systems face serious difficulties.

This does not necessarily imply that a private ownership system with clear land title is socially most desirable (Feder and Noronha 1987; Feder and Feeny 1993). For example, the private ownership system may lead to negative externalities, such as soil erosion, when forestlands are opened up and newly brought into cultivation. Private ownership may create an inequitable distribution of the benefits from natural resources. Furthermore, farmers may not be able to protect their own property if it is costly to exclude other users. In such cases, common property regimes with communal rules and regulations on the use and extraction of natural resources may be socially more desirable (Ostrom 1990; Gardner, Ostrom, and Walker 1990).

Property Rights and Gender

The issue of security of property rights is especially relevant with respect to women, land, and agroforestry. In both matrilineal and patrilineal societies in Africa, land is predominantly allocated to males and transferred intergenerationally to males—to nephews in matrilineage and to sons in patrilineage (Lastarria-Cornhiel 1997). Women gain access and use rights to land indirectly through males: in patrilineal communities through a husband, and in matrilineal communities through their father, uncle, or, sometimes, a husband.

Whereas land tenure may appear more clear-cut, being two-dimensional, tree tenure is characterized by nested and overlapping rights, which are products of social and ecological diversity as well as the relationships between various groups of people and their rights to resources (Rocheleau and Edmunds 1997). Similar to property rights in land, women's rights to trees and forest products are affected by the difference between customary and statutory law, the difference between de jure and de facto rights, and the spatial distribution of women's rights (Rocheleau 1988).

Land Tenure, Agroforestry, and Gender

This study focuses on the overlap of land tenure institutions and tree tenure—the interaction between land rights and the right to plant trees—and men's and women's rights over both land and tree resources. Whereas investment-incentive models of tenure security would argue that secure tenure motivates tree-planting, there is also evidence that, in certain circumstances, tree-planting can increase security of tenure in land. Tree-planting may actually give rise to land rights under customary tenure systems, because the planting of trees is seen as tantamount to ownership; it is proof of an intention to assert a right, which, if unchallenged, ripens into conclusive proof of right (Bruce and Fortmann 1989: 6). Forest clearance is another way to secure land rights under customary law. It requires much effort, which is rewarded by relatively strong individual rights to land. However, it is almost exclusively a male task in most societies. In contrast, women often engage in tree-planting. Gender differences in work effort to clear forests and to plant trees would therefore result in differences in the degree of tenure security on cleared forestland and agroforestry plots between men and women. Whether or not such differences in land rights and tenure security affect the comparative efficiency of agroforestry management by men and women is an important empirical question.

Organization of the Report

The remainder of this report is organized as follows. In Chapter 2 we present the theoretical framework, formulate the major hypotheses, and describe the quantitative methodology and survey design. After describing the survey areas, the prevailing land tenure institutions are characterized in Chapter 3. The following three chapters are devoted to statistical testing. Chapter 4 analyzes the impacts of population growth and other exogenous factors on land tenure choice and the manner of land acquisition; Chapter 5 examines the effects of land tenure institutions on tree-planting and farm management efficiency; and Chapter 6 explores gender differences in land inheritance and schooling investments. Chapter 7 presents the conclusions and policy recommendations.

CHAPTER 2

Intensification and Land Tenure: Theory and Hypotheses

The purposes of this chapter are threefold. First, based on an evolutionary view of farming systems and the induced innovation model, we set up a theoretical framework explaining the intensification of land use and the evolution of property rights systems. Second, based on the theoretical framework, we formulate four testable hypotheses. Third, we develop empirical methodologies to test those hypotheses.

Theoretical Framework

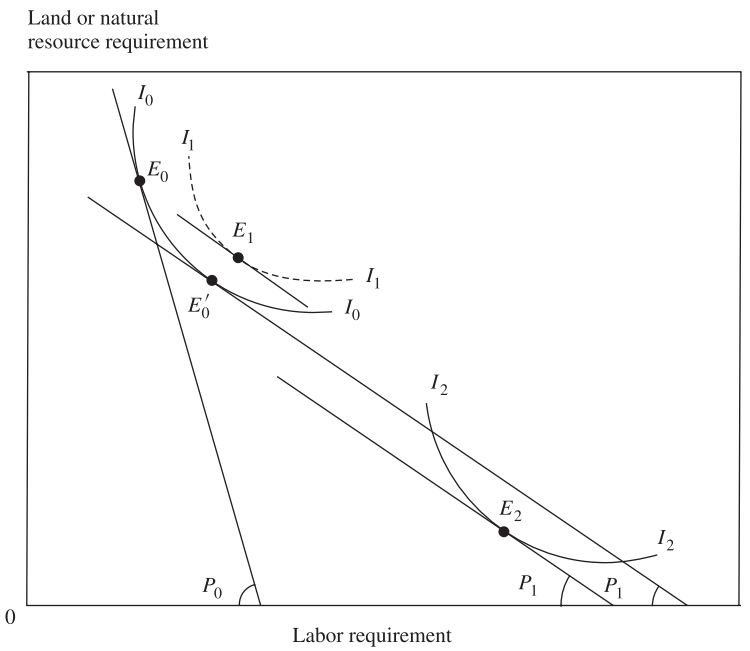
Characteristics of Communal Land Tenure Institutions

In our empirical research, land property rights are classified into bundles of rights encompassing use, investment, exclusion, and transfer rights with and without permission from chief, family head, community organizations, and outside authorities. Our study is designed to explore the perception of these rights by community members, as distinct from externally created legal rights.

A communal land tenure system may be conceptualized as a set of tenures rather than a single tenure type. Under the communal ownership regime, primary forests and uncultivated woodlands are owned communally and controlled by an authority such as a village chief, whereas rights to the exclusive use of cultivated land are assigned to individual households of the community and rights to the ownership of cultivated land are held traditionally by the extended family. Furthermore, the ownership of cultivated land has evolved toward more individualized ownership over time. This whole system is also called the customary land tenure system. Land tenure institutions that are observed in the Sumatra and Ghana sites fall in this category.

Open-access is considered to be a category of land tenure institutions by Feder and Noronha (1987), Bromley (1992), and Feder and Feeny (1993). It is more appropriate to regard open-access as an extreme outcome of land management rules, which can theoretically occur under any land tenure regime. Field observations suggest that communal forest area is characterized by open-access for the community members almost without exception.

Figure 2.1 A model of induced institutional innovation



An Evolutionary Model of Property Rights Institutions

Following Hayami (1997), a simplified version of the theoretical framework can be illustrated by assuming that there are only two factors of production, that is, land and labor. Land represents natural resources and could be cropland (with or without irrigation), rangeland, woodland, or forestland. Under shifting cultivation, food crops are typically grown for a couple of years after forest clearance, and a fallow period of variable length follows until the next period of cultivation. As Boserup (1965) emphasizes, fallow land is not "unused" land; fallowing is a labor-saving method for restoring soil fertility. Under sedentary farming, either annual food crops or perennial tree crops are grown without long fallow periods.

If initially population is scarce and land is abundant with vast areas of virgin forests, people have little incentive to claim individual property rights in land and, hence, the use of forest areas is unrestricted except for the exclusion of outsiders by groups. Whereas the usufruct rights of individual members of the community are well established for cultivated fields, the usufruct rights to fallow land are less clear and the leader of the extended family or chief of the community sometimes determines its allocation to members of the group. Usually, usufruct rights are transferred from one generation to another in accordance with traditional inheritance rules.

Since land is abundant, it is cost effective to practice shifting cultivation with sufficiently long fallow periods, which ensures complete restoration of soil fertility. Curve I_0I_0 in Figure 2.1 portrays the unit isoquant for an individual farmer to produce US$1 worth of food crops by using land and labor under shifting cultivation in period 0. Here land input is measured in terms of area "used" for cultivation, including fallow land, some of which may be secondary forest or woodlands. It is assumed for simplicity that the production function is subject to constant returns to scale, so that each technology or farming system is characterized by a single unit isoquant. The relative factor scarcity may be indicated by relative factor price line, P_0.[2] Then the optimum production point is given by E_0, where production is sustainable, that is, production can continue to take place at this point with unchanged soil fertility.

As population increases, however, land becomes scarce relative to labor. The growing population will require increasing area for agricultural production. Larger areas of forestland are thus opened up, but the rate of area expansion eventually falls short of the growth rate of population. As a result, the scarcity value of land increases relative to labor, which is reflected in changes in the relative factor price ratio from P_0 to P_1 in period 1. Accordingly, the optimum production point changes to E_0', so long as shifting

[2] Although a straight factor price line indicates the existence of perfect factor markets, such an assumption is unnecessary for the substance of the argument. A critical assumption is that the slope of the factor price curve becomes flatter as population pressure increases.

cultivation continues to be practiced. The fallow period at E'_0 tends to be shorter than at E_0.

Owing to the shorter fallow cycle, soil fertility declines and farming becomes unsustainable at E'_0, resulting in the shift of the unit isoquant from I_0I_0 to I_1I_1. Thus, the equilibrium point moves to E_1. If shifting cultivation continues with shortened fallow periods under increasing population pressure, production efficiency will further decline over time. Note that a large area of land is under fallow at E_0 but that more and less fertile land is cultivated at E_1.

The commercialization of agriculture may accelerate the process of change. Because commercialization increases crop prices at the local level, demands for factors of production will increase, with the greatest increases in the prices of those factors whose supply is less elastic. To the extent that the supply of land is less elastic than the supply of labor, which is likely to be the case when virgin forests have been cleared, the relative price of land will increase. Commercialization will also increase the profitability of cultivation compared with fallow, thereby shortening the fallow period and reducing sustainability under shifting cultivation.

During the processes of population expansion and increasing commercialization, deforestation continues to take place, corresponding to an increasing demand for cultivated land. Thus, the stock of natural resources, for example biomass and timber volume, continues to be depleted in this process.

An alternative to unsustainable farming under shifting cultivation and continued deforestation is to improve land quality by investing in land (for example, the construction of irrigation facilities or terracing) or by investing in trees (for example, commercial trees such as cocoa, rubber, coffee, and cinnamon). To maintain soil fertility under continuous cropping of annual crops, new farming systems may be adopted involving the application of compost made from grasses and leaf litter collected from the forest and woodland, as well as manure.[3] Relative to pure cropping systems, the productivity of tree farming systems can be sustained for longer periods of time with lower applications of organic or inorganic fertilizer, primarily owing to their deeper and denser rooting systems. Because of the increasing use of labor and continuous cropping, new farming systems are labor using and land saving. The unit isoquant corresponding to this farming system is depicted by curve I_2I_2 in Figure 2.1.

Crops grown under the new farming system are likely to be different from crops grown under shifting cultivation. Figure 2.1 compares the efficiency of producing different crops, where the unit isoquant is defined in terms of the combination of inputs necessary to produce US$1 worth of output, regardless of which crops are grown. What types of crops will be grown will depend, among other things, on the natural environment and access to markets. For example, if an area is mountainous and sloping, tree crops are likely to have comparative advantage over food crops. If the area has good access to urban markets, the production of fresh vegetables and fruits may have comparative advantage over storable products such as grain, cocoa, and coffee.

Given a relative factor price of P_1, the optimum is attained at E_2 in Figure 2.1 under the new farming system, at which production is assumed to be more profitable than at E_1, and possibly at E'_0 as well. The shift from E_1 to E_2, however, is not costless. As was mentioned earlier, physical investment, such as terracing and tree-planting, is required to adopt the new farming system. Thus, it does not pay to adopt the new farming system unless the difference in the short-run profitability between the old and new systems warrants the cost of long-term investment.

[3] The application of commercial fertilizer can also be considered. To do so, however, requires an extension of the model to the case with more than two inputs, which is straightforward but cumbersome.

Furthermore, land tenure institutions must change in order to encourage investments. Since usufruct rights are not totally secure and transfer rights are restricted under traditional land tenure institutions, the expected returns to investment may be depressed. Those who plant trees may not be able to reap the benefits owing to an inability to bequeath the property to desired heirs or to sell the land freely if the need arises (Besley 1995). It is hypothesized that, in order to provide appropriate incentives to invest in land and trees, land rights institutions for cultivated land are induced to change toward greater individualization.

Among the factors influencing the choice of property rights institution and its evolution, in-migration seems to have played a significant role. First, by accelerating the rate of population growth, migration has placed more pressure on local institutions to adapt to changing factor scarcities. Second, migrants often bring with them different knowledge of resource management and this will create the need for local institutions to facilitate or restrict these new practices accordingly. Finally, migrants may come with their own unique property rights institutions, such as inheritance rules, and these must somehow become integrated with local rules. Thus, there is potential for increased conflict with the influx of migrants. However, there are also great opportunities for institutional change as the migrants bring with them knowledge of alternative institutions.

In short, it is hypothesized that new land tenure institutions are induced to develop when the expected benefits of institutional change exceed the costs thereof. The expected benefits are assumed to be determined by efficiency gains associated with the institutional change; hence they are determined by, among other things, population pressure and the commercialization of agriculture. On the other hand, the costs are assumed to consist of reaching and enforcing new agreements among community members. To the extent that the new institutional rules reduce social equity and stability, the cost associated with such institutional transformation needs to be duly taken into account as well.

Land Tenure Institutions and Equity

What would be the effects on equity of the evolution of property rights institutions? Specifically, would individualization of land rights create a larger disparity of access to land among community members? What will happen to women's rights and welfare when property rights are individualized? This study attempts to address these major analytical issues about equity.

It can be assumed that asset distribution is fairly equitable when land is abundant and investment in both physical and human capital is minimal. In fact, the per capita distribution of land among households under the communal ownership system is generally equal (Otsuka and Place 2001). As land becomes scarce and valuable with population growth and commercialization, however, the distribution of land may become more skewed. It can be postulated that whether or not the individualization of land rights creates significant inequity through the accumulation of land by a small number of people depends on the existence of scale economies. If significant scale economies do not exist, the incentives for selected individuals to accumulate large areas of land will be weak. In contrast, if large scale economies exist, land may be accumulated by a few and, hence, large income disparities may emerge with changes in farming systems associated with the individualization of land rights. Better access to credit and technology by a few will also confer scale advantages. In addition, land may be accumulated by politically influential and wealthy farmers, particularly when a land titling program is implemented (Binswanger, Deininger, and Feder 1995). This point is empirically investigated by estimating a profit function in which farm size is an explanatory variable.

Another important factor affecting equity is the factor-use bias of new farming systems. Since nearly all rural households have access to labor, changes in the production

function in a labor-using direction, as described in Figure 2.1, will promote equity. Thus, the extent to which changes in property rights institutions and farming systems increase labor demand is an important issue for social equity. In order to assess this effect, a labor-use function is estimated in which property rights institutions are included as explanatory variables. Whether new farming systems use male or female labor more intensively will also affect the distribution of benefits of new farming systems by gender.

When land is abundant, migrants can "purchase" uncultivated village land by making small gifts to the community chief as a token of appreciation. Since migrants are generally poor, their acquisition of land becomes more difficult once land becomes scarce and more valuable. Indeed, in many cases migrants acquire cultivation rights by renting in land. In areas where land rights, including rights to rent out, are weak, however, migrants may not find opportunities to rent in land. One question that arises is to what extent the individualization of land rights promotes tenancy contracts. Another question is the extent to which tenancy contracts contribute to the reallocation of land from land-rich households to labor-rich households, given the inherent imperfection of agricultural labor markets owing to asymmetric information (Hayami and Otsuka 1993). Tenancy markets, if they work efficiently, will be conducive to both efficiency and equity as tenancy transactions tend to equate operational land–labor ratios across farms. The efficiency of land tenancy markets, as well as other factor markets, will be tested by assessing the effects of factor endowment on the labor inputs and profits of farm operations per unit of land.

The individualization of land rights may change the relative strength of land rights between husbands and wives. In western Ghana, for example, where women traditionally were not allowed to own land, they began to acquire land ownership rights when they helped their husbands plant and manage cocoa trees. It may well be that, when demand for women's labor in planting trees increases, greater land rights are given to them to enhance their work incentives. In areas where men do not have rights to own land, as in matrilineal Sumatra, men's land rights appear to increase when they plant trees. This study is one of the first attempts to explore rigorously the intrahousehold issues associated with the evolution of property rights.

Hypotheses

Based on the theoretical framework developed in the previous section, the following hypotheses can be postulated.

Hypothesis 1: More secure land tenure institutions will develop in response to increasing scarcity of land relative to labor in order to reap the benefits from investing in the establishment of agroforestry

In order to realize higher profits from tree crop cultivation, the individualization of land tenure must take place to provide sufficient incentives to invest in trees. One might think that strong and secure individual rights in trees, if they existed, would reduce the pressure for the individualization of land tenure. In our research sites, however, land and tree rights tend to be inseparably and positively associated.

The individualization of land tenure institutions, however, is less likely to occur if profitable investment opportunities are limited. This is the case for paddy fields in Sumatra, where only minor investments in the maintenance of traditional and simple gravity irrigation systems are required, and for food crop fields under shifting cultivation in Ghana. The empirical study therefore compares the difference in land tenure institutions among food crop fields, bush/fallow areas, and tree plot fields.

Hypothesis 2: The demographic characteristics of a household affect its choices among forest clearance, family allocation, and market forms of acquisition

Forests have been cleared on a first-come/first-served basis, which has led to the rapid

exhaustion of forestland and its conversion to cropland (including agroforest areas) in many locations. Since forests are likely to have been more abundant in earlier years, older household heads are more likely to have had better access to forestland in their youth. It can thus be hypothesized that older household heads have larger areas of land acquired through forest clearance. Moreover, because forest clearance involves strenuous tasks that are usually performed by males, families with larger endowments of male family labor will have acquired larger areas of forestland. Female-headed households would be handicapped in acquiring land through rental contracts if they require tree-planting, as in the case of cocoa in Ghana, because tree-planting is also a strenuous task. If extended families are concerned about ensuring the livelihood of clan members, however, female heads of households may be less disadvantaged with respect to land transfers acquired through family allocation and inheritance.

Hypothesis 3: Given the expected increase in individual land rights from tree-planting, such tree-planting and the management efficiency of agroforestry are not related to initial tenure security levels under different land tenure institutions

If trees are planted, individual tenure security is enhanced and rights to give land to desired heirs are strengthened. This is because the work effort for planting trees is rewarded by strong individual land rights under customary land tenure rules (see, for example, Shepherd 1991; Otsuka et al. 2001). If tree-planting enhances tenure security, the incentives to carry out subsequent management of trees through such activities as weeding and pruning may be high. In particular, weeding when trees are young has a pervasive long-term impact on the growth and future productivity of cocoa trees in Ghana. This hypothesis can be tested by estimating tree-planting and profit functions.

On the other hand, tenure security may affect the choice of fallow periods, which do not involve explicit efforts to invest. In areas of tenure insecurity, farmers will be reluctant to leave land in fallow for long, for fear that others will begin to cultivate it. The most feasible strategy to guarantee use rights is to use the land continuously.

Lastly, it is widely believed that the individualization of land rights results in the erosion of women's land rights. This assertion can be tested by examining the intrahousehold distribution of different types of land: cropland, agroforestry land, and bush/fallow land. It can be argued that gender differences in land bequests reflect gender differences in labor use, so as to provide appropriate work and investment incentives. Even in Ghana, where women do not traditionally inherit land from their husbands upon the latter's death, wives have gradually been acquiring land from their husbands as the demand for female labor in agroforestry management has increased.

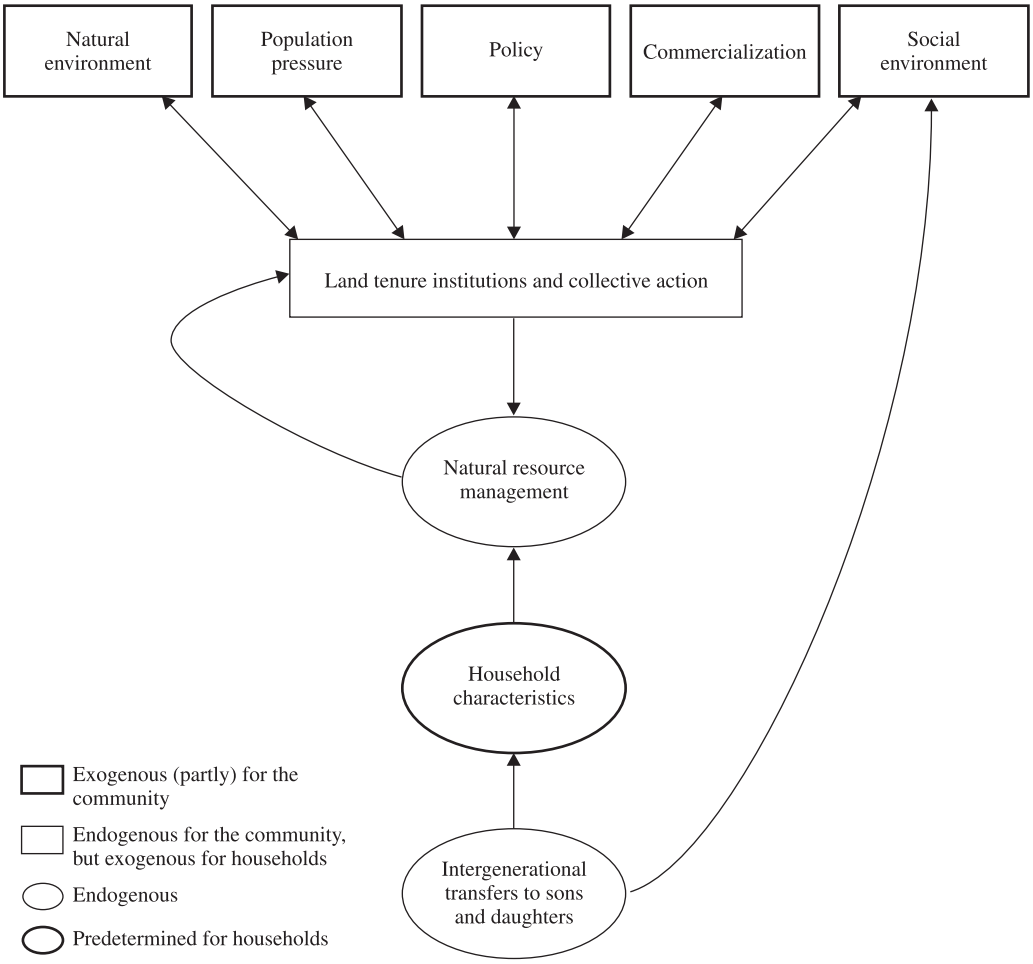
Hypothesis 4: If gender differences in labor use among different types of land exist, the distribution of land among sons and daughters within families tends to become egalitarian, for example with sons inheriting one type of land and daughters others

Because it is possible that parents transfer wealth to their children using different types of assets, whether physical or human, and because human capital is becoming increasingly essential to movement into nonfarm jobs, the gender difference in education may also change as the distribution of land ownership between men and women changes. Thus, we also examine the issue of the gender difference in both land inheritance and education.

Analytical Methodology

We propose three sets of analyses based on two different types of surveys, focusing on different aspects of the causal relationships illustrated in Figure 2.2, and map them on to the conceptual framework in Figure 2.3. The first analysis may be termed an extensive

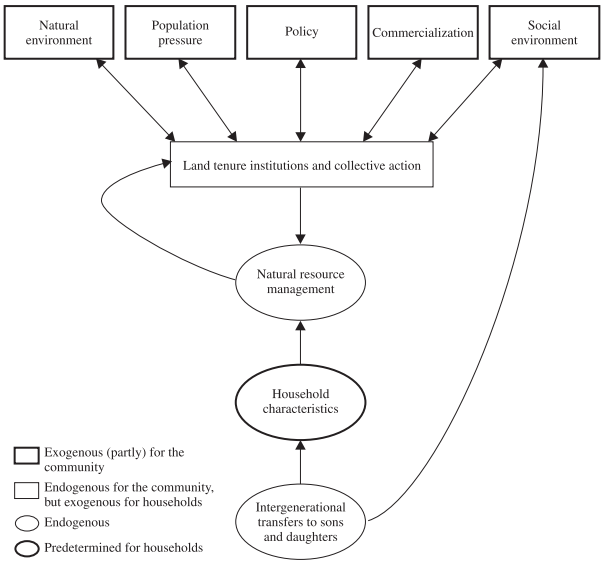
Figure 2.2 Property rights, collective action, and natural resource management: a conceptual framework



study of communities located over wide areas endowed with different natural, social, market, and policy environments and different human and natural resources. The second analysis is an intensive study of households in selected communities where different land tenure institutions and farming systems coexist. The third analysis is a study of intrahousehold and gender issues, based on a detailed retrospective survey of land inheritance and educational investment in individuals within households.

Since we are interested in evolutionary changes in land tenure institutions, it is desirable to use data both from the past and from the present to analyze changes. Data from the sufficiently distant past (for example, a decade or two), however, are not available. In order to obtain information on changes in land tenure and land use over time, we conducted brief individual surveys of selected households to collect information on changes in the manner of land acquisition. We do not expect, however, that the arguments about path dependency in the evolution of institutions proposed by North (1991) have much relevance for our study, because initial conditions were similar across sites—our sites were all covered by dense forests with few inhabitants at the beginning of the twentieth century—and property rights institutions in these areas all have evolved in the same direction.

Figure 2.3 Linkages among the conceptual framework, main hypotheses, and survey design

Conceptual Framework	Hypotheses	Survey Design
	⇦ **Hypothesis 1.** Increasing land scarcity leads to development of more secure land tenure institutions.	Extensive survey of communities in wide geographic area.
	⇦ **Hypothesis 3.** Tree-planting and management efficiency of agroforestry are not affected by initial tenure security.	Intensive household surveys in selected communities.
	⇦ **Hypothesis 2.** Household characteristics affect the mode of land acquisition.	Extensive survey: brief household surveys.
	⇦ **Hypothesis 4.** Inheritance systems evolve to reward differential labor input of sons and daughters.	Inheritance retrospective in intensive survey.

Extensive Study

Hypothesis 1 posits that land tenure institutions will evolve in response to changing relative factor scarcities, which are affected by population pressure and the commercialization of agriculture. The function explaining the incidence of land tenure (LT) institutions can be estimated using the extensive community survey data:

$$LT = F(\text{Natural environment, Population pressure, Policy, Commercialization, Social environment}), \quad (1)$$

where *LT* may be measured by the proportion of area under different land tenure institutions. In traditional areas characterized by communal ownership, the agreement of the community must be obtained in order to convey individualized rights. Thus, the incidence of different forms of land tenure is determined by the characteristics of the community, making it appropriate to test the hypotheses using village-level data. We constructed estimates of the proportions of land under different degrees of individualized rights at the village level, and estimated the following reduced-form functions explaining the incidence of the various land tenure institutions using a common set of explanatory variables:

$$\begin{aligned} S_i = {} & a_{0i} + a_{1i} && \text{(population pressure indicators)} \\ & + a_{2i} && \text{(proportion of migrant population)} \\ & + a_{3i} && \text{(a vector of other village characteristics)} \\ & + a_{4i} && \text{(regional and area dummies)} \\ & + e_{ij} && \text{(error term)} \end{aligned} \quad (2)$$

where S_i stands for the proportion of the *i*th type of land, a_{1i} are parameters, and all explanatory variables are village specific, except for the regional dummies.[4] Land tenure

[4] Since the sum of S_i is unity, it is redundant to estimate the four share functions except to show the significance of coefficients directly.

types are indexed by *i*; they cover the range from communal to individualized forms of land tenure and usually correspond to the mode of acquisition.[5] Indicators of population pressure include the person–land ratio as a proxy for population density and the population growth rate. Other explanatory variables include the proportion of migrants or other ethnic groups in the population and other village characteristics such as distance or walking time to the forest or nearest market town, the proportion of nonfarm households, and school attendance ratios. Note that the proportion of migrant population may be endogenous to the extent that migrants move depending on the availability of land. Consistent with Hypothesis 1, we expect that the person–land ratio or population density has a positive effect on the incidence of individualized forms of land tenure. Hypothesis 1 is tested in Chapter 4 using village-level data.

In both the Ghana and Sumatra sites, community-level indicators of natural resource management, such as the proportions of forest and agroforest lands in the community, are not available. We therefore use retrospective household-level data from the brief individual household surveys that complemented the extensive community survey. The brief individual household survey asked respondents about the manner of land acquisition in the past and was used to construct a data set that traced out historical changes in the relative importance of various modes of land acquisition.

Information on household processes of land acquisition throughout the life cycle was then used to formulate the appropriate model of household decision-making for testing Hypothesis 2—that is, the demographic characteristics of the household affect choices among modes of land acquisition. We assume that, whereas the acquisition or clearance of forestland, the rental and purchase of land, and the development of agroforests reflect choices made by an individual household, the acquisition of land through inheritance and family allocations is determined primarily by the extended family. In our model, we propose that a person, usually a man, follows a sequential decision-making process with respect to land acquisition over his life cycle. If forestland is available, he acquires such land through clearance when he is young, receives the family's land through inheritance, temporary allocation, or gifts either when he gets married or upon the death of a parent, and then acquires additional land through renting and private purchase. The sequence will vary across cultures and may, of course, reflect idiosyncratic variation. In some societies (for example, in Ghana), forest clearance occurs as a rite of passage for young males, and family allocations may then be made at the time of marriage or upon the death of a parent. In Sumatra, on the other hand, inheritance occurs only upon a parent's death. If potential inheritance or family allocation is correctly anticipated, young farmers may adjust their land acquisition behavior accordingly.

It would be reasonable to specify a recursive system of equations in which, first, the acquisition of forestland is determined by exogenous forces, second, the acquisition of family land is explained by the amount of forestland acquired during one's youth as well as exogenous forces, and, finally, the acquisition of land through market transactions is explained by the predetermined forest and family land areas and other exogenous factors.[6] That is:

$$\text{Forestland acquired by farmer} = b_0 + \mathbf{B}_1 (\text{vector of exogenous variables}) + e_1 \quad (3)$$

$$\text{Transfers of family land or inheritance} = c_0 + \mathbf{C}_1 (\text{vector of exogenous variables}) + \gamma (\text{forestland acquired by farmer in his youth}) + e_2 \quad (4)$$

[5] In Ghana, the land tenure types are: family land, gift, village forestland, and acquired non-forestland. In Sumatra, the categories are: joint family land, single family land, land cleared from forests, and purchased land.

[6] If inheritance is accurately anticipated, the order of the equations may be reversed.

Purchased or rented land = $d_0 + \mathbf{D}_1$ (vector of exogenous variables)

$+ \delta_1$ (forestland acquired in youth)

$+ \delta_2$ (transfers of family land) + e_3 (5)

The exogenous variables in the estimation include characteristics of the household head (such as age, gender, years of schooling, and place of origin), measures of initial wealth, and measures of family labor endowments. If extended families operate to equalize wealth among heirs, *inter vivos* transfers by the extended family may be negatively correlated with the initial wealth of the household. If land acquired through forest clearance and transfer of family land is insufficient for the family's subsistence, additional land will be acquired through renting and purchase. Population pressure will also affect inherited land per household: as population pressure increases, the size of inherited land per household decreases, and farmers purchase and rent more land. In other words, increased scarcity of land induces the development of land rental and sale markets. To test whether women are disadvantaged in terms of land acquisition, whether by clearance, family allocation, or participation in the land sale or rental market, the gender of the household head is included among the regressors.

Hypothesis 2 is tested in Chapter 4 using household-level data from the extensive survey. Two specifications are tested: in the first, current holdings of forest- and family land are regressors in the subsequent equations; in the second, the regressors are forest- and family land acquired prior to the first date of acquisition of family land and acquired non-forestland, respectively. The second specification imposes a more rigorous definition of predetermined forest and family landholdings.

Intensive Study

Although the analysis of the extensive survey data is expected to provide an overview of the evolutionary process of land tenure institutions and their consequences, it does not provide a clear picture of how users of natural resources manage them. Furthermore, in analyzing extensive survey data, the impact of household characteristics is taken into account only by using "aggregate" social variables for each community (for example, the proportion of minority ethnic groups with different inheritance rules). In order to examine how land tenure institutions and household characteristics affect natural resource management practices, as specified in Hypothesis 3, detailed household surveys were conducted in selected communities where different land tenure institutions coexist.

As already argued, it may be reasonable to assume that land tenure institutions are exogenous or predetermined in the analysis of household data, so long as they are determined by the community or the large extended family. If, however, the strength of land rights can be changed by individual farmers, for example by investing in land using their own resources and labor, they must be regarded as endogenous. In such cases, either a simultaneous equations system must be formulated or pre-existing land tenure institutions, rather than ex post land rights, must be used as explanatory variables.

First of all, using household survey data, the impact of land rights on investment in land and trees can be assessed using plot-level data:

INVESTMENT = *H* (*LT*, characteristics of plots and household). (6)

Since land tenure institutions are often different on different plots of land, it is desirable to estimate equation (6) at the plot level. Accordingly, we use the land rights of plot managers as explanatory variables in the plot-level regressions. Characteristics of households should include variables related to both human and physical capital endowments. Particularly important will be variables representing wealth, such as the size of land ownership, and the gender of plot managers if men and women own or operate differ-

ent plots of land. Of particular interest are whether or not the rich invest more resources per hectare and whether or not the strengthening of women's land rights promotes investment in land improvements.

In order to isolate the effect of the plot-level tenure variable, whenever possible we use the household-level fixed-effects model to control for the effects of unobservable household characteristics when estimating equation (6), as well as equation (7) specified below. Earlier applications of the fixed-effects model in similar contexts are found in Place and Hazell (1993) and Place, Roth, and Hazell (1994). Alternative specifications are also used to test the effect of key household-level variables that are noted above. Furthermore, to test whether plot-level heterogeneity is important relative to the effect of unobservable household characteristics, we estimate a random-effects model and test whether fixed or random effects is the appropriate specification.

Clearance of virgin forest is one form of investment for future benefits and, accordingly, the dependent variable in equation (6) may be the area acquired by clearing unclaimed forest. In this case, household data will be more appropriate for the analysis, simply because the decision to acquire new land is made by households. This creates the need to develop household-level tenure variables.

Second, it is desirable to assess the relative profitability of different farming systems, for example shifting cultivation versus sedentary food crop production or tree crop production, which correspond to unit isoquants of I_0I_0, I_1I_1, and I_2I_2, respectively, in Figure 2.1. For this purpose, the profit function can be estimated:

$$PROFIT = I(LT, \text{characteristics of plots and household}), \quad (7)$$

where profit may be measured by the residual profit per hectare, which can be obtained by subtracting the costs of non-land inputs (including the imputed value of labor) from the value of outputs. The profit thus computed is supposed to correspond to returns to land and management effort and efficiency. Prices are not used as explanatory variables, because they do not vary within a community. If perennial crops are grown, the age of trees must be included as an explanatory factor.

In equation (7), characteristics of plots should include variables representing the history of cropping patterns, which can be used to assess the sustainability of various farming systems. Important variables to be included in the household characteristics are farm size, the endowment of land relative to family labor, and the gender of the cultivator possessing use or ownership rights. Farm size is used to assess the significance of scale economies or diseconomies. The land–labor ratio is used to examine the efficiency of factor markets, because factor endowments will not affect the efficiency of production if competitive factor markets operate so as to equalize land–labor ratios across different plots. Whether ownership by gender has any significant influence on the profitability of farming has important implications for the intrahousehold allocation of land rights.

The analysis of profitability is complementary to the analyses of the evolution of land tenure institutions and investment behavior. If it is observed that land tenure institutions evolve toward individualized tenure and that such change promotes investment in land and trees, the new farming systems that required prior investment may be more profitable.

Similarly to equation (7), we would like to estimate the impact of land rights institutions on labor use per unit of land under different farming systems:

$$LABOR = J(LT, \text{characteristics of plots and household}). \quad (8)$$

A critical question is the impact of new farming systems on the demand for labor, which may be differentiated by gender.

Intrahousehold Study

Hypothesis 4 links changes in the demand for labor to intergenerational transfers of land and education. It posits that the distribution of land among sons and daughters within families tends to become egalitarian to reward the differential work effort of sons and daughters in agroforestry. In order to examine the effects of the shift from communal to individual tenure on gender equity, it will be instructive to analyze the intrahousehold distribution of wealth transfers from parents, that is, transfers of land and human capital.

Suppose that parents can transfer either assets (land) or human capital (education) to their children. If parental investments in children are motivated by the goal of maximizing lifetime welfare, as suggested by the wealth model of intergenerational transfers (Becker 1974; Behrman, Pollak, and Taubman 1982), parents may give more of one resource to the child who will derive higher returns from that resource. For example, if agriculture is more intensive in men's labor, parents may preferentially allocate land to sons. The model also predicts that parents' investment strategies will change if there are changes in the relative returns to investments in children owing to agricultural development, the expansion of nonfarm employment opportunities, or changes in the demand for male and female labor, as in the case of agroforestry.

This study uses data from the inheritance retrospective administered to households in the intensive survey to test Hypothesis 4. Results are presented in Chapter 6. To investigate the determinants of the distribution of education and land among sons and daughters, the following transfers equation is estimated:

$$\mathbf{T}^*_{\mathbf{ij}} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \mathbf{X}_{cij} + \boldsymbol{\beta}_2 \mathbf{X}_{fj} + \boldsymbol{\beta}_3 \mathbf{X}_{mj} + \boldsymbol{\beta}_4 G_{ij} \times \mathbf{X}_{fj} + \boldsymbol{\beta}_5 G_{ij} \times \mathbf{X}_{mj} + e_{ij}, \quad (9)$$

where $\mathbf{T}^*_{\mathbf{ij}}$ is a vector of transfers

$$\mathbf{T}^*_{\mathbf{ij}} = [E^*_{ij}, l^*_{kij}],$$

where E^*_{ij} is the level of education of child i in family j and l^*_{kij} is the area of land of type k given to child i in family j. In Ghana, one can distinguish between gift, allocated, and inherited land, owing to differences in land rights associated with the manner of acquisition. In the Sumatran case, the distinction is between paddy land, agroforestry land, and bush/fallow land. $\boldsymbol{\beta}$ is a vector of coefficients for each type of transfer; $\mathbf{X}_c$ is a vector of child characteristics such as birth year and dummies for the eldest and youngest children; G is the daughter dummy; $\mathbf{X}_f$ and $\mathbf{X}_m$ are vectors of exogenous father's and mother's human and physical wealth, respectively; and e_{ij} is the error term in each equation. To account for the possibility that the husband and wife do not have identical preferences regarding bestowals to children, an empirical specification consistent with a collective model of the household is used.[7] Thus, father's and mother's wealth at the time of marriage, which are exogenous to decisions made within marriage, enter separately into the regressions. Parental wealth at marriage is defined as human capital, as proxied by years of schooling, and landholdings, whether inherited or given at the time of marriage.

Equations (4) and (9) are related, even though the specifications are different. The difference is that, whereas equation (4) analyzes the acquisition of total family land consisting of both men's and women's plots *across* different families, equation (9) pertains to various types of family land transferred to son and daughters separately *within* a family. For the latter analysis, the characteristics of the father and mother are expected to exert

[7] For a review of collective models of the household, see Haddad, Hoddinott, and Alderman (1997). This formulation draws from McElroy and Horney's (1981) and McElroy's (1990) specification of the Nash bargaining model and is similar to Thomas (1990, 1994). It was applied to the analysis of inheritance decisions in the Philippines in Quisumbing (1994).

major influences; for the former analysis, household characteristics, such as the distinctions between migrant and indigene households, patrilineal and matrilineal inheritance, and the gender of the household head, are expected to be relevant.[8]

Parental land and education are interacted with child gender to test whether fathers or mothers with more physical and human capital treat children of different genders differentially, that is, to test for gender preference with respect to the influence of parental resources.[9] Note that, since parents decide on both types of transfers to children, the transfer equations for education and land are interdependent. Although Ordinary Least Squares (OLS) is equivalent to Seemingly Unrelated Regressions (SURE), if all the right-hand-side variables are the same, we cannot implement SURE because some of the independent variables (for example, land) are censored and because no tractable systems Tobit estimator exists.

Equation (9) is estimated both in levels and with family fixed effects. Since land transfers are subject to censoring (many children do not receive any land), a Tobit procedure is used for the land regressions in levels. However, it is possible that omitted family-level variables are correlated with regressors, and thus their estimated effects on transfers may be biased. For those families with at least two children, the within-family allocation can be used as the source of variation in the sample from which to estimate intrahousehold differences in transfers.[10] A fixed-effects estimation procedure could control for these unobservables using family-specific dummy variables.[11] In this specific application, only the child's sex, birth year, the eldest and youngest dummies, and interaction between child sex and parent characteristics remain as explanatory variables. Although the effects of variables that do not vary across children cannot be identified, their gender implications may be investigated to the extent that they have a different impact on children of different sex. A Lagrange multiplier test allows us to verify the importance of individual heterogeneity, while a Hausman test is used to assess the importance of family-level unobservables (fixed effects) relative to individual heterogeneity (random effects). Both levels and fixed-effects estimates of education and land transfers are presented in Chapter 6.

[8] The time required to collect detailed information on the respondents' parents is another consideration, which affected the specification of variables. Unlike equation (4), we did not include the amount of acquired forestland in equation (9), because we intend to model parents' lifetime decision in the latter before their children decide how much forestland they want to acquire.

[9] For example, Thomas (1990, 1994) finds that maternal education and nonlabor income have a bigger impact on the height of a daughter, relative to a son, and that paternal education has a bigger impact on a son, relative to a daughter.

[10] Families with at least two children are included so that birth order and sex dummies are relevant in the family fixed-effects specification. The fixed-effects procedure eliminates selectivity bias since family size, which affects selection into the sample, is a family-specific variable (Heckman and MaCurdy 1980; Pitt and Rosenzweig 1990).

[11] That is, the observed transfer, T_{ij}, to child i in family j would be given by: $T_{ij} = t_j + \beta X_{ij} + \mu_{ij}$, where the family-specific effect is a dummy variable, t_j, which is taken to be constant for a family. However, this specification, although controlling for additive unobservables, does not consider interactions between observables and unobservables (Hsiao 1986).

CHAPTER 3

Survey Areas and Sampling Strategies

Survey Areas and Land Tenure

Ghana Site[12]

Cocoa plays a major role in the Ghanaian economy.[13] Although cocoa production and cocoa prices in the world market have been declining over the past two decades, the sector remains important. It contributes 24 percent of foreign exchange earnings (Institute of Statistical, Social, and Economic Research 1995) and employs 18 percent of the country's population (Ghana Statistical Service 1995). For most households in southwestern Ghana, it is the main if not the only source of livelihood.

For these cocoa-growing farmers, the indigenous method of cocoa production has remained essentially unchanged. Although new hybrid varieties are being introduced, cultivation is still based on extensive use of land with no application of chemical fertilizer and minimal use of pesticides. Since the soil of the natural forest is inherently fertile, farmers have cleared forests for cultivation over the past hundred years. This has resulted in a decrease in Ghana's rainforest area from 8.2 million hectares to 2.1 million hectares (Ortsin 1998), of which 1.7 million hectares are reserve forest areas. It will not be long before the remaining forests outside the reserves disappear altogether. Given the high population growth rate and declining trend of cocoa production, the improvement of land-use practices to sustain the cocoa industry is becoming an increasingly important issue.

Population pressure on limited land resources has resulted in shorter fallow periods under shifting cultivation, which has reduced soil fertility and, hence, the sustainability of shifting cultivation. In the case of cocoa production, cocoa and food crops are intercropped for the first few years and, once the cocoa trees mature, only cocoa is cultivated on the land. In consequence, if the total area under cultivation is fixed, the expansion of cocoa area implies the reduction of food cultivation area. Whether the expansion of cocoa area at the expense of the area devoted to food crops is desirable for farmers remains to be verified.

[12] This section draws from Quisumbing et al. (2001b).

[13] Agriculture is important in the Ghanaian economy. In the 1990s, the agricultural sector accounted for about 44 percent of the gross domestic product and employed about 59 percent of the labor force (World Bank 1998).

All land used for cocoa cultivation in Ghana is under customary land ownership, in which land-use rights have traditionally been granted to the extended family, even though the ultimate ownership rights were vested in the village chief. Tenure arrangements, however, have been evolving toward individualized ownership over time. When population density was low and virgin forests were abundant, migrants were allowed to clear forests for cultivation and this process resulted in the rapid reduction of forest areas, as vividly described by Hill (1963). With the disappearance of virgin forests, migrants lost such opportunities and instead sought tenancy and caretaker (or labor) arrangements (Benneh 1989). Meanwhile, land tenure arrangements for the indigenous population have also undergone substantial changes, from ownership by the extended family under the uterine matrilineal inheritance system to more individualized ownership systems.

Under communal land tenure, the village chief serves as the custodian of community-owned forest area. In reality, when forestland was abundant, village forest was open access for the community members, as well as for migrants (Berry 1963; Hill 1963; Robertson 1982). Forest clearance requires much effort and, thus, those who clear forests are rewarded by relatively strong individual rights to land. Such individually rewarded land rights are further strengthened if land converters make long-term or permanent improvements in the land, such as tree-planting. Land rights, however, tend to become weaker if land is put into fallow over extended periods. In particular, individual rights to transfer and inheritance are limited and controlled by leaders of the extended family or village (Shepherd 1991; Bassett 1993). It is generally accepted that incentives to invest in land and tree resources under such land tenure rules will be thwarted owing to unclear and uncertain individual land rights (Johnson 1972; Besley 1995).

Although the evolution toward more individualized systems may be conducive to more efficient agroforestry management, the impact on women's land rights is often cause for concern, since there is a possibility that individualization would erode women's customary rights to land. This concern has often been raised in the context of matrilineal inheritance systems (Agarwal 1994). The Akan ethnic group, to which the majority of the population in western Ghana belongs, has traditionally practiced matrilineal inheritance, whereas a number of inhabitants in migrant villages, who belong to non-Akan ethnic groups, are generally subject to the patrilineal inheritance system.[14] Although inheritance among the Akans is through the uterine line, women's land rights are not strong. In the uterine matrilineal system, land is transferred from the deceased man to his brother or nephew (sister's son) in accordance with the decision of the extended family or matriclan (Awusabo-Asare 1990).[15] Wives and children were left with no rights to a man's property if he died intestate (Brydon 1987) nor was the wife provided for in case of divorce.

The mode of land transfer in this region has been evolving over time. When virgin forests were abundant, young unmarried males would appropriate areas from the forest, mainly for food crop production. Inheritance of these land rights, however, depended on the lineage system. Uncultivated fallow land was often allocated temporarily to members of the extended family who possessed small landholdings. More recently, appropriated village land is increasingly being transferred directly to one's wife and children, and even land that would technically belong to the matriclan is often transferred to them with the consent of family members, particularly after the land was planted either

[14] Migrants to the study area consist both of Akans, who migrate for relatively short distances, and of non-Akans, who tend to be long-distance migrants.

[15] The preferred order of inheritance if a man dies intestate is, first, his uterine brother; second, if there is no uterine brother, the son of a uterine sister; third, one of the sons of the deceased mother's sisters.

totally or partially with cocoa trees. Such *inter vivos* transfers are termed "gifts" in the study areas, and individual rights on such land are firmly established.[16] It is believed that gifts are used to circumvent existing matrilineal rules so that children may become heirs to their parents' land (Migot-Adholla et al. 1994). In other words, gifts can be considered an institutional innovation, which is designed to provide incentive mechanisms to stimulate tree-planting.

Property rights of wives and children were strengthened even further by the passing of the Intestate Succession Law (PNDCL 111) in 1985 (henceforth ISL). The ISL provides for the following division of the farm: three-sixteenths to the surviving spouse, nine-sixteenths to the surviving children, one-eighth to the surviving parent, and one-eighth in accordance with customary inheritance law. Thus, the law allows children and wives to gain access to land that they were previously denied under traditional law.[17] The extent to which the law is practiced, however, is not uniform, as will be shown subsequently.

Land rights have also been more clearly individualized among migrants, who either have nuclear families or practice patrilineal inheritance in which a relatively small number of sons within a single family are qualified to inherit their father's land. In contrast, under uterine matrilineal systems, a large number of heirs, including brothers and nephews of the deceased, are qualified for inheritance.

Individualization or privatization of land rights amounts to the demise of traditional matrilineal inheritance. Instead, land will be transferred to the most preferred persons at will by the landowner. Individualization, along with greater scarcity of land, may also promote the development of land rental and sale markets. It remains to be tested whether such market transfers of land may contribute to production efficiency. Whether women are equally capable of acquiring land through market transactions also remains to be verified.

Sumatra Site[18]

In Sumatra, both deforestation and individualization of land rights in response to population pressure have occurred in the context of a matrilineal inheritance system. Deforestation is a serious problem in Indonesia as a whole, but is especially acute in Sumatra, where the rate of reduction in forest area is the highest in the nation (Dick 1991).[19] With the closing of the land frontier, the traditional form of shifting cultivation with a long fallow period has become unsustainable. Thus, the prevalent farming system in Sumatra has changed from shifting cultivation to more land-saving tree-based farming systems. In this respect, the Sumatra case is similar to the case of Ghana.

Unlike the matrilineal inheritance system in Ghana, women have stronger land rights in matrilineal Sumatra. Traditionally, descent and inheritance occur through the female line, as exemplified by the Minangkabau. Except for the special case of adoption, children take the sublineage (*paruik*), lineage (*payung*), and clan (*suku*) of their mother, and remain with these groups throughout their lives (Kato 1982: 51). Unmarried men

[16] Such *inter vivos* gifts are formalized by the recipient's presenting ritual drinks to family elders and other witnesses in the *aseda* (thanksgiving) ceremony. The drink is the physical expression of appreciation for the gift, and is crucial so that the transfer of land rights by gift will not be contested in the future. When a husband gives land to his wife and children, it is their responsibility to provide the drinks, although a husband may secretly do so if the recipients cannot afford it.

[17] Interestingly enough, the common interpretation of the ISL is one-third each among spouse, children, and maternal family. This is remarkably similar to the *abusa* share tenancy arrangement, to be discussed subsequently.

[18] This section draws from Otsuka et al. (2001).

[19] In Indonesia as a whole, the FAO (1990) estimates that the forest cover of the country had declined from 74 percent to 56 percent during the previous 30 to 40 years. The World Bank (1990) reports that the estimated deforestation rate was 1 million hectares per year in 1990, which is 67 percent higher than in 1981. The forest cover in Sumatra decreased from 72 percent in 1950 to 48 percent in 1985 (Fraser 1998). Owing to rapid population growth, population density increased from 17 persons per square kilometer in 1930 to 85 persons per square kilometer in 1995.

typically work as farm laborers or emigrate to other areas to accumulate funds or establish a trade (Errington 1984), and they cultivate their wives' land upon marriage.[20] Residential patterns are also extended and uxorilocal, although Kato (1982) argues that it is, strictly speaking, duolocal. Sons-in-law, who belong to a different matrilineal line, have rights only to visit their wives, and traditionally do not live with her in the wife's natal home, or *rumah gadang*.[21] Major decisions are vested in the lineage head (*mamak*), a maternal uncle. Traditionally, the tie between a maternal uncle and his nieces or nephews (children of his sister) was stronger than the tie between a man and his children.

Classification of property and its transmission across generations occur along gender-differentiated lines. Minangkabau society classifies property into two types: *harto pusako*, or "ancestral property," and *harto pancarian* or "earned property" (Kahn 1980: 26).[22] Ancestral property belongs to the lineage, whereas earned property can be obtained or purchased with one's own efforts. For example, irrigated rice land (*sawah*), the ancestral homestead, gold, and water buffaloes are classified as ancestral property, whereas tools and workshops are "earned property."

These two forms of property are subject to different systems of inheritance. Ancestral property is always inherited by women, and almost always passes from mother to daughters. In contrast, rules of inheritance for earned or acquired property are relatively flexible. The owner is free to sell, mortgage, or give away acquired property. Earned property can also be passed on to either sex, but reverts to ancestral property in the next generation.[23] The same tendency is also observed in the Ghana site, where cleared forestland and tree-planted cocoa plots can be considered as earned property.

The growing importance of earned property has had major implications for the individualization of property systems in Sumatra. Aside from its association with commercial and artisanal activities, earned property also pertained to newly opened agricultural land, particularly a shifting cultivation area (Kato 1982: 169). Newly opened land that became wet rice fields had the potential of becoming ancestral land in the next generation, particularly if it required sizable investments of manpower and material from the developer's lineage. Newly opened land for shifting cultivation was, prior to the advent of commercial agroforestry, of a rather impermanent nature. The clearing of upland fields was not a major operation like creating new *sawah*, and shifting cultivation's impermanent nature made the lineage of its developer less likely to control it. Since shifting cultivation area was considered earned property, its rules of disposal were relatively flexible (Kato 1982: 169). The anthropological studies, however, do not indicate whether shifting cultivation area remains earned property if it is under fallow for many years, probably because this type of earned property did not have much economic significance until the growth of the cash economy and the advent of commercial tree crops, namely coffee, in the nineteenth century. More recently, our field interviews indicate that rights of disposal of cleared land are preserved only if the land is kept in continuous cultivation.

The rise in significance of the nuclear family was accompanied by the growing prevalence of *hibah* (gift), a specific type of transfer of earned property that generally takes place between a father and his children. If a man wishes to make sure that his indi-

[20] Indeed, emigration of single men to work abroad—sending them on a *rantau*—is a long-standing practice among the Minang of West Sumatra, and is considered part of the coming of age process of young men (Errington 1984).

[21] Also called an *adat* house, the *rumah gadang* is supposed to house one sublineage or *saparuik*, which literally means "people of one womb."

[22] This discussion of inheritance of different types of property is from Kahn (1980) and Kato (1982).

[23] In some villages, earned property owned by women is passed on to their daughters; that owned by men is passed on to sons.

vidually earned property goes to his children rather than to the children of his sisters, he may arrange a transfer through *hibah* while he is alive.[24] Education offers another way for a father to invest his earned property: investment in one's children produces fruits of earned property, which cannot be contested by one's matrilineal relatives after one's death (Kato 1982: 183).

As in Ghana, this summary of the anthropological and ethnographic evidence strongly suggests that inheritance regimes are not static.[25] The inheritance system appears to have evolved in parallel to the changes in communal land tenure institutions toward individualized ownership in response to population pressure.

Traditionally, the major ethnic groups—Minangkabau, Kerinci, and Melayu Jambi—have commonly relied upon wet rice cultivation and, hence, areas along streams and rivers are predominantly used as paddy fields. Paddy fields are surrounded by agroforestry plots, including both mature trees and newly planted trees intercropped with annuals, and by shifting cultivation with bush/fallow. Natural forests typically are located in the mountainous terrain further away from village centers. The bush/fallow area originally was converted from primary forests and is planted with food crops periodically for a season or two followed by another fallow period. The most common ownership system used to be ownership by lineage, which typically consists of three generations.

Field interviews indicate that husbands usually make most of the farm management decisions, even though they do not have customary land rights. So it is puzzling that women rather than men traditionally own land. In our view, the choice of matrilineal inheritance system was made in the distant past when land was abundant. Traditionally, no single member of the lineage has ownership rights and sale is strictly prohibited. Although formally the approval of the lineage or community head is required for clearing community-owned forests, approval is easily granted. Women are the custodians of lineage and family land and are expected to oppose the transfer of land to non-family members. Lineage land, however, occupies small areas in our sample villages at present.

Land under joint family ownership, which is inherited and owned jointly by daughters, is much more common than lineage ownership. The major difference from lineage land tenure is the ownership of land by a smaller number of family members. To prevent fragmentation of land beyond the minimum efficient size, cultivation of wet rice land is rotated among sisters' families. All types of decisions regarding land use, inheritance, renting, and pawning are made jointly by sisters and their husbands without intervention of other lineage members.

Joint family land tenure has developed in two ways. First, lineage members agree to divide lineage land into joint family land, usually at the time of inheritance. Second, daughters jointly inherit private land, which was acquired either by opening up forestland or by purchasing already exploited bush/fallow areas. Although the sale of lineage and family land has traditionally been prohibited, such land has actually been sold with the consent of group members. There have been cases in certain areas where sons, in addition to daughters, have jointly inherited land. Traditionally, sons participate in forest clearance and tree-planting but do not inherit. This new land tenure institution represents a break from the traditional rule of matrilineal inheritance.

[24] This is surprisingly similar to the transfer of land as a gift among the matrilineal Akan in western Ghana (see Quisumbing et al. 2001a). Similar to the ceremonies surrounding gift transfers, *hibah* requires the agreement of all parties concerned, including one's matrilineal relatives, as well as expensive feasts.

[25] The Minang themselves do not consider their culture to be static, and take pride in the flexibility of *adat* (customary law). Continuous discussions and reinterpretation of *adat* help the community make judgments that allow both continuity and development in their *adat* (Errington 1984: 99–100). Although some laws are unchangeable (the *cupak usali*, or original measure), the *cupak buatan* (the constructed measure) is subject to change through consensus, provided that it does not contradict or threaten the core *cupak cusali*.

Single family ownership, which has evolved from joint family ownership, is an emerging land tenure category. It is similar to joint family ownership, in that daughters inherit land, but ownership rights are more individualized. More recently, inheritance by sons has also been permitted. Single family ownership could also have evolved from the inheritance of private land.

Survey Design

Similar survey design and data collection methods were used in the Ghana and Sumatra sites. The first task in the data collection phase was to identify major issues in the management of land and trees in a particular region through literature review, examination of secondary data, and informal exploratory surveys. Informal surveys were particularly useful because good prior studies on property rights and collective action were often unavailable or, if available, were sometimes obsolete. Since it was necessary to obtain a variety of information through questionnaire surveys, the pre-testing of survey questionnaires through an informal survey was essential. We all participated in the extensive pre-tests of the survey instruments.

Extensive Survey

In the extensive study, either random sampling of communities located over wide areas or stratified random sampling with stratification based on demographic factors was applied. A community is defined as a single village. In both Ghana and Sumatra, 60 communities were randomly selected for the extensive survey (described in detail by Otsuka et al. 2001 and Quisumbing et al. 2001a). Various data sources and data collection methods were used in the extensive survey study. These included (1) secondary data on demographic variables and farming practices, (2) community survey data obtained from group interviews of key informants on socioeconomic variables, such as land rights, rules of resource use, access to markets, agricultural practices, and the development of credit, labor, and land markets, and (3) brief household survey data on the history of use of natural resources (farmland, forestlands, and woodlands) and their acquisition. The supplementary brief household surveys were conducted in the Ghana and Sumatra sites where village-level data on land use, land area, and/or inheritance practice were either unavailable or unreliable. The brief individual surveys were of five households per village in Sumatra and seven households per village in Ghana. As much as possible, both husbands and wives were interviewed. This was particularly important in Ghana, because husbands often do not know the size of land owned or managed by their wives.

Intensive Survey

Selection of appropriate communities for the intensive household survey was based on the results of the extensive survey. One criterion was to ensure representation of communities with contrasting characteristics in terms of prevailing land tenure institutions, farming systems, and degradation or protection of natural resources. Four villages were chosen for the household survey in Sumatra, and 10 were selected in Ghana. Sample sizes depended not only on the complexity of issues but also on the accuracy and coverage of the data necessary for our statistical analyses. Since our methodology required the estimation of tree-planting, profit, and labor-use functions, questionnaires and the timing of survey rounds were designed to obtain accurate labor and wage data. Data were also obtained on family composition, inventory of assets, histories of acquisition of assets and land use, current production and nonlabor input use, and property rights.

In Ghana, the intensive survey was conducted in 1996/97 in 10 villages in the Wassa area of western Ghana, an area previously surveyed by the World Bank (Migot-Adholla et al. 1994). Although the original intent was to create a panel data set, the coverage of mature cocoa fields was limited in the earlier survey and parcels owned or managed by women in male-headed households were not included. Given the objective of the current

study to examine land tenure—and gender differences therein—in greater detail, the original sample size was deemed insufficient. The authors of the present study conducted a census of 1,878 households in the survey villages, after which 281 households were chosen based on stratified random sampling among various tenure categories. Sample sizes were allocated to the 10 villages in proportion to village population, and an attempt was made to include respondents from the earlier study.

In Sumatra, the intensive survey was carried out in two sites in Jambi Province: Kerinci District, which is a cinnamon-growing area, and the Rantau Pandan Subdistrict, where the dominant agroforestry crop is rubber. In Kerinci, a random sample survey of 50 households in each of two contiguous villages was conducted. The three survey rounds took place in August/September 1996, February/March 1997, and August 1997. In Rantau Pandan, the sample consisted of 122 households from one village and 40 households from a contiguous village. In this research report, we present only the analysis of the efficiency of rubber production; a similar analysis of cinnamon production is found in Suyanto, Tomich, and Otsuka (2001b).

Inheritance Survey

To investigate whether broad changes in land tenure patterns due to the process of individualization have affected the distribution of land rights by gender, a retrospective survey of inheritance and education was also implemented in both the Ghana and Sumatra sites. In the Ghana site, the inheritance and education retrospective was administered to all intensive survey households; in Sumatra, it was administered to a subsample of 60 households in both the rubber and cinnamon sites randomly selected from the intensive survey respondents. The retrospective survey on inheritance was patterned after a similar survey in the Philippines (Quisumbing 1994), and included questions on the parents, siblings, and children of the respondents, yielding information on three generations—called the parents', respondents, and children's generations.[26] The respondents were asked about the pre-marriage wealth (education and landownership) of their parents and in-laws (and other familial sources of inheritance), the education and inheritance of their spouses, and the schooling of their children and proposed bequests to them. Each respondent was also asked to list all of his or her siblings, their dates of birth, their educational attainment, and the areas of different types of land that they had received or expected to receive from their parents or other relatives. In many cases, respondents received land at marriage, but stood to inherit more land after their parents' deaths.

In the Ghana study, since one can inherit from the matriclan as well as from one's own parents, inheritance was distinguished according to its source. The survey in Ghana was administered only to the head of household (usually male), because low levels of literacy among wives made it difficult for them to answer questions that involved the recall of events in the past (for example, dates or years of birth).

In the Sumatra case, higher levels of schooling of survey respondents, both male and female, made administration of the inheritance retrospective much easier. To make sure that the sample was balanced in terms of male and female respondents, husbands were interviewed in half of the sample, while wives were interviewed in the other half. In many cases, however, both wives and husbands joined the interviews.

Basic Extensive Survey Data

Ghana Site

An extensive survey was conducted in the most active cocoa-growing regions in Ghana: the Western Region, the Brong-Ahafo

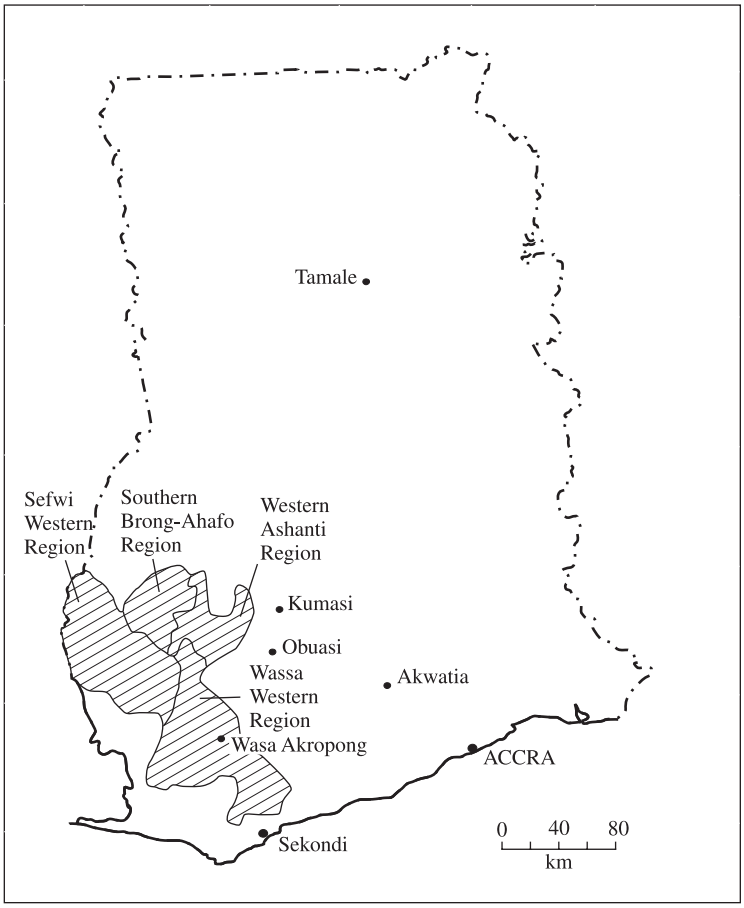
[26] The grandchild generation is called the child generation for brevity.

Region, and the Ashanti Region (Figure 3.1). In the Western Region, two areas were surveyed covering two districts each, the Wassa area and the Sefwi area. Sefwi and Wassa have different migration and settlement histories and are administratively and linguistically distinct, although the languages are related. Cocoa cultivation historically spread from the Eastern Region toward the Ashanti and Brong-Ahafo regions in the 1940s and 1950s and further toward the frontier area of the Western Region during the 1950s and 1960s (Berry 1963). The diffusion of cocoa to Wassa and Sefwi continued in the 1970s and 1980s.

We randomly selected 15 villages each in the Brong-Ahafo and Ashanti regions, and 15 each were chosen in Wassa and Sefwi, of which 9 were predetermined to be indigenous villages and 6 were migrant villages. The dominant ethnic group in these villages is the Akan (87 percent of our sample households); also present, although in smaller numbers, are the Ewe (2.7 percent), Ga-Adange (5.4 percent), and Northerners and other non-Akans (4.9 percent). A group interview with village leaders and other members was conducted to obtain information about land rights under different land tenure institutions, among other things.[27] Population census data collected in 1984, which we use to avoid the endogeneity of current population growth rates to migration, were also obtained for 58 villages.[28] Unless otherwise indicated, the extensive survey data used in this chapter come from the survey of seven households in each of the 60 villages.

The study area is characterized by undulating land, and cocoa is the dominant crop grown mainly on mildly sloping parcels (Benneh 1987). Virgin forests have largely disappeared, but annual crop fields and fallow areas under shifting cultivation, including secondary forests, coexist with cocoa fields. Table 3.1 summarizes the land-use patterns, average farm size, man–land ratio, and gender of the household head in Akan and non-Akan households.[29] The majority belong to the Akan ethnic group, which has traditionally practiced uterine matrilineal inheritance, although a number of inhabitants in migrant

Figure 3.1 Map of survey area, Ghana



Source: Quisumbing et al. (2001b: 58).

[27] Since people seldom consider the land rights under different land tenure institutions explicitly and systematically, it took considerable time to arrive at consensus on each question. This casts doubt on the feasibility of obtaining accurate information on land rights from interviews with individual households.

[28] As the migrant population increased, migrants, who tend to live on the periphery of indigenous villages, eventually formed new villages. Two of the migrant villages in the extensive survey sample had not yet been established by 1984. Owing to the establishment of new villages and associated changes in village land areas, it was not possible to compute the population growth rate at the village level from 1970 to 1984.

[29] A self-declared headship definition was used.

Table 3.1 Land-use pattern, farm size, and person–land ratio in 1997 in selected villages in Ghana

Ethnic group of head of household	Number of households	Bush/fallow cum forest area per farm		Cocoa area per farm		Total farm size		Person–land ratio (persons/ha)	% female-headed households	% female-held parcels
		ha	% of total farm area	ha	% of total farm area	ha	%			
Akan	355	4.92	42.2	5.24	52.2	11.47	100.0	1.13	14.1	21.1
Non-Akan	53	2.62	39.0	4.57	57.7	7.42	100.0	1.84	11.3	11.7

Table 3.2 Distribution of currently adopted inheritance rules by gender of head of household, Akan and non-Akan households in Ghana

Gender of head of household	Number of sample households	Matrilineal (%)	Intestate Succession Law[a] (%)	Patrilineal (%)
Akan households	355	43.9	40.6	16.5
Male	305	43.0	39.3	17.7
Female	50	50.0	48.0	2.0
Non-Akan households	53	5.7	13.2	81.1
Male	47	4.3	8.5	87.2
Female	6	16.7	50.0	33.3

[a] One-third equal sharing among spouse, children, and maternal family.

villages belong to non-Akan ethnic groups, which are generally subject to the patrilineal inheritance system.[30] The correspondence between Akan ethnicity and matrilineal inheritance is not one-to-one, however, as will be shown in Table 3.2.

Akan households tend to have larger farm sizes, a lower person–land ratio, and a large area devoted to bush/fallow land. Cocoa area per farm is also slightly higher among Akan households. A slightly higher percentage of Akan households (14.1 percent) are headed by women, compared with non-Akans (11.3 percent). A fifth of total parcels (21.1 percent) are owned by women in Akan households, compared with only 11.7 percent among non-Akans. As will be discussed later, women acquired land ownership primarily through gift, which is characterized by strong individualized land rights. Such differences may be attributed to the difference in inheritance systems and associated differences in land tenure security between Akan and non-Akan households.

Table 3.2 shows the distribution of currently adopted inheritance rules by Akans and non-Akans, by gender of the household head. Among the traditionally matrilineal Akans, the percentage of households reporting that they follow the ISL is quite high (about 40 percent) although some Akan households report the practice of patrilineal inheritance. Matrilineal inheritance and the ISL are equally important modes of inheritance. Among non-Akans, in contrast, the predominant pattern of inheritance is patrilineal (81.1 percent). On the aggregate, only a small proportion (13.2 percent) of non-Akan households follow the ISL, since land tenure systems are inherently more individualized in patrilineal systems. Among the small number of female-headed non-Akan households, however, the ISL is the predominant means for inheriting land.

[30] We omitted 12 observations owing to incomplete and unreliable answers.

Table 3.3 Distribution of area under different land tenure regimes by gender of head of household, Akan and non-Akan households in Ghana (percent in relation to category)

	Akan			Non-Akan		
Land tenure regime	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Primary modes of acquisition						
Appropriated village forestland	14.5	0.4	14.9	18.3	. . .	18.3
Purchased village forestland	4.1	0.5	4.6	1.4	1.7	3.1
Privately purchased	3.1	0.3	3.4	10.8	2.5	13.3
Acquired through renting	1.0	0.2	1.2	8.4	. . .	8.4
Currently renting	7.9	0.8	8.7	18.7	1.3	20.0
Subtotal	*30.6*	*2.2*	*32.8*	*57.6*	*5.5*	*63.1*
Secondary modes of acquisition						
Allocated family land	15.9	3.1	19.0	3.3	. . .	3.3
Inherited family land	14.4	1.6	16.0	3.6	. . .	3.6
Received as gift	23.5	7.2	30.7	26.3	2.2	28.5
Subtotal	*53.8*	*11.9*	*65.7*	*33.2*	*2.2*	*35.4*
Others	1.4	0.2	1.6	1.3	0.2	1.5
Total	85.7	14.3	100.0	92.1	7.9	100.0

Table 3.3 presents the distribution of land by manner of acquisition in Akan and non-Akan households, by gender of the household head. There are two general modes of acquisition: the primary mode, in which land is acquired from outside the family, and the secondary mode, which involves decisions made by family members. Secondary modes of acquisition are more important for Akans than for non-Akans in aggregate, but for female heads of households the reverse is true.

For both Akans and non-Akans, land received as a gift accounts for the largest proportion of land acquired, larger even than inherited land, but the processes of land transfer differ by ethnic group. Transfer of land to sons as a gift has been practiced historically (Hill 1963), but the incidence of gifts to wives seems to have increased in recent periods. In matrilineal areas, the larger share of gift land would reflect a shift to individualized property rights, reducing the matriclan's control over land.[31] Among Akan female-headed households, gifts are the most important manner of acquiring land. In Akan households, the share of temporarily allocated family land is also larger than inherited land; temporary allocation is the second most important mode of acquisition by female heads. This suggests that family allocations are more important than postmortem inheritance.

Appropriated village forestland is more important among non-Akan than among Akan households: the dominant categories for non-Akans, after gifts, are current rental agreements and appropriation of village forestland. Hill (1963) observed that the chiefs were glad to seize the opportunity of selling land outright to enterprising migrants. As uncultivated forestland has disappeared, however, renting land under share tenancy arrangements, called *abusa* (one-third of cocoa output for tenant) and *abunu* (50:50), has become the major means for migrants to acquire access to land (Robertson 1982; Boadu 1992). In these tenancy contracts, tenants are requested to plant cocoa trees, typically on bush land, and to manage cocoa trees until the whole field is planted to cocoa, at which time land ownership, rather than output, is usually divided between tenant and

[31] According to Benneh (1987: 73), migrants may also obtain access to land through gift grants if the farmer can prove that he belongs to the same clan as the villagers where he has gone in search of land. Migrant farmers may also receive a free grant of land from their wives' family lands upon marriage.

Table 3.4 Index of individual land rights under different land tenure regimes by percentage of Akans in population in Ghana

Land tenure regime	Less than 50% Akan	50–80% Akan	80% Akan or higher
Temporarily allocated family land			
Food crop land from father	0.33	0.06	0.05
Food crop land from family	0.50	0.13	0.53
Inherited family land			
Akan inheritance	0.83	1.06	1.08
Non-Akan inheritance[a]	5.67	4.63	2.32
Village forestland			
Appropriated by indigenes	3.67	3.38	3.00
Purchased by migrants	5.17	3.19	3.16
Tree-planted land transferred as gifts			
Gift from father	6.00	5.00	4.97

Notes: Six rights are considered: to plant or replant trees, to rent out, to pawn, to bequeath, to give, and to sell. The numbers in this table are based on group interviews and show the average number of cases in which farmers have rights without approval from family members or village chief.
[a] Equal division among all heirs.

landowner (Asenso-Okyere, Atsu, and Obeng 1993).[32] The fact that renting is widely practiced, with the ultimate division of land ownership between the contracting parties, suggests that land ownership rights have been strongly individualized so as to allow for the alienation of land that was formerly to be transferred to other family members. This inference is reinforced by the non-negligible incidence of private land purchase, which has traditionally been prohibited.[33]

Female heads of Akan households receive a larger proportion of area from family allocations, whereas female heads in non-Akan households are more likely to have acquired land through purchase. Non-Akan females are excluded from family allocation and inheritance under existing rules. Thus, although the ISL was intended to protect women's rights in matrilineal groups, it may well become more important in guaranteeing women's land rights in non-Akan groups.

In order to measure the strength of individualization of land rights under different land tenure institutions, farmers were asked during group interviews about the following six rights: (1) to plant and replant trees; (2) to rent out land; (3) to pawn land; (4) to bequeath land; (5) to give land; and (6) to sell land. The numbers in Table 3.4 show the average number of cases in which farmers have rights without approval from family members or the village chief. Note that the land rights index is not a cardinal number but an ordinal number, because it is absurd to assume that each right has equal weight. Since the existence of stronger rights (for example, the right to sell) implies that weaker rights (for example, the right to plant trees) also exist, the index number is useful in ranking the strength of land rights under different land tenure regimes. Moreover, land rights are likely to be more endogenous than land tenure (as represented by the mode of acquisition), because rights can change after tree-planting. For these reasons, we actually used land tenure dummies, rather than the land rights index, as explanatory variables in the regression analyses.

The percentage of Akans in the population is used to proxy the range of inheritance regimes, with matrilineal inheritance more widely practiced the larger the proportion of Akans in the population. The weakest land rights are observed in temporarily allocated family land, on which even tree-planting is not allowed. Thus, if land tenure security at the time of tree-planting determines investment incentives, one would expect to observe that cocoa trees are seldom planted on allocated family land. Land rights are also weak in inherited land among matrilineal Akan households, which is in contrast to the case

[32] The major harvesting season of cocoa extends from October to January. Perhaps the main reason for dividing land rather than sharing output is the difficulty for the owner to check cocoa output accurately. If output cannot be measured accurately, the tenant may be able to cheat the owner. Moreover, the division of land rather than of output seems to indicate that the study area is still in a relatively land-surplus situation. See Hayami and Otsuka (1993) and Otsuka, Chuma, and Hayami (1992) for surveys of the share tenancy literature.

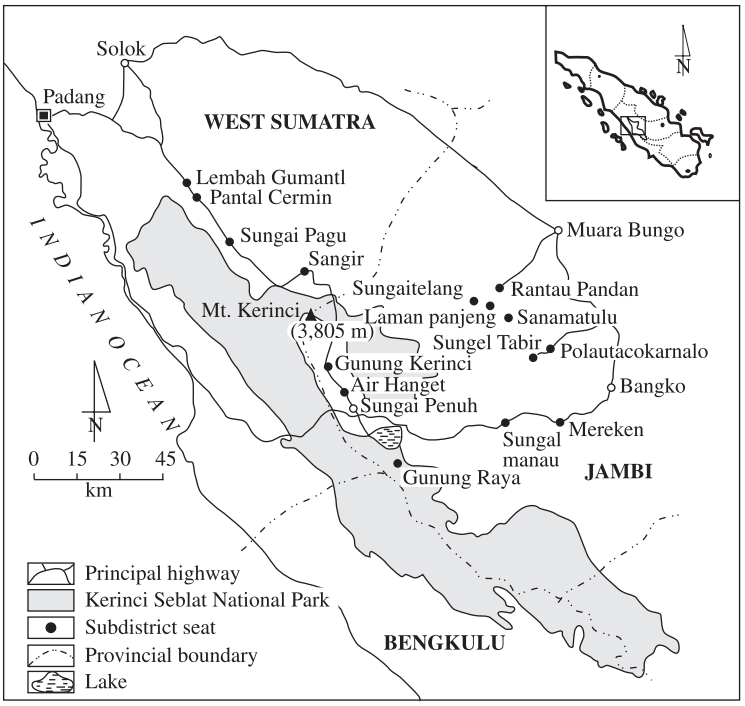
[33] Since the authors did not anticipate the prevalence of private land purchase, the formal group interviews did not ask about land rights on privately purchased land. However, informal interviews suggest that strong rights, comparable to those of gifts, are conferred to individuals who purchase land using their own funds. If purchase is financed by a group of extended family members, individual land rights are rather weak.

of non-Akan patrilineal households bestowed with fairly strong rights in inherited land. It seems that land rights are more easily individualized in patrilineal society, because the interests in the same piece of land are shared by only a small circle of individuals, consisting of a father and his sons.

Strong land rights are also observed in formerly village forestland, both appropriated by indigenes and purchased by migrants. The rights are somewhat stronger for land purchased by migrants, presumably because migrants are less subject to the tradition of the family ownership of land. Strong land rights accrue on cleared forestland, because efforts to clear forests are rewarded by strong individual land rights.

The strongest land rights are observed in tree-planted land received as a gift. After seeking the consent of members of the extended family, fathers typically give gifts to their sons, and occasionally to their wives. The strong rights are conferred as rewards for the effort to plant and grow trees. This observation clearly indicates that incentives to plant trees on allocated family land and inherited land may be strong if individual land rights are strengthened by tree-planting.

Figure 3.2 Map of survey area, Indonesia



Source: Suyanto et al. (2001c: 99).

Sumatra Site

The extensive survey villages were randomly selected with probability proportional to village population from four districts in Sumatra located along the buffer zone of the Kerinci Seblat National Park (Figure 3.2).[34] These were: Solok in West Sumatra Province, and Kerinci, Bungo Tebo, and Bangko in Jambi Province. The study sites are classified into three regions depending on altitude. Solok, which is classified as the High Region, is located at an altitude of more than 1,000 meters above sea level; the major tree crop is coffee (*Coffea canephora*), although the area planted to cinnamon has been increasing. Cinnamon (*Cinnamomum burmanii*) is the major tree crop in the Kerinci district, which is classified as the Middle Region. Bungo Tebo and Bangko are adjacent districts in a low-lying area where rubber (*Hevea braziliansis*) is the major tree crop. Since the sites in these two districts are similar in terms of ethnic composition, climate, and topography, they are classified into a single geographical area, or the Low Region.[35]

Table 3.5 presents land-use patterns and population statistics from selected villages in each of the three regions in 1995. Villages in the High Region have 31 percent of their exploited land in paddy, compared with only 9 percent for villages in the Low Region. Population density is highest in the Middle Region and lowest in the Low Region. Ac-

[34] The village-level results draw heavily on Otsuka et al. (2001) and Suyanto, Tomich, and Otsuka (2001a).

[35] For more information on the dominant farming systems in Sumatra, see Angelsen (1994, 1995, 1999) for shifting cultivation, Tomich et al. (2000) on highland coffee, Aumeeruddy (1994) on cinnamon, and Barlow and Muharminto (1982), Barlow and Jayasuriya (1984), Gouyon, de Foresta, and Levang (1993), and Penot (1997) on rubber.

Table 3.5 Land-use pattern in 1995 and size of population in 1993 in selected villages in Sumatra

		Exploited area in 1995[a]									
		Paddy fields		Agroforestry plots		Bush/fallow					
Region	Sample size	ha	% of exploited area	ha	% of exploited area	ha	% of exploited area	Total village area (ha)[b]	Primary forest area (ha)[c]	Population in 1993[b]	Population density in 1993[d]
High Region	24	259	31	377	45	204	24	5,143	4,303	1,764	34
Middle Region	19	151	19	526	66	125	16	3,173	2,371	1,340	42
Low Region	17	102	9	594	55	385	36	6,735	5,654	772	11

[a] Based on community survey.
[b] Based on Agricultural Census (Bureau of Statistics).
[c] Estimated by subtracting total exploited area from total village area.
[d] Population divided by village area.

cordingly, the bush/fallow area is smallest in the Middle Region, whereas large tracts of bush/fallow land remain in the Low Region. Low population density in the Low Region can be explained by the paucity of paddy fields in this area. In contrast, the rich endowment of flat fertile area suitable for rice cultivation and the high profitability of cinnamon would explain the highest population density in the Middle Region.

Although population density may appear much lower in Sumatra than in Ghana, the ratio of population to cultivated area is much larger in Sumatra. Since the topography in Sumatra is much more mountainous, the proportion of cultivable area is smaller. Thus, the average farm size in our rubber-growing villages in the Lower Region, where population density is lowest among three regions, is 4 hectares, which is about half of the average farm size in Ghana (see Table 3.1). Such differences in farm size may explain why the land ownership system is more individualized in Sumatra than in Ghana.

Estimates of the percentage of land under different land tenure institutions by type of land use were obtained through group interviews. To reduce measurement errors associated with the finer classification of land tenure categories, similar land tenure categories—such as single family ownership by daughters or by daughters and sons—have been combined. It must be pointed out, however, that ownership by women dominates that of men in most areas.

Some patterns can be observed in Table 3.6. First, the traditional system (joint ownership and lineage land) is dominant for paddy fields in the Middle and Low Regions, but accounts for only about one-fourth of bush/fallow and smaller portions of tree crop plots in all regions. Second, single family ownership is more important than joint ownership except for paddy fields. Third, private ownership tends to dominate in tree crop plots and accounts for a sizable portion of bush/fallow.

As in the case of Ghana, private ownership rights are granted to those who have cleared forestland, which requires a large amount of family labor. Those who have purchased land have even clearer individual land rights. If the matrilineal rule of inheritance to daughters is strictly followed, the acquired land ought to become joint family land in the next generation and lineage land after two generations. Yet the area under joint family cum lineage ownership is small in all the regions, which indicates the erosion of the traditional matrilineal inheritance system.

Primary forests are, in practice, characterized by open access, and any member of the community can open the forest for cultivation. Tacitly, however, ownership of cleared

Table 3.6 Distribution of area under different land tenure regimes by land-use type in Sumatra (percent)

Land use	Lineage ownership	Joint family ownership	Single family ownership	Private ownership (purchase)	Private ownership (clearance)
Paddy field					
High Region	2.2	9.0	75.7	7.9	4.1
Middle Region	10.4	63.9	6.3	5.5	7.8
Low Region	0.0	64.6	29.2	6.1	0.1
Tree plots					
High Region	3.1	5.2	41.8	10.4	37.1
Middle Region	4.7	1.5	61.7	13.5	18.5
Low Region	0.0	3.0	45.6	12.4	38.7
Bush/fallow area					
High Region	15.5	8.5	36.3	5.2	32.6
Middle Region	10.3	19.4	43.1	14.3	12.5
Low Region	22.5	3.1	41.7	5.7	27.0

Notes: Based on community survey. Numbers in some rows do not add up to 100% because of the small area of land under state ownership.

land is subject to community regulation if it is left fallow for long periods. More often than not, lineage or family members claim use rights on such land, which originally belonged to the community. Since continuous cropping of annuals is infeasible owing to rapid fertility loss, trees must be planted to secure land rights. This practice is similar to that in Ghana. Efforts to plant and manage trees confer strong individual land rights. This explains why joint family ownership is uncommon for the tree crop area.

To assess the strength of property rights under different land tenure institutions, a group of knowledgeable farmers in each village was asked whether households possess rights to (1) rent out land under a share tenancy, (2) rent out land under a fixed-rent leasehold tenancy, (3) pawn land, and (4) sell land with and without the approval of family and/or lineage leaders for the various tenure categories. The right to rent out under a share tenancy is the weakest right, followed closely by the right to rent out under a leasehold

Table 3.7 Index of individual land rights under different land tenure regimes in Sumatra

Land use	Lineage land	Joint family ownership	Single family ownership (daughters)	Single family ownership (daughters and sons)	Private ownership (purchased and cleared)
Paddy field					
High Region	0.5	0.8	1.6	3.2	3.6
Middle Region	0.8	2.2	2.0	2.8	3.9
Low Region	n.a.	2.7	2.0	n.a.	3.8
Upland field[a]					
High Region	0.0	0.6	1.6	2.0	3.1
Middle Region	0.8	0.9	1.9	2.9	3.8
Low Region	0.0	1.0	1.9	2.8	3.8

Notes: Four rights are considered: to rent out under share tenancy, to rent out under leasehold tenancy, to pawn, and to sell. Numbers refer to the average number of rights without obtaining approval from the family and/or lineage members. n.a. = not available.
[a] Upland field refers to both agroforestry plots and bush/fallow.

tenancy (Hayami and Otsuka 1993), whereas the strongest right rests in the right to sell without approval. Pawning is problem-ridden for family members who own land collectively, because if a pawner cannot repay the loan the land will eventually be confiscated by a pawnee. Except for the case of lineage-owned paddy fields, in which there is no individual right to sell at all, farmers' answers about the right to sell were either "yes without approval" or "yes with approval." Since there is no difference in land rights between bush/fallow and tree plots for any plots of the same tenure category, these two types of land are combined under the category of upland fields (see Table 3.7).

Individual land rights under lineage ownership are very weak, amounting at best to the right to rent out under a share tenancy. It is interesting to observe that individual land rights for paddy fields under joint family ownership in the Middle and Low Regions are comparatively strong, even stronger than land rights under single family ownership by daughters in these two regions. It appears that individual land rights under joint family ownership have been strengthened by deliberate agreement of the family members. Except for this somewhat anomalous phenomenon, land rights are stronger under single family ownership than under joint family ownership and, within single family ownership, the rights are stronger in the case of ownership by daughters and sons. But even under single family ownership by daughters and sons, there is no right to sell without the approval of family members.

The right to sell without approval is granted only to land acquired by clearing forest or by purchase. There is practically no difference in land rights between cleared land and land purchased at the time of acquisition. Particularly in the Middle and Low Regions, land rights in privately acquired land are close to perfect private ownership. Even in the High Region, where individuals' rights over cleared and purchased land are weaker, it does not seem too difficult to obtain approval from family members in order to sell land. The major difference between private ownership in Sumatra and in the Western world is the lack of official registration, so that land cannot be used as collateral for loans from banks. It is important to note, as was pointed out earlier, that land rights acquired by clearing forests tend to decline if plots are left fallow. The extent of this decline, however, is difficult to quantify. If a bush/fallow area is sold, the land remains private. But if private land is bequeathed, it is likely to become single family land after inheritance.

The data in Tables 3.6 and 3.7 for Sumatra, as well as the data in Tables 3.3 and 3.4 for Ghana, seem consistent with the hypothesis that land tenure institutions have evolved toward individualized tenure in order to enhance the incentives to invest in commercial trees. Such incentives are critically important, because planting, pruning, weeding, and thinning require large efforts. If secure individual ownership cannot be acquired, those who plant and grow trees may not be able to reap the future benefits. On the other hand, traditional irrigation works for paddy production, which are simple, small-scale facilities in Sumatra, require a minimum of effort to maintain and repair. Thus, less individualized land tenure for paddy fields is not so much of a problem from the standpoint of the investment incentives required. If population pressure is the driving force toward individualization of land tenure institutions, one would expect to observe a predominance of more individualized tenure on tree crop plots in areas where population density and population growth rates are high in both the Ghana and Sumatra sites.

The next three chapters test the main hypotheses presented in Chapter 2 at the village, household, and intrahousehold levels.

CHAPTER 4

Population Pressure, Land Tenure, and Land Acquisition

This chapter examines the impact of population pressure on the evolution of land tenure institutions at the village level, and of demographic characteristics on land acquisition behavior at the household level. The analysis draws on the extensive surveys in both sites, since these issues are better analyzed with data from a larger geographic area with greater diversity of land tenure institutions. More specifically, using community-level data from the extensive survey, we investigate whether more secure tenure institutions develop in response to increasing population pressure. Then, using household data from the brief household survey, we examine the impacts of the demographic characteristics of households on the manner of land acquisition, including forest clearance, purchase, inheritance, family allocation, and renting. In the final section, we draw a comparative perspective from the Ghana and Sumatra sites.

Determinants of Land Tenure: Village-Level Estimation

Ghana Case

In order to analyze the determinants of land tenure institutions at the village level (equation (1) in Chapter 2), using the extensive survey data we estimated regressions on the proportions of land (1) under family ownership (that is, allocated and inherited land), (2) under individualized ownership acquired by gift, (3) acquired by forest clearance, and (4) acquired by private purchase and renting. Reduced-form functions explaining the incidence of the four types of land tenure institutions were estimated using a common set of explanatory variables.[36] The person–land ratio, which is supposed to reflect population pressure, is hypothesized to have a positive effect on the incidence of gifts.

The proportion in various land tenure categories would be bounded upwards by 100 and downwards by zero, since some categories were non-existent in some villages. Results from the two-limit Tobit estimation method are exhibited in Table 4.1. The percentage of female-headed households and the percentage of Akan households in each village were initially

[36] Since the sum of the proportions in all categories is unity, it is redundant to estimate the four share equations except to show the significance of the coefficients directly.

Table 4.1 Determinants of the proportion of areas under different land tenure institutions at the village level in Ghana: Tobit regression

	Family land[a]	Gift	Village forestland	Acquired non forestland[b]
Intercept	0.476	0.197	0.041	0.044
	(3.856)***	(1.989)**	(0.324)	(0.505)
Person–land ratio	–0.070	0.183	–0.009	–0.073
	(–0.710)	(2.332)***	(–0.086)	(–1.045)
Proportion of migrant population	–0.001	0.0003	–0.0003	0.001
	(–2.468)***	(0.623)	(–0.426)	(2.656)***
Distance to town	–0.003	–0.002	0.006	–0.0001
	(–1.704)**	(–1.399)*	(2.985)***	(–0.059)
Proportion of nonfarm households	–0.002	0.002	0.0002	–0.001
	(–1.458)*	(2.422)***	(0.204)	(–0.944)
School attendance ratio in 1984	0.348	–0.313	0.243	0.222
	(1.460)*	(–1.638)*	(0.974)	(1.334)
Wassa dummy	–0.065	–0.038	0.090	0.002
	(–1.138)	(–0.844)	(1.566)*	(0.058)
Sefwi dummy	–0.096	0.030	0.084	–0.011
	(–1.545)*	(0.608)	(1.342)*	(–0.245)
Brong-Ahafo dummy	–0.147	0.017	0.018	0.101
	(–2.618)***	(0.375)	(0.321)	(2.572)***
Log-likelihood	32.06	44.95	26.64	43.02
Chi-square	20.05	16.31	17.75	29.21
p-value	.01	.04	.02	.0003
Number of observations	58	58	58	58

Notes: Two-limit Tobit estimates; ancillary parameter σ not reported. *t*-statistics are shown in parentheses.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level; one-tailed tests.
[a] The sum of inherited and allocated family land areas.
[b] The sum of areas purchased, rented, and acquired through past renting.

included among the regressors, but none of these variables was significant and regressions with these variables are not reported. It is possible that there is not much variation in these variables across villages; gender differences in household structure and inheritance practices are more likely to affect household-level outcomes.[37]

The coefficient of the person–land ratio is positive and highly significant in the gift equation, which supports Hypothesis 1, that is, that population pressure induced institutional innovation toward individualized land tenure. As expected, the proportion of migrant population is negatively associated with the share of family land. Because migrants have less access to village forestland, they acquired cultivation rights mainly by renting in land or sometimes purchasing land from indigenes, as is indicated by the positive coefficient of the proportion of migrant population in the acquired non-forestland equation.

Other variables are insignificant except in a few cases. First, distance to town has a positive effect on the proportion of forestland and a negative effect on the proportion of family land, which indicates that remaining forests are largely concentrated in areas quite remote from roads and urban centers. Second, the Brong-Ahafo dummy has a negative effect on the proportion of family land and a positive effect on acquired non-forestland, suggesting that land tenure institutions have evolved toward market-based transactions in this region. This is not surprising since

[37] The indigenous village dummy was not included because it is highly correlated with the proportion of migrants in the population ($r = .70$). Note that Akan people also migrate from one village to another, so that ethnicity is not directly associated with the length of settlement.

Table 4.2 Determinants of the proportion of village land area under different land tenure by land-use type in Sumatra: Tobit regression

	Paddy fields				Agroforestry plots			
	Joint family	Single family	Purchased	Cleared	Joint family	Single family	Purchased	Cleared
Intercept	21.29	75.29	3.54	5.73	–0.74	56.58	7.44	27.74
	(0.29)	(8.46)***	(1.31)	(4.48)***	(–0.06)	(7.09)***	(1.46)	(3.41)***
Population density	–0.20	0.21	0.11	0.13	0.22	–0.47	0.07	0.27
	(–1.67)*	(1.82)*	(2.75)***	(0.42)	(1.00)	(–3.13)***	(0.70)	(1.80)*
Population growth	0.39	–3.16	–0.32	4.07	–3.74	–4.88	–2.45	6.36
	(0.19)	(–1.34)	(–0.41)	(1.13)	(–1.06)	(–2.23)**	(–1.74)*	(2.83)**
% paddy area	0.28	–0.27	0.00	–7.73	–1.45	2.11	–0.85	–1.35
	(0.47)	(–0.31)	(0.00)	(–2.29)**	(–1.11)	(2.48)**	(–1.52)	(–2.01)**
% outsiders	–7.04	–0.16	0.04	3.45	0.47	–0.49	0.26	0.23
	(–4.22)***	(–0.21)	(0.17)	(3.03)***	(0.90)	(–1.32)	(1.08)	(0.56)
Travel time to town	–0.10	–0.07	0.02	–0.24	–0.14	–0.05	0.15	–0.02
	(–0.91)	(–0.58)	(0.50)	(–1.41)	(–0.78)	(–0.56)	(2.56)**	(–0.20)
Travel time to forest	0.11	0.37	–0.29	–1.10	–0.14	–0.47	1.15	–1.73
	(0.17)	(0.37)	(–0.91)	(–0.35)	(–0.08)	(–0.53)	(2.09)**	(–1.12)
Middle Region	75.09	–87.38	–4.20	–7.76	–30.44	29.90	–0.77	–25.99
	(8.79)***	(–8.65)***	(–1.43)	(–0.55)	(–1.89)*	(3.61)***	(–0.15)	(–3.03)***
Low Region	51.28	–45.34	0.85	–35.40	–18.31	0.47	–2.03	8.19
	(6.39)***	(–5.02)***	(0.29)	(–1.85)*	(–1.31)	(0.06)	(–0.39)	(0.96)
Log-likelihood	–221.57	–204.45	–171.51	–67.40	–80.53	–257.83	–207.60	–232.10
Sample size	55	55	55	55	58	58	58	58

Notes: Two-limit Tobit estimates; ancillary parameter σ and village fixed effects not reported. *t*-statistics are shown in parentheses.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level; two-tailed tests.

Brong-Ahafo was one of the earlier destinations of the westward geographical movement of the cocoa area from the Eastern Region (Hill 1963).

Recall that the person–land ratio and the shares of land areas under different land tenure institutions were estimated from data obtained from interviews with seven households in each village. In all likelihood, owing to the small number of observations per village, they are subject to measurement errors. Nonetheless, it is remarkable to find significant effects of population pressure on the emergence and widespread adoption of gifts in customary land areas.

Sumatra Case

We estimated regressions explaining the proportion of land under lineage, joint and single family ownership, and the two types of private ownership (purchased and cleared land) separately for paddy fields and tree crop plots, using a common set of explanatory variables. Results from eight regression functions estimated using the Tobit method are shown in Table 4.2.

Hypothesis 1 can be tested by examining whether higher population density and greater population growth rates are associated with a greater incidence of private ownership and a smaller incidence of lineage and joint family ownership.[38] Consistent with this

[38] Population pressure can be represented by past population density and the expected population growth rate, even though the expected value is replaced by the actual growth rate. Note, however, that this statistical test may be biased to the extent that population variables, particularly the population growth rate, are endogenous. Owing to the paucity of data on exogenous variables and the similarity of population growth rates among the three regions (approximately 1 percent per year in each region, on the average), it was not feasible to apply the instrumental variables method. We believe, however, that the difference in land quality is well controlled for by regional dummies and the proportion of paddy area, since differences in land quality are primarily due to regional differences, and favorable agricultural land is fully devoted to paddy fields without exception in the study sites.

hypothesis, population density has a positive and significant effect on the incidence of private ownership through purchase in the case of paddy fields. Population density also reduces the proportion of paddy fields under joint family ownership, but this effect is only weakly significant. Since all forest areas suitable for conversion to paddy cultivation have been exhausted, individualization took the form of replacing collective ownership by single family ownership and inducing market transactions in land. Note that the Middle and Low Region dummies have positive effects on the proportion of joint family ownership and negative effects on the proportion of single family ownership in the paddy field equations. These results are consistent with the observation from Table 3.7 that the land rights of joint family tenure in the Middle and Low Regions were similar to or even stronger than the land rights of single family ownership. According to the regressions on the determinants of land tenure in agroforestry plots, higher population density reduced the incidence of single family ownership and stimulated forest clearance. The effect of population density on joint family ownership, however, is insignificant, presumably because of the small area remaining under this type of ownership (see Table 3.6). Note that the Middle Region dummy has negative and significant coefficients in the joint family and cleared land regressions and a positive and significant coefficient in the single family land regression. These results indicate that, in the regions where uncultivated forestland was available (that is, the High and Low Regions), population pressure led to forest clearance, whereas in the region with limited forestland (that is, the Middle Region) single family ownership was created at the expense of joint family ownership.

Population growth has a significant impact on land tenure distribution only in agroforestry plots. Similar to population density, higher population growth resulted in a lower incidence of single family ownership and a higher incidence of private ownership through forest clearance. Counteracting the effect of the population variables is the negative effect of the proportion of paddy area on forest clearance. A larger per capita endowment of paddy fields, which produce more grain per unit of area than do upland fields, lessens the population pressure on land.

The proportion of outsiders is associated negatively with the incidence of joint family ownership of paddy fields, suggesting that the inflow of outsiders helped undermine the traditional family ownership system of the matrilineal society.[39] Most of the outsiders in the Middle Region, for example, are migrants from Java, who do not practice matrilineal inheritance. Outsiders seem to have acquired paddy land in the past by clearing forest areas suitable for paddy cultivation, which is reflected in its positive coefficient in the cleared area regression for paddy fields.

By and large, both travel time to the subdistrict town and walking time to forests have no significant effects on the distribution of land ownership, with the exceptions of positive effects of both variables on the incidence of purchased agroforestry plots. The former result—that poorer access to local markets stimulates the transaction of agroforestry plots—is difficult to interpret. The latter result, which points to a high incidence of purchase of existing agroforestry plots in areas where there is little forest near the village, is tenable.

A major question is the relative speed with which primary forest and bush/fallow areas have been converted to commercial tree plots planted to rubber, cinnamon, and coffee under different land tenure institutions. If the major source of tree plots is primary forest, agroforestry development comes at the expense of the natural environment. On the other hand, if tree plots were primarily converted

[39] The proportion of outsiders, however, may be regarded as endogenous if they were attracted by the ease of obtaining paddy fields owing to a more individualized ownership system.

from bush/fallow, this development brings environmental benefits.

Determinants of Land Acquisition: Household-Level Estimation

Ghana Case

In this section, household-level data are used to analyze the behavior of households regarding the acquisition of land. Whereas it is reasonable to assume that the acquisition of village forestland, rented land, and purchased land reflects choices made by an individual household, the acquisition of land through inheritance, allocation, and gifts is determined primarily by the extended family.

Table 4.3 shows the average year of land acquisition by land tenure, together with the proportion of area planted to cocoa trees both before acquisition and in 1997, disaggregated by the gender of the head of household.[40] Several important observations can be made. First, village forestland was acquired in the earliest years. This is partly because village forestland was acquired primarily by young unmarried males and partly because forestland had mostly been exhausted in the 1970s.[41] Clearing forestland to establish one's own farm is a rite of passage for young Ghanaian males. Among our respondents, the average age at marriage was 25 years, and they would have cleared forestland before marriage. The last time forestland was acquired from the chief or through the purchase of village land was in 1989. Second, the transfer of family land through inheritance, allocation, and gift took place more or less a decade later in the early 1980s. Third, except for the case of land acquisition through land rental in migrant villages, where migrants acquired cultivation rights in earlier years, the acquisition of land through renting and private purchase generally occurred later.[42] The sequential pattern of acquisition of different types of land provides support for the recursive model discussed in Chapter 2.

Table 4.3 Average year of land acquisition by land tenure type in Ghana and proportion of area planted to cocoa trees before acquisition and in 1997

Land tenure		Average year of land acquisition	Proportion of cocoa area (%)	
			Before acquisition	1997
Acquired village forestland				
Akan	Male	1970	0.0	64.3
	Female	1965	0.0	60.6
Non-Akan	Male	1974	0.0	78.3
	Female	1950	0.0	50.0
Inherited land				
Akan	Male	1980	37.9	44.1
	Female	1971	7.0	17.0
Non-Akan	Male	1985	56.0	44.2
Allocated family land				
Akan	Male	1985	19.0	43.3
	Female	1984	13.3	36.2
Non-Akan	Male	1982	28.0	47.6
Land received as gifts				
Akan	Male	1982	20.3	52.8
	Female	1981	41.1	68.9
Non-Akan	Male	1982	22.7	67.2
	Female	1991	51.7	87.8
Acquired land though renting				
Akan	Male	1980	13.7	62.3
	Female	1989	27.0	60.3
Non-Akan	Male	1976	3.3	84.8
Rented-in land				
Akan	Male	1989	1.9	52.1
	Female	1990	0.0	70.1
Non-Akan	Male	1991	5.4	50.3
	Female	1991	0.0	66.7
Purchased land from nonfamily				
Akan	Male	1983	4.0	54.4
	Female	1996	0.0	62.5
Non-Akan	Male	1982	4.3	60.3

Thus, functions explaining the area of land acquired through forest clearance, through allocations from the extended family, and

[40] Note that it is possible to have female parcel owners in male-headed households.

[41] Some female parcel owners do report having acquired village forestland, but it is unlikely that they undertook land clearing themselves.

[42] Renting-in land is a traditional practice for migrant households; the proportion of rental in indigene villages may be due to migrant households who have moved to predominantly indigene villages. Many early migrants who could not afford to purchase land engaged in share tenancy contracts; the recent increase of renting among indigene farmers may indicate the exhaustion of other traditional modes of acquiring land.

Table 4.4 Determinants of land acquisition at the household level in Ghana: Tobit regression with village fixed effects

	Forestland	All family land (specification 1)[a]	All family land (specification 2)[a]	Acquired non-forestland (specification 1)	Acquired non-forestland (specification 2)
Forestland (current holdings)	. . .	–0.09	. . .	–0.41	. . .
	(–0.44)	(–1.84)**			
Forestland (predetermined)[b]	. . .	. . .	. . .[c]	. . .	–0.37
	(–2.76)***				
Family land (current holdings)	. . .	. . .	. . .	–0.71	. . .
	(–2.02)**				
Family land (predetermined)[b]	. . .	. . .	. . .	. . .	–1.04
	(–11.28)***				
Age of household head	7.65	0.15	0.17	0.15	–0.05
	(2.96)***	(0.35)	(1.97)**	(0.62)	(–0.13)
Year of first marriage of household head	–0.98	–0.54	0.11	–0.35	–0.39
	(–0.55)	(–1.15)	(1.75)**	(–1.30)*	(–0.72)
Dummy for household head born outside of village	54.39	–27.44	–5.16	9.41	5.96
	(2.13)**	(–1.66)**	(–5.84)***	(2.37)**	(2.24)***
Years of schooling of head	–6.42	1.90	0.44	0.39	0.21
	(–2.02)**	(2.69)***	(3.36)***	(1.51)*	(0.65)
Dummy for female-headed household	–65.08	–18.17	–0.79	–16.98	–10.84
	(–2.34)**	(–1.34)*	(–0.51)	(–2.28)**	(–1.51)*
Dummy for patrilineal household	–87.20	–13.36	–4.83	0.90	0.01
	(–2.66)***	(–1.75)**	(–3.52)***	(0.23)	(0.002)
Chi-square	30.4	30.0	222.2	30.3	5091.3
p-value	.0	.0	.0	.0	.0
Number of observations	386	386	386	386	386

Note: Least absolute deviations estimator. *t*-statistics are shown in parentheses.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level; one-tailed tests.
[a] Family land includes allocation, inheritance, and gifts.
[b] Predetermined landholdings consist of land acquired prior to the first date of acquisition of land in the dependent variable category.
[c] Not included owing to nonconvergence.

through renting or purchase were estimated as a recursive system. The exogenous variables include the gender of the household head, the age of the household head, the year of marriage (a proxy for the start of own farming), years of schooling, a dummy for patrilineal household, and a dummy for having been born outside the village (or being a migrant to the village).[43]

Since certain types of land are not observed in a number of sample households and, because unobservable characteristics of villages may affect land acquisition decisions, Honoré's (1992) least absolute deviations Tobit estimation method with village fixed effects was used.[44] The results are shown in Table 4.4.[45] The first column shows the determinants of forest area acquisition. The age of the household head has a positive and highly significant effect, which indicates that cultivable primary forests have largely disappeared in recent years owing to the clearance of primary forests on a first-come/first-served basis. The dummy for a household head born outside the village has a positive effect on acquired forestland,[46]

[43] The patrilineal household dummy and the female headship dummy are not highly correlated; the simple correlation coefficient is .17.

[44] This estimator is preferred since it is both consistent and asymptotically normal under suitable regularity conditions and assumes neither a particular parametric form nor homoscedasticity.

[45] These equations were also estimated using the household-level data from the intensive survey. The results are qualitatively similar and are not reported here.

[46] In an earlier version with regional dummies, the coefficient of the migrant dummy was negative but insignificant.

whereas the dummies for a female-headed household and for a patrilineal household have negative effects on forest acquisition. The negative effect of female headship will reflect women's relative disadvantage in acquiring land through forest clearance, since forest clearance is a male activity. Patrilineal households, who are usually long-distance non-Akan migrants, have no rights to clear forests, unlike short-distance Akan migrants. The positive effect of the outside dummy is likely to capture the active forest clearance activity by Akan migrants.

The next two columns display the estimation results of the function accounting for the acquisition of family land (including gifts). In the first specification (where current holdings of forestland and family land are regressors in the subsequent equations), the coefficient on forestland is not significantly different from zero, contrary to expectations that it would have a negative coefficient.[47] Thus, egalitarian motives do not appear to offset efforts to clear forests. In both the first specification and the second (which imposes a more rigorous definition of predetermined forest and family landholdings), patrilineal households and those who have migrated to their current villages of residence have smaller areas of family land since they do not inherit family land in the area of relocation. The coefficient of years of schooling is positive, which may be taken to imply that the amounts of schooling and landholdings of the extended family are positively correlated. Female heads of households are also less likely to have acquired family land, but this effect is not significant. Family allocation mechanisms seem less biased against women compared with forest clearing and land market transactions, which supports Hypothesis 2.

According to the last two columns, forestland and family land have negative and significant coefficients, which strongly indicates that households seek additional land through renting and purchase when the traditional methods of land transfer are insufficient. In short, land scarcity stimulates land market transactions. It is also important to realize that the negative coefficients of acquired forestland and family land imply that land market transactions transfer land from land-rich to land-poor households, which would be conducive to the more equitable allocation of land. The coefficient of the migrant dummy is positive, indicating that migrants seek additional land more actively through renting or purchase. It also appears that better-educated household heads are able to acquire land through renting or purchase, probably because these require previous savings, managerial ability, and access to information. In addition, better-educated individuals may be engaged in nonfarm activities that provide easier access to cash for purchasing land. In the specification using current forestland and family land, female heads of households are significantly less likely to have acquired land through purchase and rental, indicating that they may be disadvantaged, relative to men, in land sales and rental markets. Since purchase of property requires resources, women may be renting or buying less land because they control fewer resources than men. Similarly, renting requires strenuous labor and hard work in tree-planting, so women seldom rent in land.

Before proceeding to the efficiency implications of different land tenure institutions (to be examined in Chapter 5), it is instructive to review briefly the possible effects of the tenure security of tree-planting. Table 4.3 exhibits the proportion of area planted to cocoa immediately before land acquisition and in 1997, by manner of land acquisition. Although this proportion tends to be higher in land with strong individual land rights (that is, acquired village forestland, land received as a gift, land purchased from nonfamily members) than in land with weak land rights (that is, inherited and allocated family land), the differences are not conspicuous.

[47] It was not included in the second specification because the estimator did not converge.

This observation indicates that incentives to invest in tree-planting are not simply determined by the strength of land rights or land tenure security, but are also affected by expected changes in land rights after tree-planting. Indeed, without considering the effect of tree-planting on land rights, it is difficult to explain the nonnegligible proportions of parcels planted to cocoa in inherited and allocated lands, which are characterized by weak individual land rights (see Table 3.4).

The importance of previous tree-planting as a prerequisite for receiving gifts appears to differ by gender. For male recipients, only 20–23 percent of the parcel was planted to cocoa trees before land was transferred as a gift. In other words, planting cocoa trees on a small portion of the parcel is often sufficient to obtain permission to transfer land to male heirs through a gift from the extended family members according to the current practice. If so, it is not surprising that trees are planted on inherited and allocated land with the expectation that the land parcels planted to trees may be allowed to be transferred as gifts in the future. For female recipients, however, some 40–50 percent of land was planted to cocoa before it was acquired as a gift. This confirms our field observations that *inter vivos* gifts to wives are given strictly in return for their helping their husband plant and cultivate cocoa.

Sumatra Case

This section examines household-level determinants of land acquisition in Sumatra. It seems that, in Sumatra, young farmers are able to predict relatively accurately how much land they will acquire through inheritance in the future because, unlike the case of Ghana, inheritance and forest clearance occur during the same period of the life cycle.

Functions explaining the area of land acquired by forest clearance (deforestation) and by purchase were estimated. The explanatory variables in the regressions are the area of inherited land, interaction of inherited land with two inheritance system dummies with matrilineal inheritance as the base for comparison, the percentage of trees planted at the time of acquisition of inherited land, age of household head, schooling of head, owned paddy area, the number of male and female workers between 16 and 60 years of age, and an outsider household dummy for those who were migrants from Java or another areas in Sumatra. The inheritance system dummies correspond to bilateral inheritance and patrilineal inheritance. Because certain forms of land acquisition do not exist for a number of sample households, and because unobservable village characteristics may affect land acquisition decisions, the Tobit estimation method with village fixed effects was implemented. The estimation results are shown in Table 4.5.

The first column shows the determinants of forest areas acquired through forest clearance or deforestation. As is implied by Hypothesis 2, inherited land, which is predetermined for the household, has a negative and significant effect on deforestation. This is consistent with the popular belief that increasing population pressure on limited land is a major cause of deforestation, to the extent that the declining area of inherited land is due to an increase in household size. The interaction terms of inherited land with two inheritance dummies, however, were not significant. This result shows that incentives to invest in forest clearance under the traditional matrilineal inheritance system are as strong as those under the more recent bilateral and patrilineal inheritance systems. Owned paddy area has a positive and significant effect on deforestation, which is consistent with the fact that wealthier farmers usually employ laborers to clear forests. The percentage of area planted to trees on inherited land is not significant, indicating that the development of profitable agroforestry does not deter deforestation.

Household demographic characteristics also affect deforestation. The age of the household head has a positive and significant effect on deforestation. This result is consistent with Hypothesis 2 that, the older the household head, the greater would have

Table 4.5 Determinants of land acquisition and area planted to trees at the household level in Sumatra: Tobit regression with village fixed effects

	Forest clearance	Purchase	Tree-planted area
Intercept	–2.99	–3.97	–0.54
	(–1.45)	(–1.53)	(–1.38)
Forestland	. . .	. . .	0.77
			(25.67)***
Inherited land	–0.97	–0.26	0.69
	(–2.69)***	(–0.65)	(8.63)***
Inherited land × bilateral inheritance dummy	–0.12	1.42	–0.17
	(–0.12)	(1.62)	(–0.74)
Inherited land × patrilineal inheritance dummy	0.65	–0.16	0.19
	(1.18)	(–0.15)	(0.76)
Percentage of area planted to trees in inherited land	–0.01	–0.02	. . .
	(–1.43)	(–2.00)**	
Purchased land	. . .	. . .	0.38
			(5.43)***
Age of head	0.05	0.03	0.01
	(2.50)***	(1.00)	(1.00)
Schooling of head	0.09	0.16*	0.03
	(1.13)	(1.78)	(1.50)
Own paddy area	0.97	1.20**	0.19
	(2.20)**	(2.03)	(1.73)*
Number of male workers	0.61	0.42	0.16
	(1.74)*	(0.98)	(2.00)**
Number of female workers	–0.26	0.10	–0.14
	(–0.76)	(0.26)	(–2.00)**
Outsider dummy	–12.46	–1.16	0.12
	(–0.03)	(–0.50)	(0.29)
Log-likelihood	–305.19	–254.00	–223.97
Number of observations	273	273	231

Notes: Two-limit Tobit estimates; ancillary parameter σ and village fixed effects not reported. *t*-statistics are shown in parentheses.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level; two-tailed tests.

been access to forestland in one's youth and, hence, the larger would be the acquired forestland area. Families with a larger endowment of male family workers also tend to clear more forestland. Since clearance of forest requires hard work by male workers, this result is not surprising.

The second column shows the estimation results of the determinants of purchased land. Owned paddy area has a positive and highly significant effect on purchased land, which indicates that wealthier farmers tend to purchase larger upland areas. Schooling of the household head has a positive and significant effect on land purchase, implying that better-educated farmers tend to buy more land. The coefficient of inherited land is insignificant, and the interaction terms of inherited land with the two inheritance dummies are also insignificant. The percentage of area planted to trees on inherited land has a negative and significant effect. It may well be that the larger demand for labor in agroforestry deters purchase of additional land. The gender composition of the family workforce does not affect land purchase.

Using brief household survey data, a tree-planting function in which area planted to trees is the dependent variable is also estimated. The explanatory variables included the acquired forestland and purchased land that are considered to be predetermined.[48]

[48] We did not include percentage of area planted to trees on inherited land as an explanatory variable in the tree-planting function, because our interest lies in identifying whether the incidence of tree-planting is lower on inherited land compared with other tenure categories at the present period.

The estimation results are also shown in Table 4.5.

Forestland and inherited land areas have positive and highly significant effects on the area planted to trees. Purchased land also has a positive but weaker effect, judging from its coefficient, which is significantly smaller than the coefficients for forestland and inherited land. Thus, the incentive to plant trees on purchased land is lower, even though land rights on purchased land are very strong. Indeed, because of secure land rights, farmers are in no hurry to plant trees. In contrast, if land use is limited to food crops grown under shifting cultivation, individual rights acquired through forest clearance and inheritance tend to diminish over time. This explains why tree-planting, which strengthens land rights, is more active on forestland and inherited land. In other words, land tenure insecurity is an incentive for tree-planting, as least in systems where investment is rewarded with strong tenure.

The interaction terms of inheritance dummies (bilateral inheritance by daughters and sons and patrilineal inheritance by sons only) do not have significant coefficients. It appears that the incentives to invest in tree-planting are more strongly affected by expected changes in land rights after tree-planting than by the level of land rights before tree-planting. This result, however, is quite different from the findings of Besley (1995), who uses a data set from western Ghana to show statistically that stronger land rights lead to a higher incidence of tree-planting. It can be argued, however, that Besley's methodology of simply counting the number of rights (for example, rights to rent out and to sell) to measure tenure security without considering the relative importance of each right leads to biased estimation.

The number of male workers has a positive and significant effect on the area planted to trees, whereas the number of female workers has a negative and significant effect. These results are plausible, since the establishment of agroforest requires primarily male labor (Barlow and Muharminto 1982; Suyanto, Tomich, and Otsuka 2001a, 2001b). Finally, better-educated farmers tend to establish agroforestry plots more actively.

Concluding Remarks

Following Boserup (1965), we hypothesize that increasing population pressure induces a shift toward more labor-intensive and land-saving farming systems. Although doing so requires investment in land, the incentives to invest are often considered to be weak under traditional family ownership systems owing to restricted land rights. This study, however, has found that customary land tenure institutions have evolved toward individualized ownership systems in both Ghana and Sumatra. Furthermore, it is also found that population pressure is an important factor in the increasing prevalence of gift in Ghana, which is characterized by strong individual land rights, and of private land ownership in Sumatra. These findings clearly support Hypothesis 1. The implication is that, so long as population continues to grow, the profitability of long-term investment for intensified land use will further increase, which will either sustain or accelerate the evolution of customary land tenure institutions toward individualized ownership.

The next chapter examines the implications of more individualized land tenure systems for the efficiency of land use.

CHAPTER 5

Efficiency of Land Use

We have hypothesized that greater individualization of land tenure institutions leads to more efficient land use. Data from the intensive household survey in selected communities are best suited to testing this hypothesis. This chapter assesses the efficiency of land use under various land tenure institutions by estimating tree-planting, fallow choice, revenue, and profit functions. The major purpose is to test the validity of Hypothesis 3, which argues that, owing to the expected strengthening of individual land rights as a result of tree-planting, the tree-planting and management efficiency of agroforestry are independent of the initial level of security associated with different land tenure institutions. This hypothesis is tested in both Ghana and Sumatra. Before proceeding to the statistical analyses, the chapter presents descriptive statistics from both study sites.

Land Tenure and Land Use in Ghana

Land Tenure and Land Use

Table 5.1 shows the distribution of all fields and selected fields by land-use type. Cocoa trees begin to produce output starting from the fourth to fifth year. Cocoa fields are classified into mature cocoa fields from which cocoa can be harvested and young cocoa fields intercropped with food crops. There are fewer mature cocoa fields than young cocoa fields, but mature cocoa fields are much larger. This is because cocoa trees are planted gradually from one portion of the parcel to the next, with new fields being merged with other tree-planted fields. Although the majority of cocoa fields are monocrop fields, some cocoa fields are intercropped with other perennials. Fallow land occupies a large area, whereas land devoted entirely to food crops is less common. Food crops and cocoa are traditionally grown in an intercropped farming system: food crops are planted while the cocoa trees are still young; once the cocoa trees are too tall to let in adequate sunlight for food crops, food is no longer grown as an intercrop. Growing food as an intercrop also takes advantage of weeding labor, because the ground around young cocoa trees has to be kept free from weeds. Since cultivators often do not know the length of the fallow period on all their parcels, the data on the duration of the fallow period for the selected sample fields are incomplete. However, available information indicates that the fallow period commonly ranges from 5 to 10 years.

Table 5.1 Distribution and size of operational landholdings for all sample fields and selected sample fields by land-use type in Ghana

	All fields[a]		Selected fields[b]		
Land use	**Number**	**Size (ha)**	**Number**	**Size (ha)**	**Number of households**
Mature cocoa	504	1.85	276	2.02	213
Young cocoa	701	0.60	218	0.67	187
Food only	197	0.52	112	0.53	106
Fallow only	548	2.37	0	n.a.	n.a.
Food and fallow	12	0.54	6	0.43	6
Others[c]	39	1.65	0	n.a.	n.a.
Total	2,001	1.42	612	1.25	249

Note: n.a. = not available.
[a] All fields of sample households. A field is defined as a portion of a parcel characterized by the same cropping pattern.
[b] Fields selected for the detailed input and output survey.
[c] Fields entirely planted to kola or palm oil trees.

Food crop fields were over-sampled for the collection of detailed production data. Various food crops are usually intermingled in the same field and 12 crop types, including maize, plantain, cassava, and yams, were identified. Although production data were collected for one year, a few crops, such as plantain, need more than a year to bear fruit and are continuously cultivated for two to three years in the survey area. Thus, in estimating the net revenue function of food crops, in order to control for the effects of crop mix, estimates of the proportions of various crops were used as explanatory variables, assuming that the various crops grown together in multiple-crop fields account for equal proportions of land area. As may be expected, there are only a small number of mixed fallow/crop fields.

Table 5.2 describes the distribution of land use according to prevailing land tenure categories. Among the sample villages, seven are indigenous villages inhabited primarily by Akan people subject to matrilineal inheritance, and three are villages inhabited mostly by migrants, who generally follow patrilineal inheritance. The sample households are 85 percent matrilineal, 9.4 percent patrilineal, and 5.6 percent mixed. According to this table, temporarily allocated family land is more important than inherited land. Renting has become a common way for migrants to obtain access to cultivable land. Tenants are contracted to plant and establish cocoa trees. Migrants, as well as young Akan men, also work as caretakers in mature cocoa fields, for which they commonly receive one-third of the harvested crop output. A non-negligible number of fields are borrowed from non-relatives.

As in the extensive survey villages, the weakest land rights are observed in relation to temporarily allocated family land, on which even tree-planting is not allowed. Thus, if land tenure security at the time of tree-planting determines investment incentives, one would expect to observe that cocoa trees are seldom planted on allocated family land. Land rights are also weak in relation to inherited land among matrilineal Akan households. Yet about one-half of allocated and inherited areas are planted to cocoa according to Table 5.3. These observations are consistent with Hypothesis 3—that not only tenure security but also expected changes in tenure security affect tree-planting decisions. Although data on land rights on borrowed land were not collected, field interviews indicate that borrowed land has even weaker rights than allocated and inherited land. In fact, usufruct rights are well established in the case of family land, so long as fields are used for crop cultivation, but this is not the case for borrowed land. Such rights tend to be

Table 5.2 Distribution of all sample fields under different land tenure regimes by land-use type in Ghana (number of fields)

Land tenure	Mature cocoa	Young cocoa	Food only	Fallow only	Food/ fallow	Others	Total
Allocated family land	42	62	42	83	3	6	238
Inherited family land	29	27	5	43	2	3	109
Appropriated village land	52	74	18	64	0	8	216
Purchased village land	26	19	7	24	0	2	78
Received as a gift	188	293	72	202	5	16	776
Privately purchased	12	25	5	19	0	0	61
Acquired through renting	16	8	0	7	0	0	31
Currently renting	78	185	23	88	0	3	377
Caretaking	61	5	8	10	1	1	86
Borrowing from nonrelatives	. . .	3	17	8	1	. . .	29
Total	504	701	197	548	12	39	2,001

stronger for inherited land than for temporarily allocated family land.

Patrilineal households are endowed with fairly strong rights on inherited land. Strong land rights are also observed in relation to former village forestland, whether appropriated by indigenes or purchased by migrants. Equally strong land rights are observed for tree-planted land received as a gift. Gifts are usually made by a man to his children and sometimes to his wife, after seeking agreement from members of the extended family. Actually, the transfer of land to a man's wife and children as an *inter vivos* gift is not a new phenomenon. According to Figure 5.1, which shows the changing relative importance of different modes of land transfer over time based on retrospective survey data, gift transfers were already practiced in the 1960s. It is also important to point out that there was no noticeable increase in the incidence of gifts after the enactment of the Intestate Succession Law in 1985. This strongly indicates that the evolution of land tenure institutions, rather than the law, led to the increasing incidence of gifts as a mode of land transfer.

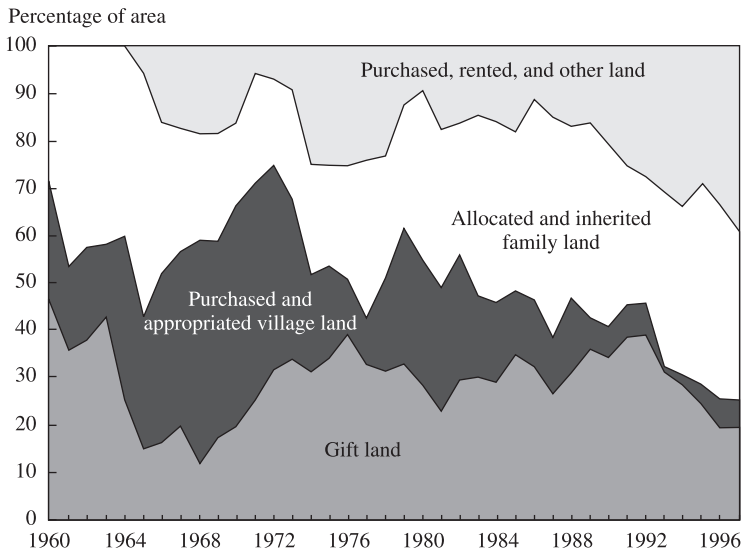
Table 5.3 shows cocoa fields as a proportion of the total area in 1997, compared with land-use patterns before acquisition. In 1997 cocoa trees were planted on 45 percent of allocated parcels and 53 percent of inherited parcels, which suggests that the level of

Table 5.3 Distribution of land use before acquisition and in 1997 by land tenure type in Ghana

	Before acquisition (% of total land area)			In 1997 (% of shifting cultivation area)	
Land tenure	Forest	Cocoa[a]	Others[b]	Cocoa[a]	Fallow
Allocated family land	10.8	3.25	86.1	44.8	64.8
Inherited land	11.4	25.2	63.3	52.8	86.0
Appropriated village land	92.8	0.9	6.3	60.6	78.0
Purchased village land	87.2	1.9	10.9	59.2	77.4
Received as a gift	17.9	5.6	76.5	63.3	72.4
Privately purchased	14.5	9.1	76.4	60.7	79.2
Acquired through renting	42.3	15.4	42.3	77.4	100.0
Currently renting	19.0	6.3	74.7	70.3	79.3
Caretaking	0.0	90.7	9.3	77.6	52.6
Borrowing from nonrelatives	0.0	0.0	100.0	10.3	30.8

[a] Including both mature and young cocoa fields.
[b] Including food production and fallow fields.

Figure 5.1 Proportion of area acquired by type and year, five-year moving averages



tenure security alone does not determine the incidence of tree-planting. However, the proportion of cocoa fields in 1997 is somewhat higher on parcels with stronger land rights, such as appropriated and purchased village land. The proportions are also high in the case of renting and caretaking, because tenants are assigned to plant trees and workers are employed to take care of mature trees. On land received as a gift, the proportion of cocoa fields prior to acquisition was very small, because tree-planting on non-cocoa fields is a prerequisite for transferring land as a gift. Most of the parcels without trees that were transferred as gifts were given to sons by their fathers, especially in Akan households (45 percent). This confirms that gifts are being used as a way to transfer land to designated heirs rather than to let it revert to the matriclan after death.

Net Revenues from Mature Cocoa

Data on gross revenue, paid-out costs, and the net revenue or cash income per hectare of mature cocoa fields, together with data on labor hours and the relative contribution of women and children within the household, are shown in Table 5.4. Since dried cocoa is sold only to the village office of the state cocoa marketing board, the revenue data are expected to be highly accurate. Three visits to the respondents were made over a one-year

Table 5.4 Gross revenue, paid-out costs, net revenue, and labor inputs for mature cocoa production at the field level, by average age of cocoa trees, in Ghana

Average age of cocoa trees	Number of observations	Gross revenue (thousands of cedis/ha)	Paid-out costs (thousands of cedis/ha)	Net revenue (thousands of cedis/ha)	Total labor hours per hectare	Percent women and children
4	15	402	62	325	460	27
5	21	636	56	564	669	34
6	19	534	59	452	695	36
7	14	515	36	464	314	32
8	19	658	49	584	602	35
9	18	488	43	423	627	30
10	96	74	37	614	468	33
11	12	531	69	447	571	34
12	12	674	126	531	451	32
13	10	341	43	286	458	34
14	6	497	26	451	398	23
15	7	338	47	273	503	34
16	7	564	60	486	582	35
17	6	319	39	267	446	43
18	7	412	51	344	362	29
19	5	408	88	306	432	25
20–24	23	343	58	273	378	27
25–29	13	396	37	350	328	22
30+	18	381	54	319	467	33

Table 5.5 Gross revenue, paid-out costs, net revenue, and labor inputs for young cocoa and pure food crop fields in Ghana

Type of crop and years of cultivation	Number of observations	Gross revenue[a] (thousands of cedis/ha)	Paid-out costs[a] (thousands of cedis/ha)	Net revenue (thousands of cedis/ha)	Total labor hours per hectare	Percent women and children	Average fallow period[a]
Young cocoa							
Less than 1 year	52	253	79	171	1,401	41	15.60 (5)
1st year	40	489	32	452	894	51	9.96 (72)
2nd year	49	443	36	397	616	35	11.91 (54)
3rd year	28	271	66	189	687	32	7.87 (24)
4th year	14	207	46	142	274	15	7.86 (7)
Food crops	98	494	38	456	1,106	48	7.73 (56)

[a] We obtained information on fallow periods prior to the current cultivation from only a limited number of cases, shown in parentheses.

period to obtain accurate labor data. Paid-out costs account for roughly 15 percent of gross revenue and consist mainly of payments to hired labor. Chemical fertilizers were not applied, and only a few farmers utilize pesticides, albeit in small amounts. Net revenue, defined as total revenue less paid-out costs, represents the return to land and family labor. There is no strong association between average age of trees and revenue, even though there appears to be some declining trend.

For mature cocoa, the major task is harvesting, which may start as early as October and is completed in March. Cocoa farming is highly labor intensive: if a person works for 7 hours per day, the average labor input amounts to 70 days per hectare. Similarly to revenue, there is no strong trend in labor requirements associated with aging of trees. Family labor of women and children, particularly the wife, accounts for about one-third of labor total inputs. The labor market for harvesting is relatively active and hired labor contributes roughly 40 percent of total labor inputs.[49]

Net Revenues from Food Crops

There seem to be few, if any, investment opportunities in food crop fields, so there is no theoretical reason to assume that land tenure security affects the intensity of cultivation. Yet will it be of interest to examine whether women manage food crop fields differently from men.

According to Table 5.5, both gross revenue and net revenue from pure food crop fields are much higher than those from mixed crop/cocoa fields, except in the first two years of cocoa cultivation. The relatively high revenue from young cocoa fields clearly explains the advantage of cocoa and food intercropping. Paid-out costs and labor hours, however, are much higher in the initial year of cocoa cultivation, owing to the high labor requirement when establishing cocoa fields. Although total labor input and net revenue per hectare are higher in pure food cultivation than in cocoa cultivation (see Tables 5.4 and 5.5), the intensity of cultivation is much higher in cocoa cultivation. This is because food crops are typically produced in two consecutive seasons under shifting cultivation and land is left fallow for nearly eight years on average. Therefore, roughly speaking, the average net revenue per year in shifting cultivation is 90 cedis and the average labor input is 220 hours, both of which are far smaller than the annual revenue and labor hours in cocoa cultivation. Thus, the shift

[49] Wages, however, are substantially different among the 10 villages, even for the same tasks, which indicates segregation of local labor markets due to labor market imperfections or high transaction costs. These 10 villages are located fairly far apart and it would take several hours by motor vehicle to go from one remote village to another remote village in different directions. Because of the non-comparability of wages, we did not impute the cost of family labor using prevailing wages to estimate profits.

from shifting cultivation to cocoa cultivation is consistent with the evolutionary view of farming systems postulated by Boserup (1965) and the view of induced innovation formulated by Hayami and Ruttan (1985). Note that the variations in the gross and net revenue as well as paid-out costs are relatively small, as indicated by the standard deviation, which suggests that resource allocations are largely equalized across fields.[50]

Land Tenure and Land Use in Sumatra

Land Tenure and Land Use[51]

According to Table 5.6, the sampled households in Rantau Pandan operated 550 upland fields, of which 27 were planted to upland rice in the wet season of 1995/96. The rest of these plots comprised 177 young rubber fields (dominant tree age[52] of one to seven years), 198 mature rubber fields (dominant tree age of eight years and above), and 148 bush/fallow fields.[53] The rubber farming system under investigation is sometimes called "jungle rubber" because wild woody species are allowed to grow among the rubber trees, which may help protect the rubber from grass weeds (Gouyon, de Foresta, and Levang 1993). The plant biodiversity of the jungle rubber is half to two-thirds that of natural forest (Michon and de Foresta 1995). The production technologies have changed little since rubber was introduced a century ago, despite the availability of seemingly profitable alternative technologies (Barlow and Jayasuriya 1984). Bush/fallow areas are generally located in areas far away from village centers and were planted to food crops in the distant past. At present, some of them are secondary forests. All these sample plots are used for the probit analysis of tree-planting.

Because of the increase in cinnamon prices relative to rubber in recent years, some farmers have experimented with intercropping some cinnamon in young rubber fields. Thus, only 33 young rubber fields were pure rubber fields, whereas most mature rubber fields were pure stands (aside from the natural regeneration of wild species described above). By and large, cinnamon occupies only small areas, as the elevation is too low for commercial cinnamon production. For this study, all the fields planted exclusively to rubber were included in the surveys conducted during the wet and dry seasons of 1996/97 (December 1996 and June/July 1997). The altitude and slope of the rubber plots were measured to serve as indicators of land quality. The quality of land may be affected not only by these physical characteristics but also by the extent of competition with weeds and the fertility of the soil, which are significantly affected by previous land use (Gouyon, de Foresta, and Levang 1993).

Table 5.6 Distribution of sample plots by land use in upland area of villages in Sumatra

Land use	Number of plots	Number of households
Total	550	162
Upland rice fields	27	27
Young rubber fields[a]	177	111
Subsample[b]	33	. . .
Mature rubber fields[c]	198	122
Subsample[d]	128	. . .
Bush-fallow	148	102

[a] Dominant tree age of zero to seven years.
[b] Selected for the assessment of costs of production.
[c] Dominant tree age of eight years and above.
[d] Selected for the assessment of revenue and costs of production.

[50] The standard deviations for gross revenues and net revenues are lowest at 306.8 and 305.6 cedis/ha, respectively, for cocoa fields under one year old and are highest at 555.5 and 565.5 cedis/ha for second-year cocoa fields. The standard deviation for paid-out costs is lowest for four-year-old cocoa fields at 50.3 cedis/ha and highest for cocoa fields under one year old at 115.6 cedis/ha. The standard deviations for gross revenues, net revenues, and paid-out gross costs for food crop fields are 460.9, 463.4, and 70.7 cedis/ha, respectively.

[51] This section draws from Suyanto, Tomich, and Otsuka (2001a). A similar analysis for cinnamon can be found in Suyanto, Tomich, and Otsuka (2001b).

[52] The age of trees is measured using the "dominant" age because gap-filling and natural regeneration of tree growth result in a distribution of rubber trees of various ages in older rubber plots.

[53] In addition, there are lowland paddy fields. The management of paddy fields is not analyzed in this study.

Table 5.7 Land tenure distribution of sample plots by land-use type in Sumatra (percent)

Land tenure	Upland rice	Young rubber	Mature rubber	Bush/fallow
Communal/lineage	67	0	0	0
Joint family	4	0	0	4
Single family	11	35	24	37
Daughter only	7	4	1	8
Private (purchase)	0	44	53	21
Private (forest clearance)	4	15	10	37
Renting	0	0	9	0
Borrowing	11	6	5	0
Others	4	0	0	0

Thus, attention was also given to the types of land cover (primary forest, rubber fields, or bush/fallow) on these plots before the current cohort of trees was planted.[54] Among these three land cover types, land previously under forest cover is likely to have the highest soil fertility and the fewest weed problems.

The prevailing land tenure institutions were markedly different among upland rice, rubber, and bush/fallow fields. Table 5.7 shows the land tenure distribution of all sample plots by land-use type. In the case of upland rice fields, communal/lineage ownership still dominates. Strictly speaking, use of this communal area is controlled by the village chief, who allocates land for shifting cultivation. After one season of cultivation of upland rice, fields are put into fallow. The average bush/fallow period now is 5.8 years, which is much shorter than the previously common fallow periods (15–20 years) considered sufficient to restore soil fertility (Gouyon, de Foresta, and Levang 1993). Under this system, individuals are prohibited from planting trees on the communal area and they have no rights to rent out land. Although there is no formal rule of access rights to this communal area, villagers obey the implicit customary rule on fallow periods and access rights assigned to various lineage groups. Usually lineage members work together in contiguous fields in order to protect rice crops from wild pigs, a serious pest in this region.

Aside from communal land, which is located on a relatively flat and fertile plain, there are a small number of upland rice fields owned jointly by daughters, individually by daughters or sons, and privately by individuals who cleared their plots from forestland, as well as rice fields borrowed from relatives. Generally, these upland fields are scattered and susceptible to attack by wild pigs.

Land tenure on rubber fields is much more individualized. Private purchase is dominant, and there is no communal and joint family ownership of this type of land. In fact, there are only a few cases of single family ownership by daughters alone. Interviewed respondents replied, almost without exception, that rights to rent out under leasehold and share tenancy contracts, to pawn, and to sell exist not only under private ownership but also under single family ownership and that in neither system is permission required from any other members of the extended family or lineage group. Strong property rights are necessary to provide incentives for the effort to plant and grow trees. Indeed, the act of planting trees traditionally has been rewarded by strong individual property rights in Sumatra and was recorded by European visitors in the late eighteenth century (Marsden 1811). There also is some share tenancy in trees, in

[54] Investigation of previous land use was difficult and time consuming because present cultivators often did not possess the relevant information, either because they had acquired land relatively recently or because the acquired fields had been planted to rubber for long periods.

Table 5.8 Land use before acquisition and before last planting of rubber trees of upland plots currently planted to rubber trees or under bush/fallow in Sumatra

		Land use at present (%)		Land use before planting (%)[a]		
Land use before acquisition	Number of plots	Rubber	Bush/ fallow	Forest	Rubber	Bush/ fallow
Forest	103	46	54	100	0	0
Rubber fields	202	99	1	4[b]	88	9
Bush/fallow	218	59	41	. . .[c]	. . .[c]	. . .[c]

[a] Before planting of rubber trees of currently dominant age.
[b] Pertaining to 128 mature rubber plots selected for the assessment of revenue and costs of production.
[c] No data were collected.

which output is shared one-third for the owner and two-thirds for the tenant, as well as borrowing from relatives. On average, tenants and borrowers operated plots for 2.1 and 6.0 years, respectively.

The prevailing land tenure institutions on bush/fallow land are not so different from those on rubber fields, though renting and borrowing are not practiced on bush/fallow land. Compared with neighboring areas of Sumatra, land tenure arrangements for bush/fallow fields are more clearly individualized in this study area (Otsuka et al. 2001).

We would like to examine how different land tenure institutions and past land-use patterns affect tree-planting decisions and the profitability of rubber production at present. Before they were acquired by the current operator, about one-fifth of our sample of rubber and bush/fallow plots were primary forests, two-fifths were rubber fields, and two-fifths were bush/fallow fields (Table 5.8). Although virtually all forested land in Indonesia officially is classified as state land, from a local perspective these primary forests are communally owned and under the control of the village chief. In practice, these forests are open access to community members, so that very few easily accessible primary forests remain in the study area.[55] Roughly speaking, about half of both cleared forest plots and acquired bush/fallow plots are planted to rubber trees at present. The productive life span of a rubber tree can be 50 or 60 years or more.[56] Moreover, once established, rubber trees generate seedlings and, with proper thinning and other management, the rubber forest can be sustained over extended periods. Hence, with very few exceptions, acquired rubber fields remain planted to rubber either through replanting or through regeneration. As shown in Table 5.8, 88 percent of the present rubber fields in our sample were rubber fields before the current cohort of trees was planted, which indicates that many rubber fields were cleared and replanted after trees became unproductive. More recently, however, farmers may have been less inclined to replant rubber since wild pigs eat the roots of young rubber trees and the problem of depredation by pigs appears to be worsening.

Revenues and Costs

Labor, particularly family labor, is the main input of rubber production. In order to estimate the total cost of production, the cost of family labor by activity and by season was imputed using the relevant prevailing wage rates for hired labor. Daily wage contracts are

[55] See the model of Anderson and Hill (1990), which describes how unused open-access land would be exploited when property rights are conferred on those who have cleared the land.

[56] The average life of rubber trees in these sites seems significantly longer than that reported by Barlow and Muharminto (1982) of 15–25 years for regular tapping, after reaching the tappable age of about 10. Barlow and Muharminto point out, however, that the productive life of rubber trees is negatively related to the intensity of tapping.

Table 5.9 Labor use for rubber production by activity, gender, and dominant age of trees, compared with labor use for upland rice production in Sumatra (person-days/year/hectare)

	Land preparation and planting		Crop care[a]		Harvesting and hauling		
Age range	Men	Women	Men	Women	Men	Women	Total
Rubber							
1 (Forest clearance)	53.3	28.6	6.9	4.1	9.4[b]	25.0[b]	127.4
1 (Bush clearance)	19.6	12.2	17.8	7.7	1.0[b]	1.0[b]	59.3
2–3	2.9	0.0	24.2	6.3	0.0	0.0	33.4
4–7	0.0	0.0	9.8	4.2	0.0	0.0	14.0
8–10	0.0	0.0	4.8	4.6	62.2	6.2	77.8
11–15	0.0	0.0	4.8	1.4	90.5	4.5	101.2
16–20	0.0	0.0	3.2	2.6	78.9	3.1	87.8
21–25	0.0	0.0	4.0	11.5	94.3	0.0	109.8
26–30	0.0	0.0	4.2	0.0	109.3	0.0	113.5
30+	0.0	0.0	4.8	4.2	81.7	0.0	90.7
Upland rice	29.2	53.6	10.1	38.5	11.5	29.8	172.7

[a] Mostly weeding.
[b] Including small amount of labor for harvesting annual crops intercropped with rubber seedlings.

common for forest clearance, land preparation, and crop care (mostly weeding). Wage rates are quite uniform across crop care activities in rubber and upland rice cultivation, but there are marked differences between wage rates for men and women: the average daily wage was Rp 4,600–4,800 (about US$1.50) for men and Rp 3,000 for women. Wages for clearing natural forest, which requires heavy labor and entails significant risk of injury, typically are Rp 8,000 per day. Because of the nature of the work, forests are usually cleared by men.

The labor requirements of rubber production change dramatically as trees mature. Table 5.9 presents the statistics on labor use per hectare by activity, gender, and age of rubber trees compared with labor use for upland rice cultivation. Several observations can be made. First, labor by men predominates in most rubber production activities. This may explain, at least partly, why the matrilineal inheritance system, which formerly covered all asset classes, gradually has been replaced for rubber plots by the patrilineal system, thereby providing incentives to the males who do much of the work on these plots. Second, there are large differences in labor costs in the first year between clearance of primary forest and of bush or old rubber fields, owing partly to the higher costs of felling big trees and partly to higher labor requirements for harvesting annuals intercropped with rubber seedlings. Because of the higher fertility of soils in plots recently cleared from natural forest, annual crops are more frequently planted on these plots, resulting in higher yields. In contrast, annual crops are seldom intercropped with rubber seedlings on plots cleared from bush/fallow. Third, labor requirements for rubber production change over the years. Requirements are high in the first year; then they decline for several years when trees are immature. Labor requirements rise again when trees are old enough to be tapped and they increase until trees are about 30 years old. Finally, they decline with decreases in harvesting labor for the oldest trees. In contrast with rubber, women provide most of the labor for upland rice. This is consistent with the existence of joint- and single-family ownership of upland fields by daughters and also conforms to social norms regarding women's role in the household food supply. Finally, it is important to point out that rubber production is highly labor intensive. Although labor use per cultivated hectare during the cropping

Table 5.10 Gross revenue, production costs, and residual profit per hectare of rubber production, by dominant age of trees, in Sumatra (thousands of Rp in 1996)

Age range	Sample size	Gross revenue	Labor cost		Total costs[b]	Residual profit
			Family[a]	Hired		
1 (Forest clearance)[c]	10	197	655	51	745	–548
1 (Bush clearance)[d]	14	23[e]	197	46	362	–339
2–3	6	0	113	36	193	–193
4–7	13	0	24	36	60	–60
8–10	30	728	392	161	564	165
11–15	40	1,007	418	358	790	217
16–20	22	1,017	473	249	739	278
21–25	8	1,166	118	701	838	328
26–30	14	1,303	436	472	924	378
30+	14	964	470	195	681	284

[a] Imputed costs of family labor from prevailing wages.
[b] Sum of labor cost and cost of current inputs (seeds, seedlings, and chemical inputs).
[c] The total cost of forest clearance, land preparation, and tree planting.
[d] The total cost of bush clearance, land preparation, and tree planting. Cost of clearance may be underestimated.
[e] Small amount of food crops harvested.

season was higher for upland rice than for rubber, upland rice requires a fallow period of five years or more. Thus, if the fallow period is also included, the average labor intensity for the land-use systems taken as a whole is much greater for rubber production than it is for upland rice. Thus, the shift from upland rice production under shifting cultivation to rubber production fits Boserup's (1965) generalization about agricultural intensification as the extensive margin closes.[57]

Output sharing is the dominant form of labor contract for tapping latex from rubber trees and the sharetapper receives two-thirds of the revenue. Tapping in dense stands of "jungle rubber," as well as hauling of coagulated slabs, is done primarily—but not exclusively—by men (Table 5.9; Barlow and Muharminto 1982; Barlow and Jayasuriya 1984; Gouyon, de Foresta, and Levang 1991).

Production costs and gross revenue over time for rubber plots were estimated using average wages to impute the costs of family labor, actual wage payments for hired labor, and actual costs of current inputs (seeds, seedlings, and chemical inputs for latex coagulation) (Table 5.10). Residual profit, defined as gross revenue minus the costs of labor and current inputs, was calculated in order to estimate returns to land and management effort and efficiency. We assume that the age profile of revenue and cost closely mirrors their time profile, to the extent that output and factor prices are stable. It is clear that the cost in the first year is much higher for forest clearance compared with conversion of bush/fallow or replanting old rubber. Residual profit is negative for the first seven years, though its magnitude declines as trees mature and labor costs decrease. Most if not all trees begin to produce latex in the eighth year, and consequently the residual profit turns positive. Subsequently, the growth rate of gross revenue exceeds that of cost, thereby producing annual increases in residual profits until around age 30, beyond which the productivity of rubber trees declines under this management system. Note that the variation in residual profit as measured by the standard deviation is relatively small, which suggests that resource allocations are largely equalized across fields.[58]

[57] An added advantage of rubber agroforestry is the largely uniform labor requirement throughout the year. Tapping is carried out throughout the year and there are only slight seasonal differences in labor requirements.

[58] The mean and standard deviations for the whole sample are Rp 181,000/ha and Rp 212,000/ha, respectively.

Table 5.11 Gross revenue, production costs, and residual profit per hectare of upland rice cultivation, by land tenure, in Sumatra (thousands of Rp in 1996)

	Communal/lineage		Others		Average	
	Rp	% of gross revenue	Rp	% of gross revenue	Rp	% of gross revenue
Gross revenue (1)	617	100	632	100	622	100
Cost of current inputs (2)	19	3	24	4	21	3
Cost of labor (3)	550	89	690	109	597	96
Men	210	. . .	279	. . .	233	. . .
Women	340	. . .	411	. . .	364	. . .
Residual profit: (1) – (2) – (3)	47	8	–81	–13	4	1

Since rubber trees are established and managed primarily by labor effort, the residual profit from mature trees will be higher, the larger is the work and management effort. As the simple model of Besley (1995) clearly indicates, it is reasonable to postulate that work effort is critically affected by land tenure security, which influences the expected future benefits to those who plant and grow trees. Thus, if one can successfully control for the quality of land, the difference in residual profit among different land tenure institutions, if there is any, can be attributed to the incentive effects of land tenure institutions on work effort.

To assess the scarcity value of land, it is useful to estimate the profitability of upland rice production, which presently is the main alternative to rubber production (Table 5.11). Current inputs consist mostly of seeds, and only one farmer applied a small amount of chemical fertilizer and another farmer applied a little pesticide. Manure was not used, in part because most fields are far from farmers' dwellings (on average, it took about an hour to travel to upland rice fields). In any case, it is clear that the profitability of upland rice production is very small, despite the large inputs of family labor. The residual profit per hectare of upland rice grown on communal land is positive but far smaller than the profit from mature rubber trees. It is negative in the case of non-communal fields, which may be explained partly by the less favorable location of these fields, including greater exposure to attacks by wild pigs. Another factor affecting the low profitability of upland rice is the shortening of fallow periods as a result of increasing population pressure and limited access to new forestland. The low profitability of upland rice with a five-year bush/fallow rotation has been independently confirmed in an unpublished study in the same area by Bustanul Arifin and Agus Hudoyo with additional analysis by Suseno Budidarsono.

The average residual profit of all 27 upland rice plots was almost identical to zero.[59] Considering that upland rice fields are located in flat upland areas, unlike the sloping areas planted to rubber, the low profitability indicates that annual crop farming is not profitable on uplands where rubber trees are currently grown. In other words, the opportunity cost of land in the case of rubber production is small. The higher profitability of planting rubber compared with the upland rice–bush/fallow system explains the trend toward conversion from the latter land use. The question is whether tenure security, particularly under single family ownership, is sufficiently well established to ensure the realization of the potential pay-off.

[59] The residual profit function of upland rice production, using previous fallow periods and a communal land tenure dummy as explanatory variables, among others, was estimated. Although the coefficients of both variables have the expected signs, none of them were significant, partly because of the small sample size.

Determinants of Land Use and Profitability in Ghana

Cocoa Tree Planting

It is assumed that land tenure institutions are predetermined for each household but may differ within each household, depending on the gender of the parcel owner, the mode of land acquisition, and, consequently, the tenure status of field managers. In order to control for a possible correlation between land tenure variables and unobservable household characteristics, a Tobit with household fixed effects is estimated, with the proportion of area planted to cocoa as the dependent variable.[60] The estimated function corresponds to equation (6) developed in Chapter 2.

In explaining the proportion of area planted to cocoa, 10 land tenure dummies representing the manner of land acquisition, with matrilineal inheritance as the base of comparison, were included.[61] Other regressors included parcel characteristics such as the distance from house to parcel, parcel size, years since acquisition, and its squared term. In the cocoa-planting function, years since acquisition and its squared term capture effects related to the timing of investment. The characteristics of the parcel at the time of acquisition are controlled for by using dummies for previous land use (forest or cocoa) and the real farm-gate cocoa price. According to our informal interviews with farmers, the slope of cocoa fields does not affect cocoa yield and the most important parcel-specific factor affecting yield is the previous use of land. It is expected that, because virgin forest is more fertile than previously cultivated fallow land, parcels that were previously covered by forest may induce tree-planting.[62] Cocoa prices at the time of acquisition control for the possibility that the surge in cocoa prices in the 1980s stimulated a conversion of land to cocoa. Finally, the educational attainment of the parcel manager and a dummy variable for the gender of the parcel owner are included among the regressors.

The estimation results are shown in the first column of Table 5.12. Parcel size has a negative and significant effect on the proportion planted to cocoa, implying that an inverse correlation exists between parcel size and tree-planting. This indicates that the transactions undertaken through the land rental market, not to mention the land sales market, are imperfect, because some portions of the parcel could have been rented for tree-planting if the land rental market were perfectly competitive (Hayami and Otsuka 1993). Although one might expect more secure land rights to have a positive and significant effect on tree-planting, the results are not wholly consistent with such expectations. Trees are more likely to be planted on land received as a gift as compared with inherited and allocated land. This is largely explained by the fact that tree-planting is a prerequisite for transferring land as a gift. The coefficient on privately purchased land is positive but insignificant, and that on patrilineal gift and inheritance is negative and insignificant. This is surprising, because these categories have the strongest individualized rights. Thus, although tenure security may have a positive effect on tree-planting, as argued by Besley (1995), its effect is not dominant, as postulated by Hypothesis 3. One also finds positive and significant effects of land under caretakership, rented land, and land acquired through renting, because cocoa planting or harvesting is the major task under

[60] Since the proportion of area planted to mature cocoa is censored upwards at 100 percent and downwards at 0 percent, a two-limit Tobit procedure with household dummy variables was applied.

[61] Owing to the small number of observations in the patrilineal categories, allocated family land in patrilineal villages was aggregated with allocated family land in matrilineal villages; patrilineal gifts and inheritance, having the same degree of strength of land rights in the Wassa region, were aggregated into a single category.

[62] López (1997) found that biomass had a positive effect in his estimation of production functions using regional data from western Ghana. Whereas he attributes this effect to the positive production externality arising from the effect of biomass on protection from soil erosion and flooding, it is perhaps more plausible to interpret it as the positive correlation of biomass with soil fertility.

Table 5.12 Determinants of current land use at the parcel level in Ghana: Tobit and logit regressions with household fixed effects

	Proportion of parcel planted to cocoa (Tobit with household dummies)	Probability shifting cultivation area is fallow (fixed effects logit)[a]
Current parcel characteristics		
Distance to parcel	0.04	0.78
	(1.94)	(2.71)***
Parcel size (hectares)	–0.01	2.35
	(–2.35)***	(6.53)***
Years since acquisition	0.12	0.05
	(2.09)**	(0.74)
(Years since acquisition)^2	–0.00	–0.00
	(–1.50)	(–0.09)
Woman-owned parcel	0.17	1.93
	(1.66)*	(1.78)*
Schooling of parcel owner	0.01	0.34
	(0.59)	(1.32)
Characteristics of parcel at acquisition		
Dummy for forest	0.01	. . .
	(0.13)	
Dummy for cocoa	0.23	. . .
	(2.54)***	
Real cocoa farmgate price	–0.00	. . .
	(–0.23)	
Land tenure dummies[b]		
Allocated land	–0.22	–2.38
	(–1.56)	(–2.16)**
Land received as gift	0.34	–1.50
	(2.80)***	(–1.59)
Patrilineal gift or inheritance	–0.23	0.32
	(–1.13)	(0.28)
Appropriated village land	0.26	0.41
	(1.54)	(0.32)
Purchased village land	0.30	1.71
	(1.47)	(0.79)
Privately purchased	0.14	1.38
	(0.72)	(0.90)
Rented in	0.43	0.18
	(3.23)***	(0.19)
Ownership through renting	0.71	. . .
	(3.53)***	
Caretaker	1.08	–0.15
	(6.58)***	(–0.12)
Borrowed from nonrelatives	–0.71	–4.43
	(–3.29)**	(–2.70)***
Constant	0.07	. . .
	(0.19)	
Log-likelihood	–438.91	–110.29
Chi-square	503.98	168.35
p-value	.00	.00
Number of observations	688	483

Notes: Two-limit Tobit estimates; ancillary parameter σ and household dummies not reported. *t*-statistics are shown in parentheses.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.
[a] Estimated using field-level data for all fields, for households with more than one field devoted to shifting cultivation.
[b] Owing to the small number of observations in the patrilineal categories, allocated family land in patrilineal villages was aggregated with allocated family land; patrilineal gifts and inheritance, having the same degree of strength of land rights, were aggregated into a single category.

these contractual arrangements. The dummy for a female parcel owner has a positive but insignificant effect on the proportion of area planted to cocoa. Since women receive land only after it has been planted to cocoa, subsequent observations will not reveal any difference between male and female parcel owners in the probability of planting cocoa.

Fallow Choice

This section examines the choice to keep a field fallow on land solely devoted to shifting cultivation, that is, land either devoted to food crops or left fallow, using data from all fields enumerated by respondents.[63] Close to three-quarters of all shifting cultivation area is left fallow (Table 5.3). A smaller proportion of fields is left fallow on land borrowed from nonrelatives (31 percent) and allocated family land (65 percent). Since it is difficult to measure the proportion of fallow area accurately, and given that almost three-quarters of all field area under shifting cultivation is fallowed, a conditional (fixed effects) logit model was estimated, where the dependent variable is the probability that a parcel under shifting cultivation will be totally devoted to fallow. The regressors are identical to those in the cocoa-planting regression, with the exception of the dummies for previous land use, cocoa price, and ownership through renting. Since land acquired through renting would already have been planted to cocoa trees, sample fields in the current analysis do not include this tenure type.

Results are shown in the second column of Table 5.12. Larger and more distant fields are significantly more likely to remain fallow. Consistent with our hypothesis that land with insecure tenure is less likely to remain fallow, the dummies for allocated family land and borrowed land are negative and significant. That is, individuals holding allocated family land have a stronger incentive to continue cultivating it, rather than face the risk of losing use rights to another member of the extended family. Likewise, individuals who borrow land from nonrelatives have very little reason to keep it fallow, because borrowing is usually undertaken to obtain land on which to raise subsistence crops.

However, the data do not provide clear evidence that stronger land tenure security results in less frequent fallow periods. One reason may be the strong security of use rights on inherited land compared with other land tenure categories. Moreover, we were not able to control for the effect of soil fertility, which would be critically determined by the fallow periods before the current cultivation.

Net Revenue from Mature Cocoa

In order to identify the effects of land tenure institutions on the intensity of cocoa farming, net revenue and labor-use functions per hectare, which correspond to equations (7) and (8) in Chapter 2, respectively, were estimated using household-level fixed effects and plot-level random effects models. Since random effects are the preferred specification, indicating the importance of plot-level heterogeneity, only these results are presented in Table 5.13.[64]

The random effects specification includes both plot-level and household-level characteristics, as both are sources of heterogeneity. In addition to the land tenure dummies, characteristics of the parcel at acquisition, and current parcel characteristics found in the tree-planting and fallow choice regressions, regressors included the age of trees and the number of kola, oil palm, and other trees per hectare on the parcel. It is possible that the

[63] Information on all fields, not just the sample fields, is used in this regression. Although this equation could have been estimated using parcel-level data, fields are a finer level of disaggregation. The number of observations is larger using data for all fields, but information on previous uses of the field was collected only for the sample fields. Regressions that included information on previous land use, for those fields for which information was available, showed that these variables were insignificant.

[64] A Hausman test does not indicate that fixed effects are significant ($\chi^2(24) = 15.44$; $p = .91$) and the Breusch–Pagan Lagrange multiplier test ($\chi^2(1) = 3.31$; $p = .07$) shows that plot-level heterogeneity is important.

presence of other trees may affect labor use as well as net revenue from cocoa, if competition exists among different tree species owing to overcrowding. It is remarkable to find from Table 5.13 that no land tenure variables are significant in the net revenue functions.[65] These results support Hypothesis 3 that the management intensity of cocoa fields tends to be equalized owing to the establishment of secure land tenure after tree-planting, regardless of the manner of land acquisition. The insignificant effect of renting is also interesting, because it suggests that share tenancy arrangements are efficient not only in Asia but also in some parts of Africa (see Hayami and Otsuka 1993 for the case of Asia). Although field size has a negative effect on net revenue, the coefficient is insignificant. It may appear that women enjoy lower net revenues from cocoa, but these effects are not significant.

Some household-level variables do affect revenues from mature cocoa: older heads of households appear to earn less revenue from cocoa, and patrilineal households enjoy greater revenues than do matrilineal households. Finally, female-headed households (as distinguished from female parcel managers) do not earn significantly more or less revenues from cocoa than their male counterparts.

The estimation results of the labor-use function provide added support for the hypothesis that resource allocation is equalized across fields with different land tenure. Again, no land tenure variables are significant. Field size has a negative and significant coefficient, which suggests that, owing to the imperfection in factor markets (for example, labor markets), large fields are less intensively cultivated. The presence of other trees on the parcel also increases labor input per hectare, and new cocoa varieties, particularly *Amazonia* and hybrid varieties, appear to use less labor. Although labor use is higher on woman-owned fields, indicating that women

Table 5.13 Determinants of net revenue from mature cocoa production and total labor use per hectare at the field level in Ghana: Random effects estimates

	Net revenue	Labor use
Current field characteristics		
Distance to field	−17.61	−12.30
	(−0.55)	(−0.48)
Field size (hectares)	−30.99	−72.51
	(−1.02)	(−3.04)***
Years since acquisition	38.45	22.20
	(1.79)*	(1.30)
(Years since acquisition)^2	−0.85	−0.33
	(−1.83)*	(−0.89)
Woman-owned field	−38.06	119.31
	(−0.44)	(1.75)*
Schooling of field owner	−8.98	−40.53
	(−0.31)	(−1.72)*
Number of kola trees per hectare	2.75	2.93
	(0.40)	(0.56)
Number of oil palm trees per hectare	3.89	−0.24
	(0.24)	(−0.20)
Number of other trees per hectare	4.37	31.76
	(0.33)	(2.97)***
Characteristics of parcel at acquisition		
Dummy for forest	−68.67	−150.91
	(−0.45)	(−1.28)
Dummy for cocoa	449.58	−89.20
	(2.11)**	(−0.52)
Tree characteristics		
Amazonia dummy	−122.79	−472.89
	(−0.56)	(−2.73)***
Hybrid dummy	−242.60	−517.45
	(−0.98)	(−2.67)***
Average age of trees	−10.05	3.49
	(−0.49)	(0.21)
(Age of trees)^2	0.01	−0.27
	(0.02)	(−0.80)
Land tenure dummies[a]		
Allocated and matrilineal	147.51	−257.72
	(0.42)	(−0.93)
Land received as gift	190.70	−84.83
	(0.58)	(−0.32)
Patrilineal gift	234.57	168.40
	(0.49)	(0.44)
Appropriated village land	695.05	37.11
	(1.77)*	(0.12)
Purchased village land	35.45	−248.17
	(0.08)	(−0.75)
Privately purchased	. . .	. . .
Rented in	176.69	−34.83
	(0.53)	(−0.13)
Ownership through renting	157.68	−335.86
	(0.40)	(−1.07)
Caretaker	−21.74	176.64
	(−0.06)	(0.59)
Household characteristics		
Gender of head (1 = male)	−232.53	134.62
	(−0.74)	(0.57)

[65] This finding is robust to the choice of estimation method, whether fixed or random effects.

Table 5.13 (*continued*)

	Net revenue	Labor use
Age of head (years)	−14.35	3.71
	(−2.47)**	(0.84)
Schooling of head (years)	18.69	47.53
	(0.63)	(2.03)**
Patrilineal household	371.50	340.09
	(1.99)**	(2.37)**
Total landholdings (hectares)	9.77	1.10
	(1.65)*	(0.24)
Number of adult males in household[b]	60.27	85.26
	(1.39)	(2.72)***
Number of adult females in household[b]	25.83	4.19
	(0.60)	(0.13)
Constant	705.15	326.37
	(1.26)	(0.77)
Breusch–Pagan Lagrangian multiplier test	3.31	0.06
p-value	.07	.81
Hausman specification test	15.44	19.29
p-value	.91	.74
Number of observations	105	105

Note: *Z*-statistics are shown in parentheses.
*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.
[a] Dummies for allocated patrilineal land, borrowing, and inherited patrilineal land were dropped owing to collinearity with the fixed effects.
[b] Adults are those aged 15–65 years and those older than 65 but who list their main occupation as farming.

tend to apply more labor to their own plots, this effect is only weakly significant at 10 percent. Interestingly enough, higher education of the household head is associated with greater labor use per hectare, perhaps indicating better access to resources to hire labor, if needed. Lastly, the number of adult males in the household is also associated with higher labor use per hectare.

Net Revenue from Food Crops

In order to identify the effects of land tenure institutions on net revenue and total labor use in young cocoa and pure food crop fields, net revenue and labor-use functions per hectare were estimated using household-level fixed effects and plot-level random effects models. Since cocoa is intercropped with a variety of food crops in different combinations, regressors included the proportion of area planted to each of the food crops present in the field (for example, the proportion devoted to cocoyam in 1997) as well as their interactions with a dummy variable indicating that young cocoa is grown in the field. Also included were dummy variables for the age of the cocoa trees, with trees less than a year old as the reference category. Since 34 percent of the sampled food crop fields have a female cultivator other than the male or female manager, a dummy variable for the presence of another female cultivator or field manager was also added. This person is typically the wife of the male field manager, or a co-wife in the case of a female manager. All other regressors are identical to those in Table 5.13.

The results, not reported here, are very similar to those for mature cocoa fields. Net revenue per hectare and labor use are not significantly different in fields under different land tenure regimes. The difficulty of identifying crop mix may be partly responsible for the failure to obtain significant effects of land tenure systems. However, tree age dummies significantly affect labor use, as would be expected. Relative to trees less than a year old (the excluded category), labor use per hectare in succeeding years is significantly lower. Consistent with the earlier finding that land under allocated family tenure is less likely to be left fallow, the coefficients of the family allocation dummies are negative in the net revenue function, even though they are not significant. None of the household-level characteristics is significant.

Given that a major proportion of labor input is provided by women and children, it is not surprising that gift transactions have evolved to increase their incentive to provide labor in establishing cocoa. Note that there are no significant differences in either net revenue or labor use per hectare depending on whether or not a field is managed by a woman. Thus, the transfer of land to women through gifts has improved gender equity without sacrificing production efficiency.

Determinants of Land Use and Profitability in Sumatra

In this section, the gross revenue, total cost, and residual profit functions are estimated using data from mature tree plots. Since residual profits can be zero or negative, a

linear rather than a logarithmic specification is used. The Heckman two-step estimation procedure was applied to correct for the endogeneity of the choice to grow rubber. First, the tree choice function was estimated as a probit regression model using observations from the entire sample of 523 rubber and bush/fallow plots. In the tree choice function, the dependent variable is unity if trees were already planted at the time of the survey in 1996. The second-stage regressions were estimated using ordinary least squares (OLS) over the subsample of 128 mature rubber plots, with the inverse Mill's ratio as a regressor.

Explanatory variables used in the regressions in Table 5.14 include plot-specific characteristics, household characteristics, and characteristics of the household head. Bush/fallow fields were acquired in the earliest year of 1981 on the average and were located generally in the most remote areas measured in terms of walking time. In contrast, young and mature rubber fields were located nearer to home. In terms of altitude and slope, there was no difference between young and mature rubber fields.

Total lowland paddy area and the rubber area owned by the household are used as proxies for the wealth of these farm households. Of course, the area of land owned also affects the demand for labor. Paddy and rubber areas at the time of plot acquisition were also used in the regression analysis of tree choice. One interesting question is whether wealthy people acquire and establish disproportionately larger rubber areas and obtain higher profits from rubber production. However, differences in the owned area and the number of family workers among different types of fields were not large.

The supply of family labor is proxied by the number of family workers between 16 and 60 years of age. Most children go to junior high school and the lower age bound coincides with the age of graduation from that school level. The upper age bound is somewhat arbitrary. Male and female workers are separated because of the gender division of labor by task. The number of family workers between 26 and 70 years of age is also included, because this age bracket would be more appropriate for the potential supply of family workers at the time when uplands were acquired, which was a little more than 10 years earlier on average. Although the land–worker ratio may be more appropriate to represent the balance of supply of and demand for family labor, it is difficult to use here because two types of land and family labor are specified.

The average age of household head at the time of land acquisition and at the time of the survey (1996) and the average years of schooling are also included as regressors. Because of the effect of the household's life cycle, owners of young rubber fields were among the youngest at the time of the survey. These younger households had received the longest period of schooling largely because of the cohort effect arising from the spread of education opportunities in rural Indonesia.

The estimation results of the first-stage probit function are shown in column 1 of Table 5.14, while the second-stage estimation results of the gross revenue, total cost, and residual profit functions for mature rubber fields are shown in columns 2–4. With respect to the land tenure institutions, three dummy variables are used in the tree-planting function (joint family tenure, purchased land, and land obtained by clearing forest), whereas four dummies are specified in the other functions (purchased land, forest clearance, land borrowing, and land renting). In both cases, the base of comparison is single family ownership. Joint family ownership appears only in the former regression because it did not exist in mature rubber fields. Borrowing and renting dummies were not included in the tree-planting function because only fields already planted to trees were rented and borrowed. Thus, the decisions to plant trees on these two types of land are predetermined and this is captured by the dummy variable for rubber fields at the time of acquisition. In the revenue, cost, and profit regressions, we included the dominant age of trees and its squared term.

Table 5.14 Two-stage regression of rubber tree choice function, and gross revenue, total costs, and residual profit of rubber productions in Sumatra

	Tree planting (Probit)	Gross revenue (OLS)	Total costs (OLS)	Residual profit (OLS)
Intercept	43.53	–36.408	326.95	–363.36
	(3.19)***	(-0.09)	(0.99)	(–1.86)*
Dominant age of trees	. . .	35.87	14.03	21.84
		(2.25)**	(1.05)	(2.73)***
(Dominant age of trees)^2	. . .	–0.56	–0.238	–0.319
		(–2.07)**	(–1.04)	(–2.35)**
Slope	. . .	–2.29	–0.37	–1.92
		(–0.59)	(–0.11)	(0.98)
Altitude	. . .	1.20	1.47	–0.27
		(1.63)	(2.39)**	(–0.73)
Bush (before planting)	. . .	–216.93	–174.13	–42.81
		(–1.33)	(–1.27)	(–0.52)
Forest (before planting)	. . .	644.20	260.80	383.39
		(1.24)	(0.60)	(0.147)
Dummy for rubber field[a,b]	1.64	. . .	. . .	. . .
	(8.55)***			
Walking time	0.01	–0.25	–0.70	0.45
	(3.00)***	(–0.24)	(–0.81)	(0.87)
Age of head[a,b]	0.01	0.89	–0.59	1.48
	(1.50)	(0.22)	(–0.17)	(0.73)
Schooling of head	–0.01	–17.57	–18.09	0.52
	(–0.50)	(–1.37)	(–1.67)*	(0.08)
Year of acquisition	–0.02	. . .	. . .	. . .
	(–3.33)***			
Paddy area owned	0.04	30.69	30.74	–0.06
	(0.43)	(0.61)	(0.72)	(–0.02)
Rubber area owned	–0.05	–35.65	–41.54	5.89
	(–1.62)	(–2.26)**	(–3.14)***	(0.75)
Number of male workers	0.02	92.51	95.47	–2.96
	(0.13)	(1.51)	(1.85)*	(–0.10)
Number of female workers	0.01	148.52	66.12	82.40
	(0.04)	(2.17)**	(1.15)	(2.40)**
Joint family ownership	–2.91	. . .	. . .	. . .
	(–0.55)			
Purchased land	–0.03	108.32	29.43	78.89
	(–0.20)	(1.07)	(0.34)	(1.55)
Forest clearance	–0.12	–468.30	–374.81	–93.50
	(–0.71)	(–0.99)	(–0.95)	(–0.40)
Borrowed land	. . .	341.94	161.11	180.83
	(1.65)	(0.93)	(1.74)*	
Rented land	. . .	36.08	–177.93	214.00
	(0.25)	(–1.44)	(2.90)***	
Inverse Mill's ratio	. . .	350.22	155.66	194.57
	(1.21)	(0.64)	(1.34)	
Log-likelihood	–218.80	. . .	. . .	. . .
R^2	. . .	.29	.26	.26

Notes: *t*-statistics are shown in parentheses.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.
[a] At the time of land acquisition.
[b] At the time of acquisition for the tree-planting function and at present or in 1996 for other functions.

As expected, estimation of the tree choice function produces a highly significant dummy variable for plots that were already planted with rubber at the time of land acquisition. Walking time has a positive effect on tree-planting, which is unexpected because it is more costly and, hence, less profitable to cultivate distant plots (as argued by

Angelsen 1995). It may be that newly planted rubber plots were located far from residential areas because closer areas had already been planted. Another possible explanation is that monitoring to prevent losses from pests and theft is more difficult for isolated plots and that rubber may be relatively less susceptible than upland rice to these risks.

Another significant variable is the year of land acquisition, which has a negative coefficient, suggesting that the availability of fields suitable for rubber production has decreased over time. Neither the coefficient of the area of rubber plots owned nor that for area of paddy owned is significant, which indicates that wealthier households (those owning larger areas) do not necessarily plant more rubber trees. The lack of significance of these proxies for wealth may also result from the relative lack of social stratification within this community.

None of the land tenure variables is significant. The coefficient of joint family ownership is negative but far from significant, partly because there are only four such cases (see Table 5.7). The fact that the two private ownership variables are not significant suggests that the lower tenure security of single-family ownership status does not distort incentives to invest in trees. These results support Hypothesis 3.

The coefficients of the inverse Mill's ratio are insignificant in all three second-stage regressions, which indicates that selectivity bias is not a serious problem. As expected, age of rubber trees and age squared have positive and negative coefficients, respectively, and both coefficients are significant in the gross revenue and residual profit functions. Judging from the estimated coefficients, the peak ages of trees are 32 and 34 years for the gross revenue and residual profit, respectively.

Whereas ownership of paddy land does not affect the gross revenue and cost functions, ownership of rubber fields has a negative and significant effect on gross revenue and costs. It seems that the effect of wealth on management efficiency in rubber fields is not particularly strong in this context, whereas the size of rubber fields reduces both costs and revenue. Yet, judging from its insignificant effect on the residual profit, field size does not appreciably affect production efficiency.

Since tapping is mainly men's work under the customary division of labor (see Table 5.9), the positive and significant effect of the number of female workers on gross revenue and residual profit was somewhat unexpected (Table 5.14).

Several important results were obtained regarding the effects of land tenure institutions. First, private ownership, acquired through either purchase or forest clearance, has no significant effect, which supports Hypothesis 3. This indicates that there is no difference in the incentive structure between single-family ownership and these types of private ownership. The implication is that the advent of the single-family ownership system is an institutional innovation in these indigenous communities to establish de facto private property. Qualitatively the same results are obtained from the estimation of fixed-effect regression models applied to cinnamon production in Sumatra-based intensive household survey data (Suyanto, Tomich, and Otsuka 1998b).

Second, both borrowing and renting through share tenancy have positive and significant coefficients in the residual profit regression. The significance of renting in this case runs counter to the familiar Marshallian argument of the inefficiency of share tenancy arising from tenants' shirking, because shirking ought to reduce gross revenue, costs, and residual profit before rent payments (see Otsuka, Chuma, and Hayami 1992; Hayami and Otsuka 1993). Recall, however, that both borrowing and renting tend to be short-term arrangements in the study area. As a result, temporary operators may seek to squeeze as much output from rubber trees as possible in the short run. Unlike the case of annual crops, such behavior (known as "overtapping") can have detrimental effects on profitability over time, since tapping in-

tensity is negatively related to future latex production. Indeed, Binswanger and Rosenzweig (1986) presented a theoretical argument that rubber share-tapping should be rare because of this incentive incompatibility.

In reality, however, this institutional arrangement is common in Sumatra. The first part of the explanation of this puzzle rests with social relations within the study villages. Although incentives for overtapping exist, monitoring and enforcement are apparently easy enough within the context of these close-knit village societies to prevent serious effects on long-term profitability (after all, borrowing usually is among relatives). The second part of the explanation may lie with the suitability of a cross-section of rubber plots to estimate a yield curve over time. This data set is probably not well suited to capturing the long-term effects of borrowing and share tenancy because it is likely to pick up the current productivity-enhancing effects of overtapping under borrowing or share tenancy without their offsetting effects on future yields. The long-term effects can probably be observed only in a longitudinal study.

Concluding Remarks

The analysis of intensive household survey data consistently finds that the incidence of tree-planting and tree field management are unaffected by land tenure regimes in both Ghana and Sumatra. These findings imply that the incentives to invest in tree-planting and to carry out subsequent management are equally strong between traditional family ownership and more individualized ownership systems. In all likelihood, this is due to the expected strengthening of land rights after tree-planting on family-owned land. In this way, the family ownership system does not deter the development of agroforestry.

It is interesting that, in Ghana, women farmers who planted trees on their husbands' plots were able to acquire ownership rights to land through gift transfers. Gifts therefore can be regarded as a reward for the work effort of women in cocoa. In Sumatra, in contrast, land tenure institutions not only have become individualized but also have been transformed from matrilineal to bilateral or even to patrilineal systems. Here, too, such changes would reflect the fact that men often carry out the clearance of fields and the planting of trees.

This study also finds that the cultivation of upland rice in the traditional bush/fallow rotation in Sumatra is much less profitable than planting rubber. Similarly in Ghana, fallow periods are shorter on allocated family land and borrowed land, owing to insecure land rights. Continuation of upland rice farming in Sumatra and of shifting cultivation in Ghana will be inefficient. Together with population pressure, however, the greater profitability of agroforestry will drive the transformation from more communal forms of tenure to quasi-private arrangements in the process of the shift from land-using farming systems to land-saving systems.

CHAPTER 6

Land Inheritance and Schooling

The previous chapters have shown that individualization of land rights has increased efficiency of land use. However, Lastarria-Cornhiel (1997) has argued that such evolutionary changes toward individualized rights have detrimental effects on women's traditional land rights. Although this may be true in some societies, one cannot generalize that individualization of land rights necessarily leads to weaker rights for women. In Chapter 4, we found that women are disadvantaged in the acquisition of forestland in both Ghana and Sumatra. Since easily cultivable forestland has disappeared, however, the more relevant issue for women is how individualization of the ownership of *cultivated* land affects ownership by women.

Using inheritance survey data, this chapter explores how the individualization of land tenure institutions may have affected parental allocations of land between sons and daughters. Our basic hypothesis is that the proportions of land transferred to sons and daughters depend on the relative amount of labor men and women contribute to agriculture, or the gender division of labor. More specifically, we hypothesize that the increase in the demand for women's labor in cocoa production induced an increase in the amount of cocoa land that women receive in Ghana, whereas the growing importance of men's labor in agroforestry has led men to receive more agroforestry land in Sumatra. Because land transfers and investments in the schooling of children are the major alternative ways of transferring wealth from one generation to another, we expect that investments in the schooling of sons and daughters will adjust when the gender distribution of land inheritance changes.

Ghana Case

Sample Description

This section examines the distribution of education (represented by years of schooling) and land among potential heirs. The definition of inheritance sources and potential heirs is slightly more complicated in Ghana owing to the uterine matrilineal system and the practice of polygyny. Under the matrilineal system, a person can inherit from a number of matrilineal relatives, depending on the order of succession. As a result of polygyny and the practice of

serial marriage, an individual may have several sets of maternal and paternal half-siblings. Rights on land received from the extended family differ markedly depending on the manner of acquisition—whether by inheritance, allocation, or gift.

Based on the above considerations, and after extensive pre-tests in the field, the inheritance retrospective was designed to capture the possibility of acquiring land from four sets of matrilineal relatives: mother, maternal uncle, maternal grandmother, and other matrilineal relatives. Only one source of paternal inheritance was identified: the father. Respondents (heads of households) were also asked to list all their paternal and maternal full- and half-siblings. Interestingly enough, individuals were often uncertain how many half-siblings they had, particularly if one of their parents had moved to another village upon remarriage. Since not only siblings but also cousins, nieces, and nephews can inherit from the matriclan, the number of heirs can potentially be very large. To simplify matters, the analysis is confined to the siblings and half-siblings whom the respondent can name, and thus parental landholdings are not divided by the number of potential heirs to capture the effects of population pressure. The type of inheritance—paternal or maternal—is also distinguished according to the mode of transfer: inheritance per se (usually given at the time of the parent or relative's death, technically a bequest), allocation, or gift.

Table 6.1 presents summary statistics regarding the education and landholdings of the parent and respondent generations in the Wassa study site. Only households for which parental information is complete are included in the analysis, and only children 21 years of age and over are included in the regressions. The age cut-off is imposed so that schooling decisions will have been completed in the respondent generation, although, in practice, children leave school much earlier. The general level of education in the parents' generation is low—84 percent of fathers and 94 percent of mothers had never been to school—and fathers have more years of schooling than mothers (1.4 years compared with 0.3 years). At the time of marriage or independent farming, fathers had 9.1 hectares of land; mothers had only 1.7 hectares. This is consistent with the household-level analysis of land acquisition: men typically start farming independently by clearing forests, whereas women heads of household are less likely to acquire forestland.

Schooling attainment has increased in the children's generation, but it is still low: 38 percent of sons and 64 percent of daughters have never attended school. The mean completed years of schooling for sons is 5.7, whereas that of daughters is 2.9 years. Although the land transfer questionnaire distinguished among four types of matrilineal inheritance, in practice, there were very few observations in each of the separate categories, so the analysis aggregated all the matrilineal categories.[66] Sons received 0.86 hectares from matrilineal relatives, whereas daughters obtained 0.37 hectares. Sons received more than daughters did in all four categories. Sons received 1.13 hectares, on the average, from their fathers, whereas daughters received 0.49 hectares. Again, sons received more than their sisters did in each of the paternal transfer categories. Although these simple descriptive statistics do not control for the complexities of family structure in Ghana, they do reveal that gender gaps are large in both schooling and land inheritance. The gaps, however, seem to have narrowed over time, if they are measured by the difference across successive generations.

Regression Analysis

Because sources of inheritance differ between maternal and paternal half-siblings, separate

[66] Distinguishing among the different sources of matrilineal inheritance greatly improved survey response, however, since it was easier for respondents to identify a piece of land as coming from a specific relative, say a maternal uncle, than from a larger category called the matriclan.

Table 6.1 Education and landholdings of parent and respondent generations, Wassa study site in Ghana

Generation	Mean	Standard deviation
Parent generation		
Father		
Years of schooling	1.40	3.29
Land at time of marriage (hectares)	9.08	13.38
Mother		
Years of schooling	0.32	1.42
Land at time of marriage (hectares)	1.67	3.88
Respondent generation		
Sons		
Year of birth	1951	14.83
Years of schooling	5.74	5.19
Total land inherited from maternal relatives	0.86	2.90
Inherited land	0.41	2.35
Allocated	0.14	0.90
Gift	0.31	1.39
Total land inherited from father	1.13	4.66
Inherited land	0.49	3.88
Allocated	0.30	1.75
Gift	0.34	1.79
Daughters		
Year of birth	1951	14.80
Years of schooling	2.88	4.25
Total land inherited from maternal relatives	0.37	2.21
Inherited land	0.23	1.94
Allocated	0.05	0.59
Gift	0.09	0.59
Total land inherited from father	0.49	0.91
Inherited land	0.29	0.71
Allocated	0.08	0.38
Gift	0.12	0.54

Note: Number of households = 167; number of potential heirs = 1,475.

analyses were conducted for the respondent and his or her paternal siblings, and for the respondent and his or her maternal siblings. The first set of regressions consists of levels estimates for all families, while fixed effects estimates comprise the second set. The specification of the regression equation corresponds to equation (9) in Chapter 2.

Table 6.2 presents levels estimates on education and land received by the respondent and his or her maternal siblings. Because all dependent variables are censored—a large proportion has never attended school or received transfers—the Tobit estimation procedure is used. Village characteristics are controlled for, using village dummies (not reported). Four land transfers equations are presented: the total received from maternal relatives, inheritance, allocation, and gifts. To test whether half-siblings are treated differently from full siblings, a dummy for a half-sibling is included, in addition to controls for birth year and its square, and eldest and youngest dummies.

Among the respondent and his or her maternal siblings, daughters receive significantly less education than sons. Field interviews reveal that parents think that investment in daughters is useless, because they will marry early and have children. Secular trends favor later-born children, as evidenced by the significant coefficients on birth year and its square. Both father's education and father's land positively affect schooling attainment by children. Turning now to total land inherited from maternal relatives, none of the

Table 6.2 Education and land received in Ghana, by mode of transfer, respondent and maternal siblings: levels estimates, Tobit

	Education		All land		Inheritance		Allocation		Gift	
	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*
Constant	–32,014.09	–5.36***	–7,403.58	–1.53	–25,825.36	–1.90*	–979.19	–0.24	–4,725.11	–1.34
Daughter	–5.32	–6.33***	0.86	1.20	–0.67	–0.45	–0.33	–0.45	0.03	0.04
Half-sibling	0.15	0.16	0.17	0.23	0.48	0.36	1.58	1.98**	1.35	2.05**
Birth year	32.65	5.33***	7.54	1.51	26.34	1.89*	1.07	0.25	4.87	1.35
(Birth year)^2	–8,323.92	–5.30***	–1,918.68	–1.50	–6,720.26	–1.88*	–293.87	–0.27	–1,253.97	–1.35
Eldest	0.76	0.69	1.69	2.06**	–0.92	–0.47	–1.40	–1.43	–0.60	–0.76
Youngest	–0.44	–0.45	0.14	0.19	–1.17	–0.76	0.52	0.60	0.22	0.32
Father's education	0.37	2.82***	0.07	0.66	0.03	0.17	0.12	0.94	0.18	1.84*
Mother's education	–0.35	–1.07	0.11	0.46	–12.11	. . .	–13.50	. . .	–0.28	–1.04
Father's land	0.08	2.62***	–0.01	–0.17	0.03	0.48	0.04	1.69*	0.03	1.29
Mother's land	0.10	1.16	0.03	0.41	0.22	2.05**	0.04	0.61	0.11	1.82*
Daughter × father's education	0.05	0.25	0.06	0.36	–0.15	–0.42	0.07	0.38	0.05	0.36
Daughter × mother's education	0.53	1.01	–15.89	. . .	0.93	. . .	1.44	. . .	–21.63	. . .
Daughter × father's land	–0.06	–1.18	–0.10	–1.48	–0.02	–0.14	–0.02	–0.52	–0.03	–0.76
Daughter × mother's land	0.03	0.26	0.03	0.26	–0.07	–0.43	0.02	0.20	–0.03	–0.31
Number of observations	954		954		954		954		954	
Uncensored observations	426		203		116		39		69	
Log-likelihood	–1,787.86		–859.05		–519.62		–206.42		–330.73	
Chi-squared	263.52		51.57		84.71		62.31		48.19	
p-value	.00		.00		.00		.00		.00	

Note: Village dummies included but not reported. Sigma not reported.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

parental land or education variables, or their interaction with child gender, are significant. However, the levels estimates do not control for family-level unobservables, which are dealt with more satisfactorily using the fixed effects estimates. The daughter dummy is insignificant in the total land transfer equation, as well as in each of the transfer categories. Thus, it is possible that matrilineal inheritance does not discriminate against daughters, although, again, family-level unobservables need to be controlled for.

Parental landholdings are significant determinants of education, total land transfers, and inherited land for the respondent and his or her paternal siblings (Table 6.3). Whereas father's land and education positively affect years of schooling, mother's education has a negative effect. This result should be taken with caution because it is possible that father's and mother's education are correlated. Father's land does not significantly affect the amount of land allocated to children, since allocations seem to be more closely associated with the practice of matrilineal inheritance. However, daughters with better-educated fathers receive more allocated land than their brothers do. The dummy for a daughter has

Table 6.3 Education and land received in Ghana, by mode of transfer, respondent and paternal siblings: levels estimates, Tobit

	Education		All land		Inheritance		Allocation		Gifts	
	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*
Constant	–27,614.59	–5.14***	5,080.38	1.20	5,768.15	0.85	1,042.42	0.32	–8,528.95	–1.48
Daughter	–3.67	–3.42***	–0.34	–0.35	–0.45	–0.28	–1.66	–1.81*	–1.96	–1.64
Half-sibling	1.38	2.07**	0.07	0.12	–0.71	–0.74	0.65	1.35	–0.42	–0.60
Birth year	28.16	5.11***	–5.24	–1.20	–5.95	–0.85	–1.07	–0.31	8.68	1.47
(Birth year)^2	–7,178.62	–5.07***	1,349.16	1.21	1,530.32	0.86	273.28	0.31	–2,209.14	–1.46
Eldest	–0.31	–0.27	–0.77	–0.80	–0.02	–0.01	–0.29	–0.41	–0.90	–0.79
Youngest	–0.57	–0.57	–1.64	–1.74*	–0.60	–0.40	–1.02	–1.26	–1.92	–1.76*
Father's education	0.41	3.66***	0.07	0.65	–0.16	–0.73	0.02	0.23	0.08	0.70
Mother's education	–0.56	–2.30**	–0.42	–1.85*	–2.05	–2.31**	0.04	0.30	–0.16	–0.73
Father's land	0.07	3.08***	0.17	8.72***	0.22	7.57***	–0.02	–0.85	0.04	1.60
Mother's land	0.07	0.97	–0.10	–1.28	–0.08	–0.79	–0.01	–0.16	–0.12	–0.82
Daughter × father's education	–0.06	–0.25	0.25	1.17	–0.88	–1.32	0.36	2.52**	–0.16	–0.47
Daughter × mother's education	–0.44	–0.82	–0.54	–0.92	–4.67	. . .	–0.42	–1.23	–3.70	. . .
Daughter × father's land	0.03	0.33	–0.02	–0.22	–0.02	–0.13	0.02	0.25	0.22	2.81
Daughter × mother's land	0.07	0.23	–0.04	–0.16	0.81	1.72*	–0.10	–0.40	–0.45	–1.22
Sigma	7.38		5.97		7.63		3.14		4.12	
Number of observations	796		796		796		796		796	
Uncensored observations	452		341		181		96		75	
Log-likelihood	–1,794.09		–1,304.24		–773.59		–385.87		–333.81	
Chi-square	184.66		122.03		191.78		88.51		93.05	
p-value	0.00		0.00		0.00		0.00		0.00	

Note: Village dummies included but not reported.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

negative coefficients, even though its significance level is low. This indicates that, across family members, daughters are not strongly disadvantaged with respect to land transfers. However, these results can be questioned in the light of the fixed effects results.

As mentioned earlier, the levels estimates do not control for unobservable characteristics of families that may make them prone to have more children (and thus smaller amounts transferred per heir) or to favor one type of transfer over the other. Fixed effects estimates do control for these family-level unobservables, so these are implemented in the next two sets of regressions. For the fixed effects estimates, the samples used in the estimation were restricted to those families who had more than two children aged 21 years and above, and, more importantly, to those families who actually made a particular type of land transfer to their children. If a family did not transfer any land at all to a child, it was excluded from the fixed effects estimation. This reduced the number of families included in the estimation from 167 in the levels estimates

Table 6.4 Education and land received in Ghana, by mode of transfer, respondent and maternal siblings, within maternal sibset estimates: Tobit with household dummies

	Education		All Land		Inheritance		Allocation		Gifts	
	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*
Constant	–8,457.90	–1.20	–5,678.16	–1.29	4,830.17	0.96	–232.06	–1.28	–17,706.92	–3.21***
Daughter	–6.09	–7.70***	0.43	0.61	1.23	1.48	–5.65	–2.48**	–0.98	–0.96
Half-sibling	–2.49	–2.22**	–3.90	–4.29***	–4.07	–4.16***	–3.51	–1.74*	–2.01	–1.55
Birth year	8.71	1.20	5.90	1.31	–4.84	–0.94	0.12	1.31	18.22	3.22***
(Birth year)^2	–2,238.70	–1.21	–1,534.58	–1.32	1,212.74	0.91	. . .[a]	. . .	–4,685.49	–3.22***
Eldest	2.09	1.86*	1.49	1.67*	–0.30	–0.28	–0.17	–0.07	2.39	2.61***
Youngest	–0.65	–0.74	–0.58	–0.85	–0.38	–0.47	–4.03	–2.09**	0.15	0.20
Daughter × father's education	0.27	1.55	0.03	0.22	–0.18	–0.91	0.63	0.93	0.25	1.49
Daughter × mother's education	0.19	0.46	–2.19	. . .	. . .[a]		. . .[a]		–2.00	. . .
Daughter × father's land	–0.02	–0.36	–0.14	–2.33**	–0.20	–2.96***	0.20	1.28	–0.06	–0.51
Daughter × mother's land	0.04	0.29	0.16	1.12	0.53	2.27**	–0.12	–0.48	0.23	0.51
Sigma	5.56		2.97		2.70		3.06		1.92	
Number of observations	681		327		166		69		140	
Uncensored observations	426		203		116		39		69	
Number of families	139		69		32		17		33	
Chi-square	338.50		159.04		98.04		26.64		75.38	
p-value	.00		.00		.00		.27		.00	

Note: Household dummies included but not reported.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.
[a] Variable was dropped from the estimation because of nonconvergence.

to as few as 17 for some transfer categories. However, there were sufficient observations for estimation because family sizes are large. In addition, because father's and mother's land and education are family-level variables, they are included as interaction terms with the daughter dummy, and thus appear only so far as they impact differently on daughters and sons.

Table 6.4 presents the fixed effects results for the respondent and his or her maternal siblings, while Table 6.5 shows the corresponding results for the paternal sibset. Consistent with the levels results, daughters are disadvantaged relative to their maternal brothers in education (Table 6.4). Contrary to the levels results, once family-level unobservables are controlled for, daughters are also discriminated against with respect to maternal allocations of land. Sons are advantaged if their fathers have more land: this is shown in the total maternal land transfer equation and the inheritance equation. Half-siblings also get less than full siblings, which is consistent with the expectation that biological children are treated better than stepchildren.

Turning now to the distribution of land and education among paternal siblings (Table 6.5), the results for education are similar in that daughters complete fewer years of schooling than their brothers do. Secular trends in schooling also appear more impor-

Table 6.5 Education and land received in Ghana, by mode of transfer, respondent and paternal siblings, within paternal sibset estimates: Tobit with household dummies

	Education		All Land		Inheritance		Allocation		Gifts	
	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*
Constant	–15,139.36	–2.49**	2,197.12	0.36	–5,466.77	–0.48	5,743.56	1.35	230.22	3.25***
Daughter	–5.16	–5.12***	–1.71	–1.36	–1.42	–0.46	–2.29	–1.60	–1.51	–1.84*
Half-sibling	–0.79	–1.28	–1.45	–1.96*	–1.28	–0.93	–1.49	–2.76***	–0.99	–1.99**
Birth year	15.47	2.48**	–2.25	–0.36	5.51	0.47	–5.87	–1.34	–0.12	–3.24***
(Birth year)^2	–3,949.89	–2.47**	575.95	0.36	–1,387.50	–0.46	1,497.61	1.33	. . .[a]	. . .
Eldest	0.10	0.09	–1.54	–1.30	0.16	0.07	–1.34	–1.64	–2.89	–3.42***
Youngest	–0.57	–0.63	–1.33	–1.13	–1.89	–0.92	–0.69	–0.73	–0.82	–1.11
Daughter × father's education	0.19	1.01	0.25	1.05	–0.37	–0.31	0.28	1.22	0.25	0.83
Daughter × mother's education	–0.27	–0.66	–0.77	–1.11	. . .[a]	. . .	–0.16	–0.42	–1.05	. . .
Daughter × father's land	0.06	0.73	0.05	0.59	0.23	0.86	–0.05	–0.30	0.09	2.10**
Daughter × mother's land	–0.23	–0.93	0.06	0.19	0.07	0.10	0.66	0.77	–1.02	–2.88***
Sigma	5.22		5.31		6.92		1.99		1.57	
Number of observations	648		503		235		162		124	
Uncensored observations	452		341		181		96		75	
Number of families	128		93		45		27		29	
Chi-square	321.83		169.54		69.45		64.58		105.83	
p-value	0.00		0.00		0.05		0.00		0.00	

Note: Household dummies included but not reported.
*** significant at 1% level; ** significant at 5% level; * significant at 10% level.
[a] Variable was dropped from the estimation because of nonconvergence.

tant for paternal sibsets. Half-siblings receive less allocated land and gifts.

The gift equation deserves special attention among the land transfer equations for both paternal and maternal sibsets. We predicted that gifts may become more prevalent as population pressure increases and incentives exist for land tenure institutions to evolve to more individualized forms. Consistent with this hypothesis, later-born children are more likely to receive gifts from maternal relatives, but not from paternal relatives. Such secular trends in birth year are insignificant in the other land transfer equations. Moreover, the coefficient for daughters, although negative, is only weakly significant (at 10 percent) in the gift equation from paternal relatives. Thus, gifts may actually be more gender neutral than allocations in terms of transfers from the matriclan. This supports Hypothesis 4. There are indications of parental gender preference with respect to gifts from fathers. Daughters are favored if their fathers have more land, whereas sons are favored if mothers have larger areas of land (Table 6.5).

It seems, therefore, that daughters are disadvantaged in terms of both education and land transfers, particularly allocations, once family-level unobservables are controlled for. Gifts, however, are found to be more gender neutral. The general discrimination against females is borne out by the significantly

higher incidence of poverty of both females and female-headed households in rural Ghana, estimated from a nationally representative data set, the Ghana Living Standards Survey (Quisumbing, Haddad, and Peña 1998). With such large gender disparities, efforts to improve women's land rights and access to education will be important policy recommendations.

Sumatra Case

Sample Description

Table 6.6 presents the distribution and average size of the owned and/or cultivated land of 120 subsample households in the Middle and Low Regions. In the Middle Region, most of the households own or cultivate both lowland rice fields and upland cinnamon fields. Consistent with the relatively low proportion of bush/fallow in this area, only 28 households (around 47 percent) report having bush/fallow land. In the Low Region, on the other hand, 88 percent of the households also have lowland rice fields, and a smaller percentage (17 percent) have upland rice fields. Around 90 percent of the households have plots devoted to mature rubber, and around three-quarters have bush/fallow land.

In the Middle Region subsample, Table 6.7 shows that 40 percent of owned/cultivated lowland rice fields is owned under the joint family system, with ownership by daughters and sons as the predominant category. Around 27 percent of owned/cultivated plots is under single family ownership, with ownership by daughters and sons again the major category. Thus, it seems that, even in the category of "ancestral land," in which paddy land has traditionally been classified, the inheritance system seems to have evolved to include both daughters and sons. Both young and mature cinnamon fields are more likely to be owned by a single family (by both daughters and sons) or to be acquired privately, whether through purchase or forest clearance.

In the Low Region (Table 6.8), lineage land is found only in upland rice, accounting for 70 percent of upland rice plots. Most joint family land is found in lowland rice fields, accounting for 55 percent of lowland rice plots. Almost 50 percent of lowland rice plots are owned jointly by daughters, with the remainder jointly owned by daughters and sons. Only 7 percent of lowland rice fields are under single family ownership. In contrast, ownership of rubber plots is more individualized. Single family ownership and private

Table 6.6 Number and average size of owned/cultivated plots by land use, Middle Region and Low Region subsamples in Sumatra

	Middle Region			Low Region		
Land use	No. of plots[a]	Average size (ha)	No. of households	No. of plots[a]	Average size (ha)	No. of households
Total	370	1.18	60	180	1.35	60
Lowland rice fields	136	0.49	59	96	0.64	53
Young cinnamon fields[b]	96	1.33	52	. . .	. . .	. . .
Productive cinnamon fields[c]	154	1.25	53	. . .	. . .	. . .
Upland rice fields	. . .	. . .	. . .	10	0.73	10
Young rubber fields[d]	. . .	. . .	. . .	30	0.75	25
Mature rubber fields[e]	. . .	. . .	. . .	79	1.45	55
Bush/fallow	30	1.66	28	61	1.58	46

[a] Owned under joint family ownership, owner-cultivated under other ownership systems, and cultivated under tenancy and borrowing arrangements.
[b] Those with trees of age one to three.
[c] Those with trees of age four and above.
[d] Those with dominant tree age of zero to seven years.
[e] Those with dominant tree age of eight years and above.

Table 6.7 Land tenure distribution of owned/cultivated plots by land-use type, Middle Region subsample in Sumatra (percent)

Land tenure	Lowland rice	Young cinnamon	Productive cinnamon
Joint family	41.9	0.0	0.0
Daughters	4.4	0.0	0.0
Daughters and sons	37.5	0.0	0.0
Sons	0.0	0.0	0.0
Single family	27.2	33.3	37.7
Daughters	1.5	1.0	0.6
Daughters and sons	22.8	27.1	35.1
Sons	2.9	5.2	2.0
Borrowing	5.1	11.5	11.7
Private (purchase)	6.6	25.0	18.2
Private (forest clearance)	0.7	18.7	22.1
Share/fixed-rent tenancy	18.4	11.5	10.4

purchase are the dominant tenure categories for young and mature rubber plots. Rubber plots have also been acquired by forest clearance, accounting for 13 percent of young rubber plots and nearly 9 percent of mature rubber plots. Finally, bush/fallow area is mostly under single family ownership (41 percent of plots), followed by forest clearance (31 percent) and private purchase (23 percent). For both rubber and bush/fallow areas, single family ownership is dominated by ownership by sons.

The distribution of plots by land tenure status in the Middle Region seems to indicate that more traditional inheritance systems prevail, but are gradually shifting to a more egalitarian system whereby both sons and daughters inherit. In the Low Region, on the other hand, the evolution of inheritance systems seems to have gone further, with women specializing in paddy land and sons in agroforestry and bush/fallow areas. Note that the evolution has taken place in both locations based on the traditional ruling that earned property (such as fields obtained by purchase and forest clearance) can be disposed of at will to children of either sex.

The relative contributions of men and women to labor in lowland and upland rice and in the two major tree crops, cinnamon and rubber, may provide an explanation for the different evolutionary paths of land tenure institutions in these two regions (see Table 6.9).[67] In the Middle Region, wet rice and cinnamon use male and female labor relatively equally. In wet rice cultivation, male family labor accounts for 57 percent and female family labor for 43 percent. Whereas young cinnamon uses slightly more male family labor—males contribute 55 percent and women 45 percent—women are more involved in mature cinnamon cultivation, accounting for 70 percent of family labor input. The proportions are slightly different when both hired and family labor are considered. Wet rice and young cinnamon cultivation continue to use relatively equal amounts of male and female labor, but the male labor share in mature cinnamon production is much higher (61 percent) when hired labor is included.

In the Low Region, on the other hand, upland rice is very intensive in female family labor: women contribute 68 percent of family labor input, and men only 32 percent. However, both young and mature rubber plots utilize substantial inputs from male family members: men contribute 83 percent of

[67] The labor input data come from the sampled fields used for the computation of net revenue from food crops and agroforestry discussed in Suyanto, Tomich, and Otsuka (2001a, 2001b). In the Middle Region, wet rice, young cinnamon, and mature cinnamon fields were sampled. In the Low Region, upland rice, young rubber, and mature rubber fields were included. Since the focus of the study in the Low Region was the relative profitability of upland rice and agroforestry (rubber), we do not have data on labor input and net revenue in lowland rice fields.

Table 6.8 Land tenure distribution of owned/cultivated plots by land-use type, Low Region subsample in Sumatra (percent)

Land tenure	Lowland rice	Upland rice	Young rubber	Mature rubber	Bush/ fallow
Communal/lineage	0.0	70.0	0.0	0.0	0.0
Joint family	55.2	0.0	0.0	0.0	3.3
Daughters	49.0	0.0	0.0	0.0	0.0
Daughters and sons	6.2	0.0	0.0	0.0	3.3
Sons	0.0	0.0	0.0	0.0	0.0
Single family	7.2	0.0	33.3	29.1	41.0
Daughters	1.0	0.0	6.7	0.0	8.2
Daughters and sons	1.0	0.0	3.3	2.5	6.6
Sons	5.2	0.0	23.3	26.6	26.2
Private (purchase)	10.4	0.0	33.3	49.4	22.9
Private (forest clearance)	0.0	0.0	13.3	8.9	31.2
Renting	14.6	0.0	0.0	8.9	0.0
Borrowing	11.5	20.0	13.3	3.8	0.0
Others	1.0	10.0	6.7	0.0	1.6

family labor in young rubber and 91 percent in mature rubber. The relative proportions of male and female labor input do not change substantially when both family and hired labor are considered. The relatively high use of male labor arises from the "jungle rubber" farming system, in which woody species are densely grown among the rubber trees (Gouyon, de Foresta, and Levang 1993), so that it is difficult for women to work. In contrast, cinnamon trees are grown in rows and cinnamon fields are easily accessible for women. Such differences in working conditions seem to explain the division of labor between men and women in the cultivation of wet rice and tree crops in the two regions.

Table 6.10 presents the average landholdings, by type, and years of schooling of the parent and respondent generations in the Middle and Low Regions. In both regions, fathers are better educated than mothers, by at least one year of schooling. Years of completed schooling increase in the respondent generation: in contrast to their fathers, who had 2.9–3.7 years of schooling, sons have 7.1–8.9 years of schooling. Daughters have lower educational attainments than sons—6.3 years on the average. This is, however, a

Table 6.9 Labor use in food crops and agroforestry in Sumatra (person-days/hectare)

	Middle Region						Low Region					
	Wet rice		Young cinnamon		Mature cinnamon		Upland rice		Young rubber		Mature rubber	
Labor use	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Family labor												
Men	37.0	57.5	25.8	54.7	5.1	30.2	47.7	31.8	32.3	82.6	48.4	90.6
Women	27.4	42.5	21.4	45.3	11.8	69.8	102.5	68.2	6.8	17.4	5.0	9.4
Total	64.4	100.0	47.2	100.0	16.9	100.0	150.2	100.0	39.1	100.0	53.4	100.0
Total labor												
Men	120.0	54.2	32.0	47.3	15.2	61.3	53.6	30.5	35.1	67.9	87.6	92.3
Women	101.6	45.8	35.7	52.7	9.6	38.7	121.9	69.5	16.6	32.1	7.3	7.7
Total	221.6	100.0	67.7	100.0	24.8	100.0	175.5	100.0	51.7	100.0	94.9	100.0

Note: Data obtained from sampled fields.

Table 6.10 Education and landholdings of parent and respondent generations, Middle and Low Regions in Sumatra

	Middle Region		Low Region	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
Parent generation				
Father				
Years of schooling	3.67	2.95	2.90	1.70
Inherited paddy (ha)	0.61	1.10	0.11	0.26
Inherited agroforestry land (ha)	0.44	1.02	0.57	1.60
Inherited bush/fallow area (ha)	0.03	0.23	0.42	1.14
Mother				
Years of schooling	2.77	2.59	1.73	1.61
Inherited paddy (ha)	0.67	1.07	0.47	0.57
Inherited agroforestry land (ha)	0.40	0.96	0.41	1.45
Inherited bush/fallow area (ha)	0.06	0.34	0.51	1.85
Respondent generation				
Number of potential heirs	4.87	2.56	4.17	2.30
Sons				
Year of birth	1956	15.58	1957	13.96
Years of schooling	8.92	4.23	7.07	3.39
Inherited paddy (ha)	0.23	0.30	0.07	0.20
Inherited agroforestry land (ha)	0.23	0.64	0.33	0.86
Inherited bush/fallow area (ha)	0.12	0.75	0.39	0.96
Daughters				
Year of birth	1958	12.97	1956	14.83
Years of schooling	8.02	4.04	4.57	2.78
Inherited paddy (ha)	0.21	0.31	0.20	0.29
Inherited agroforestry land (ha)	0.28	0.74	0.18	0.82
Inherited bush/fallow area (ha)	0.02	0.11	0.11	0.39

substantial gain in comparison with their mothers, who had an average of only 2.2 years. Educational attainments are lower for both generations in the Low Region, and the gender gap in education is much larger in the Low than in the Middle Region. To some extent, the lower schooling attainment of women in the Low Region seems to be compensated for by their larger holdings of owned paddy land. It is also important to note that there has been a declining gender gap in schooling over the generations as measured by the ratio of completed schooling years between men and women.

In the parents' generation, mothers' inherited landholdings tended to be larger than their husbands'. This pattern no longer holds in the respondents' generation. In the Middle Region, daughters and sons have approximately equal inherited areas of paddy land, but daughters have larger inherited agroforestry areas and smaller inherited bush/fallow areas. In the Low Region, daughters maintain the matrilineal custom of inheriting paddy, having larger areas than their brothers, but receive less agroforestry land and bush/fallow area. Thus, a gender-differentiated pattern of inheritance seems to be emerging that is different from the traditional matrilineal system.

Regression Analysis

In the regression analysis, parental wealth is defined as human capital (as proxied by years of schooling) and each parent's inherited holdings of paddy land, agroforestry land, and bush/fallow area. These different types of land are not aggregated because they are associated with different degrees of land tenure security and ownership regimes. In the Sumatra case study, each parent's inherited land is defined as the sum of inherited land at the time of marriage, plus inherited land received after marriage. Be-

Table 6.11 Determinants of education and land inheritance by respondent and siblings, levels estimates, Middle Region in Sumatra

	Education[a]		Paddy land[b]		Agroforestry land[b]		Bush/fallow land[b]	
	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*
Constant	–1,524.63	–0.35	–747.88	–3.35***	–1,471.38	–1.42	–3,499.40	–0.53
Daughter	–1.30	–1.35	0.14	2.35**	0.38	1.47	6.28	2.04**
Birth year	1.47	0.33	0.77	3.36***	1.49	1.41	3.69	–0.54
(Birth year/1,000)^2	–350.04	–0.31	–197.14	–3.37***	–379.54	–1.40	–973.45	–0.56
Eldest	–0.45	–0.78	0.02	0.56	0.07	0.47	–0.06	–0.07
Youngest	–0.84	–1.46	0.08	2.16**	–0.06	–0.36	1.20	1.23
Father's education	–0.07	–0.30	0.03	2.57**	0.07	1.57	0.76	2.65***
Mother's education	0.11	0.42	–0.00	–0.25	0.00	–0.05	–0.73	–1.97**
Father's paddy land	0.69	1.34	0.16	7.62***	0.09	0.99	–0.04	–0.08
Mother's paddy land	1.10	2.82***	0.16	8.49***	–0.01	–0.08	–0.69	–1.01
Father's agroforestry land	0.26	0.42	–0.02	–0.67	0.43	4.93***	0.51	0.88
Mother's agroforestry land	0.18	0.21	–0.12	–2.86***	0.22	1.43	–0.25	–0.32
Father's bush/fallow land	–3.12	–4.09***	0.10	0.77	0.61	1.26	3.42	2.04**
Mother's bush/fallow land	–0.52	–0.40	0.17	1.76*	–0.10	–0.30	2.14	1.44
Daughter × father's education	–0.05	–0.22	–0.03	–2.08**	–0.07	–1.17	–1.54	–1.75*
Daughter × mother's education	0.43	1.50	0.01	0.73	0.01	0.16	–0.36	–0.32
Daughter × father's paddy land	–0.92	–2.59***	–0.07	–2.13**	–0.24	–1.60	–21.29	–1.56
Daughter × mother's paddy land	–0.69	–1.47	0.01	–0.22	–0.18	–1.20	1.11	1.07
Daughter × father's agroforestry land	0.36	0.70	–0.02	–0.67	0.10	0.85	–69.81	. . .
Daughter × mother's agroforestry land	–0.48	–0.53	0.09	2.01**	0.22	1.27	–6.11	–1.63
Daughter × father's bush/fallow land	1.79	2.29**	–0.10	–0.65	–0.42	–0.70	–1.32	–0.57
Daughter × mother's bush/fallow land	0.70	0.35	–0.28	–2.18**	–0.03	–0.07	7.34	1.30
Sigma	. . .		0.24		0.81		2.43	
Number of observations	292		292		292		292	
Uncensored	. . .		254		160		19	
Log-likelihood	. . .		–9.23		–248.30		–63.95	
F-statistic	32.03		. . .		. . .		. . .	
Chi-square	. . .		220.07		134.26		59.79	
R^2	.29		. . .		. . .		. . .	
Pseudo R^2	. . .		.92		.21		.32	

*** significant at 1% level; ** significant at 5% level; * significant at 10% level.
[a] Ordinary least squares with standard errors corrected for clustering.
[b] Tobit estimator.

cause inheritance decisions are generally public knowledge in this closely knit matrilineal society, expected inheritance is likely to be correctly anticipated and to affect each spouse's bargaining power within marriage.[68] Interaction terms with the daughter dummy reveal whether or not parents exhibit gender preferences associated with their landholdings and education.

Table 6.11 presents levels estimates of education and land inheritance functions of the respondent and his or her siblings in the Middle Region subsample, while Table 6.12 shows similar results for the Low Region subsample. Education equations were estimated using ordinary least squares, with standard errors corrected for household clustering, and land inheritance equations were estimated using Tobit. Family fixed and random effects regression results for the Middle and Low Region subsamples are presented in Tables 6.13 and 6.14 respectively.

Although daughters in the Middle Region obtain less schooling than sons, this difference

[68] Indeed, many couples start married life by farming a piece of the woman's family's paddy land, which is technically not "inherited" while her parents (or, more likely, her mother) are still living. However, that land is considered to be that woman's property, together with other properties she expects to inherit from her family.

Table 6.12 Determinants of education and land inheritance by respondent and siblings, levels estimates, Low Region in Sumatra

	Education[a]		Paddy land[b]		Agroforestry land[b]		Bush/fallow land[b]	
	Coef.	*t*	Coef.	*t*	Coef.	*t*	Coef.	*t*
Constant	–3,508.25	–0.78	–574.56	–1.17	197.66	–0.06	–4,184.13	–1.53
Daughter	–1.83	–2.02**	0.29	1.78*	–0.77	–0.52	–2.37	–1.94*
Birth year	3.53	0.76	0.59	1.12	0.21	–0.06	4.29	1.53
(Birth year/1,000)^2	–886.74	–0.75	–151.49	–1.12	54.64	0.06	–1,101.23	–1.54
Eldest	–0.63	–1.44	0.07	0.92	0.28	0.63	0.11	0.36
Youngest	–0.29	–0.68	0.21	3.22***	1.07	2.43**	–0.08	–0.22
Father's education	0.29	1.89*	0.02	1.06	0.09	0.77	0.22	2.49*
Mother's education	0.02	0.06	0.02	0.85	0.25	1.72*	0.04	–0.37
Father's paddy land	–0.63	–0.64	0.47	3.45***	0.57	0.78	–0.27	–0.37
Mother's paddy land	1.42	2.36**	0.22	2.11**	–0.89	–1.66*	–0.79	–2.16**
Father's agroforestry land	0.15	1.44	–0.01	–0.34	0.48	6.06***	–0.25	–1.62
Mother's agroforestry land	0.01	0.09	–0.03	–0.99	0.34	2.65***	0.38	3.36***
Father's bush/fallow land	–0.66	–3.76***	–0.06	–1.12	0.14	0.53	0.84	5.43***
Mother's bush/fallow land	–0.26	–3.37***	0.05	2.89***	–0.08	–0.54	0.36	5.12***
Daughter × father's education	–0.14	–0.66	–0.01	–0.30	–1.25	–1.49	0.26	1.54
Daughter × mother's education	–0.01	–0.04	–0.03	–0.89	–12.45	–1.18	0.13	0.59
Daughter × father's paddy land	0.32	0.26	0.43	1.99**	11.93	1.37	0.43	0.25
Daughter × mother's paddy land	–1.66	–2.01**	0.40	2.73***	1.20	0.60	–0.53	–0.61
Daughter × father's agroforestry land	0.16	0.43	0.00	0.01	1.06	0.94	0.32	1.40
Daughter × mother's agroforestry land	0.32	1.63	–0.01	–0.31	0.78	1.60	0.28	1.12
Daughter × father's bush/fallow land	0.23	0.64	0.01	0.10	. . .[c]	0.11	0.33	
Daughter × mother's bush/fallow land	0.36	1.65*	–0.24	–1.24	. . .[c]	0.05	0.14	
Sigma	. . .		0.33		1.48		1.31	
Number of observations	247		247		247		247	
Uncensored	. . .		93		44		51	
Log-likelihood	. . .		–85.28		–113.58		–129.15	
F-statistic	25.38		. . .		. . .		. . .	
Chi-square	. . .		142.30		128.79		123.39	
R^2	.36		. . .		. . .		. . .	
Pseudo R^2	. . .		.45		.36		.32	

*** significant at 1% level; ** significant at 5% level; * significant at 10% level.
[a] Ordinary least squares with standard errors corrected for clustering.
[b] Tobit estimator.
[c] Variable was dropped from the estimation because of nonconvergence.

is not statistically significant. Mother's paddy land has positive and significant effects on schooling; however, larger bush/fallow area of the father is associated with lower educational levels. This may reflect the relatively low returns to education when ample areas of uncultivated land exist. There is an indication of parental gender preference, however: daughters do less well than sons if mothers have more paddy land, whereas fathers with more bush/fallow area favor daughters.

In the Low Region, daughters are clearly more disadvantaged with respect to education, receiving almost two years less than their brothers. However, daughters are preferred with respect to inheritance of paddy land, consistent with traditional practices in these matrilineal communities, whereas sons inherit bush/fallow areas preferentially (both effects are significant only at the 10 percent level). Larger paddy areas held by the mother increase the schooling attainment of all children, whereas holdings of bush/fallow areas by both the mother and father reduce it. This implies that the availability of uncultivated land reduces parents' investments in schooling, suggesting that education and land bequests are substitutes. In all likelihood, this is because ownership of uncultivated land, which would require labor input from family

Table 6.13 Family fixed effects and random effects estimates of education and land inheritance of respondents and siblings, Middle Region in Sumatra

	Education Random effects		Paddy land Fixed effects		Agroforestry land Random effects		Bush/fallow land Fixed effects	
	Coef.	*z*	Coef.	*t*	Coef.	*z*	Coef.	*t*
Constant	–1,255.11	–0.36	–660.94	–2.75***	–330.89	–0.65	–369.52	–0.50
Daughter	–1.85	–2.25**	0.09	1.90*	–0.00	–0.04	–0.01	–0.06
Birth year	1.19	0.33	0.68	2.77***	0.34	0.65	0.38	0.50
(Birth year/1,000)^2	–276.23	–0.30	–174.97	–2.79***	–88.01	–0.66	–96.14	–0.50
Eldest	–0.41	–0.76	–0.04	–1.10	–0.07	–0.88	0.00	0.03
Youngest	–0.80	–1.48	0.03	0.91	–0.01	–0.19	–0.05	–0.51
Father's education	–0.08	–0.36	. . .		0.03	1.06	. . .	
Mother's education	0.19	0.85	. . .		0.01	0.29	. . .	
Father's paddy land	1.17	1.03	. . .		–0.10	–0.67	. . .	
Mother's paddy land	2.87	1.90*	. . .		–0.00	–0.01	. . .	
Father's agroforestry land	–3.25	–2.51**	. . .		1.02	5.76***	. . .	
Mother's agroforestry land	0.82	0.30	. . .		0.07	0.18	. . .	
Father's bush/fallow land	–10.70	–1.62	. . .		0.32	0.35	. . .	
Mother's bush/fallow land	–3.20	–0.33	. . .		–0.32	–0.24	. . .	
Daughter × father's education	0.02	0.11	–0.01	–1.12	–0.01	–0.38	–0.03	–1.03
Daughter × mother's education	0.23	1.17	–0.00	–0.19	–0.01	–0.29	0.03	0.97
Daughter × father's paddy land	–2.20	–1.69*	0.02	0.27	–0.35	–1.70*	–0.22	–0.99
Daughter × mother's paddy land	–2.70	–1.61	–0.09	–0.94	0.06	0.24	0.18	0.57
Daughter × father's agroforestry land	3.98	2.75***	–0.03	–0.38	0.83	3.51***	–0.04	–0.15
Daughter × mother's agroforestry land	–0.96	–0.34	0.15	0.67	0.88	2.15**	–0.25	–0.36
Daughter × father's bush/fallow land	6.59	1.00	–0.14	–0.38	–0.48	–0.44	–0.03	–0.03
Daughter × mother's bush/fallow land	1.67	0.19	–1.29	–2.61***	–0.37	–0.26	–1.32	–0.86
Wald chi-square (*p*-value)	71.68	(.00)	. . .		193.94	(.00)	. . .	
F-test (*p*-value)	. . .		2.49	(.00)	. . .		0.48	(.93)
Breusch–Pagan Lagrangian multiplier (*p*-value)	40.70	(.00)	26.79	(.00)	11.67	(.00)	0.19	(.66)
Hausman specification test (*p*-value)	9.88	(.70)	161.30	(.00)	6.89	(.91)	41.52	(.00)
Number of observations	292		292		292		292	

*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

members if it were to be developed, increases the children's opportunity cost of schooling. Larger areas of land also contribute to larger areas inherited by children. Similarly to the schooling equation in the Middle Region, mothers with more paddy land invest preferentially in sons' schooling, whereas fathers with more bush/fallow area favor daughters. In contrast, parents prefer daughters in the bestowal of paddy land relative to sons: larger holdings of paddy land by the mother or the father increase areas preferentially bestowed to daughters.

The different inheritance patterns of paddy land, agroforest, and bush/fallow land by gender are consistent with work differentiation between men and women in cultivation of different fields, which suggests that land inheritance institutions have evolved so as to provide proper work incentives to men and women. These findings are consistent with Hypothesis 4, which argues that the distribution of land among sons and daughters is tending to become more egalitarian.

We also examined the within-family distribution of education and land. Both family fixed effects and random effects models were used; the results reported in Tables 6.13 and 6.14 are the preferred specifications, judging from the Breusch–Pagan Lagrange multiplier test for the significance of random effects and the Hausman test for the significance of fixed effects. Although the results are consistent with the levels results, individual

Table 6.14 Family fixed effects and random effects estimates of education and land inheritance of respondents and siblings, Low Region in Sumatra

	Education Random effects		Paddy land Fixed effects		Agroforestry land Random effects		Bush/fallow land Fixed effects	
	Coef.	*z*	Coef.	*t*	Coef.	*z*	Coef.	*t*
Constant	–6,498.73	–2.01**	–310.51	–1.16	–4.26	–0.01	–1,306.52	–1.63
Daughter	–2.53	–2.73**	0.04	0.64	–0.01	–0.05	0.07	0.35
Birth year	6.59	1.99**	0.31	1.15	0.00	0.01	1.33	1.63
(Birth year/1,000)^2	–1,669.79	–1.97**	–79.84	–1.15	–0.64	–0.00	–337.98	–1.62
Eldest	–0.55	–1.21	0.01	0.23	0.01	0.11	0.06	0.52
Youngest	–0.24	–0.56	0.00	0.10	0.18	1.74*	–0.26	–2.20**
Father's education	0.36	2.26**	. . .		0.02	0.54	. . .	
Mother's education	–0.13	–0.65	. . .		0.03	0.97	. . .	
Father's paddy land	–1.68	–0.50	. . .		0.42	0.62	. . .	
Mother's paddy land	3.36	1.63	. . .		–0.36	–0.85	. . .	
Father's agroforestry land	1.31	1.71*	. . .		1.25	9.14***	. . .	
Mother's agroforestry land	0.41	0.47	. . .		0.47	2.74***	. . .	
Father's bush/fallow land	–1.48	–1.62	. . .		0.04	0.21	. . .	
Mother's bush/fallow land	–0.85	–1.43	. . .		0.07	0.62	. . .	
Daughter × father's education	–0.15	–0.87	0.01	0.55	–0.00	–0.09	–0.05	–1.40
Daughter × mother's education	0.16	0.77	–0.01	–0.63	–0.05	–0.99	0.06	1.20
Daughter × father's paddy land	–1.60	–0.34	1.75	4.76***	–1.54	–1.37	0.46	0.42
Daughter × mother's paddy land	–1.12	–0.40	0.94	4.41***	0.79	1.17	–0.96	–1.51
Daughter × father's agroforestry land	1.60	1.29	0.04	0.42	–1.11	–3.76**	0.20	0.73
Daughter × mother's agroforestry land	0.36	0.30	0.11	1.23	1.46	5.16**	–0.00	–0.01
Daughter × father's bush/fallow land	0.52	0.43	–0.06	–0.70	–0.10	–0.33	–1.21	–4.44**
Daughter × mother's bush/fallow land	1.42	0.95	–0.04	–0.38	–0.12	–0.36	–1.61	–4.56**
Wald chi-square (*p*-value)	117.66	(.00)	. . .		239.79	(.00)	. . .	
F-test (*p*-value)	. . .		10.33	(.00)	. . .		4.99	(.00)
Breusch–Pagan Lagrangian multiplier (*p*-value)	65.95	(.00)	1.84	(.17)	14.74	(.00)	0.07	(.79)
Hausman specification test (*p*-value)	19.43	(.11)	22.04	(.05)	4.91	(.98)	86.98	(.00)
Number of observations	242		242		242		242	

*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

heterogeneity rather than family unobservables characterize the education and agroforestry regressions, and fixed effects are important in bestowals of paddy and bush/fallow land.

In the Middle Region, sons receive more education than daughters, but daughters whose fathers have more agroforestry land receive more schooling. Contrary to the levels results, sons and daughters inherit all types of land equally. This is consistent with the relatively equal use of male and female labor in paddy and cinnamon production. However, daughters whose fathers and mothers have larger agroforestry areas tend to inherit more than their brothers. This is consistent with the more traditional matrilineal practice in the Middle Region compared with the Low Region.

In the Low Region, the random effects results confirm that daughters are disadvantaged with respect to schooling. Schooling attainment does increase with birth year. Unlike the levels results, in the land inheritance regressions the gender dummy is, in itself, insignificant, but mothers and fathers treat sons and daughters differently. Larger paddy areas of both father and mother are associated with larger areas inherited by daughters. In contrast, sons receive more agroforestry area when their fathers have larger holdings; daughters have larger inherited agroforestry holdings when their mothers have larger areas of this type of land. However, both fathers

and mothers with larger bush/fallow holdings favor sons.

Concluding Remarks

In this chapter, we have examined how wealth is transferred from parents to children, focusing on the differences in land inheritance and schooling between sons and daughters. The evidence suggests that schooling and land are substitutes in the sense that greater availability of unused land reduces parents' incentives to invest in children's schooling. Thus, increasing levels of schooling in Sumatra can be explained partly by the increasing scarcity of cultivable land area. It may well be that schooling will continue to increase in Ghana as land becomes more scarce.

It is encouraging to observe that in the Middle Region of Sumatra, which is more developed than the Low Region, sons and daughters are equally educated. Although daughters are less educated than sons in the Low Region, the gender gap in schooling has significantly narrowed over the generations. In Ghana, the gender gap in schooling is wider and the schooling levels are lower than in Sumatra: in Ghana, sons received 5.7 years of schooling on the average, which is much lower than the corresponding average of 8.5 years in Sumatra; the figures for daughters are 2.9 years in Ghana and 5.8 years in Sumatra. Thus, the average schooling attainment of daughters is only one-half that of sons in Ghana. Their mothers, however, were far less educated than their fathers, indicating that the gender gap may have narrowed over time in Ghana as well.

Contrary to the widely held belief that women's access to land tends to be weakened in the process of individualization of land tenure institutions, women in Ghana, who traditionally did not inherit land from their husbands and fathers, are now acquiring land through gift transfers. According to the results of the regression analysis of land transfers, the gifts are gender neutral. This finding is consistent with Hypothesis 4 that the contribution of female labor to the establishment of agroforestry fields is rewarded by the acquisition of land rights. Women, however, own only 20 percent of land, and whether or not they will acquire significantly more land of their own remains to be seen.

Interesting changes in the ownership of land by men and women are also observed in the matrilineal societies of Sumatra, where only women used to own land. In the Middle Region, where men and women work more or less equally on both cinnamon and paddy fields, sons and daughters inherit land equally. In the Low Region, in contrast, where men work primarily on rubber fields and women work primarily on paddy fields, sons inherit larger areas of upland fields and daughters inherit larger areas of lowland paddy fields. It seems clear that the division of labor in farm work between men and women is closely mirrored in the division of inherited land between sons and daughters, which provides additional support for Hypothesis 4.

In conclusion, we want to emphasize that gender equity is not necessarily incompatible with economic development. In particular, our study suggests that the gender gap in schooling tends to become smaller with an increase in the level of development. Our study also suggests that it is possible for the intergenerational transfer of land to move toward a more egalitarian system. In order to substantiate such conjectures, however, further research is needed to identify the economic and sociocultural forces that promote more equitable changes in the gender distribution of schooling and land inheritance.

CHAPTER 7

Conclusions and Policy Implications

Introduction

This study has attempted to identify, systematically and quantitatively, the factors affecting the evolution of land tenure institutions and their effects on the use of land for agroforestry and annual cropping, and on management efficiency. Indeed, although massive deforestation has been taking place in the developing world, resulting in ecological deterioration, a sign of hope is the significant and often growing adoption of agroforestry. The study also paid special attention to differences in land rights between men and women and between family and individual ownership, and to the consequences of such differences on the rate of deforestation and tree-planting and on the management of tree resources. In-depth attention was also given to gender equity in the distribution of land inheritance and educational investments. We wanted to draw generalizable conclusions by making a comparative study between Ghana and Sumatra, where cultural, natural, and policy environments are vastly different. We deliberately chose sites where traditional matrilineal regimes—the uterine matrilineal system of the Akans in western Ghana and the matrilineal system in western Sumatra—were evolving in the process of individualization.

This final chapter attempts to summarize the major findings of the two country studies so as to draw policy implications. Discussions in this overview will be organized around the major issues addressed in this study. First, we characterize the common types of property rights institutions and explore how they are evolving. Second, we summarize how land tenure institutions and their differences by gender affect the incidence of planting commercial trees and management efficiency, as well as the efficiency of annual crop farming. Third, we discuss the effects of the different tenure systems on gender equity. The final section discusses the policy implications of this study.

Major Findings

Characteristics of Property Rights Systems

Under the communal tenure system, population pressure has led to the privatization of land rights on land converted and utilized for agriculture or agroforestry. Strong individual land

rights are granted to cultivated land converted from forests, though such rights are weakened when the land is left fallow for long periods. Rights have been further individualized through long-term investment, most notably in tree-planting, which was clearly demonstrated in the case studies of both Ghana and Indonesia. There has also been evidence that, during this process, land markets have strengthened and that they further contribute to the process of individualization of land rights. All of these trends have caused traditional land acquisition methods to erode. In the matrilineal inheritance systems of Ghana and Indonesia, matrilineal customs have given way in part to patrilineal or egalitarian systems, through gifts or outright sales of land.

Communal Land Tenure and Deforestation

Field observations indicated that uncultivated forest areas under the communal tenure system are open access, at least for members of the community. In Ghana and Sumatra, the village chief readily allowed villagers to clear the forest for cultivation, even if he was supposed to be the custodian of the communal forest. It appears that the major responsibilities of the village chief are to approve the clearance of forests and to record land ownership so as to avoid possible land disputes in the future.

Although it is difficult to prove rigorously that primary forests have been operating under open access over an extended period of time, there is no question that forest areas under communal ownership have easily been cleared as population increased. In fact, the age of the household head is a critical variable explaining the area of acquired forestland in both Ghana and Sumatra. The positive relationship reflects the fact that cultivable primary forests have gradually disappeared owing to their clearance on a first-come/first-served basis.

The major factor accounting for the decrease in forestland is identified as population pressure. The household surveys in Sumatra find that reduction in inherited land, due primarily to an increased number of family members relative to family-owned land, resulted in larger clearance of forestland. Although the effect of inherited land on forest area in Ghana was insignificant, the fact that migrants from land-scarce areas actively sought newly cleared forestland strongly indicates that population pressure has also resulted in deforestation.

An important factor affecting deforestation is the conventional rule of communal land tenure, which honors ownership rights on cleared forestland. In other words, the work effort of clearing forests is rewarded by strong individual land rights. It is clearly reported from the case studies in Ghana and Sumatra that those who have cleared village forestland are granted strong individual rights.

Gender considerations have some implications for the rate of forest clearance as well as the subsequent development of agroforestry. In Ghana, female-headed households are less likely to have acquired land through forest clearance, since this has traditionally been a male task. Although women can and do hire male laborers, female heads of household typically have less access to the resources to do so. In Sumatra, on the other hand, where husbands and wives cultivate family farms jointly, the number of male workers in the household increases forest clearance as well as the area planted to trees (see also Suyanto and Otsuka 2001).

The most important conclusion is that there is no built-in mechanism under the communal ownership system to protect forest area and forest resources. Halting the trend of deforestation will not be simple.

Communal Land Tenure, Gender, and the Development of Agroforestry

Land in our study sites is marginal for agriculture and some parcels are very steep. It would be socially desirable to promote agroforestry systems on such land to mimic many of the forest functions and to provide income-earning opportunities for the rural population.

Many of the farmers plant and grow trees, such as commercial trees and shade trees, which provide positive environmental benefits. Commercial tree farming is usually more sustainable and often more efficient than food crop farming in marginal areas, partly because of the low yields of pure food crop enterprises on these lands, and partly because of the ease of shipping tree products that are storable.

It is widely believed, however, that, because of weak individual land rights or tenure insecurity, trees are not planted and well managed under communal ownership regimes in which the extended family often has influence over use rights in cultivated land (for example, Johnson 1972; Besley 1995). In particular, matrilineal systems have been criticized because they do not keep the benefits of investment within the patriarchal family, and so provide weaker incentives to invest. If, indeed, this is the case, it will be difficult to promote agroforestry in marginal areas, even though agroforestry has comparative advantage over food production under shifting cultivation. In this study, we explored in depth whether communal tenure institutions provide insufficient incentives to plant and manage trees. If tree-planting is not deterred, the incidence of poverty in marginal areas can be reduced by enhancing the efficiency of land use in such areas. Furthermore, the establishment of agroforestry on sloping land will help reduce soil erosion and siltation and contribute to the partial restoration of tree biomass and biodiversity. This is reported to be the case in cocoa fields with big shade trees (Gockowski, Nkamleu, and Wendt 2000) and in the so-called jungle rubber forest mixed with non-rubber trees (Tomich et al. 2000).

In matrilineal communities of Sumatra, cultivated land was traditionally owned by lineage members consisting typically of three generations descended from the same grandmother. Gradually, joint ownership by sisters became common. However, agroforestry plots are more likely to be bequeathed from a mother to daughters and even to sons individually. Private ownership acquired through land market transactions and forest clearance is also common. An important observation is that individual land rights are stronger under single family ownership than collective family ownership. Since sons carry out the bulk of forest clearance and tree-planting, inheritance of agroforestry plots and bush/fallow areas by sons rewards their work effort. Daughters continue to inherit paddy land, which has traditionally been considered ancestral property to be inherited by women. In this way, the matrilineal inheritance system in Sumatra has been evolving toward a more egalitarian system. Strengthened land rights under the single family ownership regime also promoted land market transactions.

In indigenous Akan villages in western Ghana, uterine matrilineal inheritance has been practiced: land is bequeathed from the deceased man to his uterine matrilineal relatives, for example, his brother or his nephew. Although those who clear forests are granted strong land rights, the cleared land eventually becomes the property of the extended family and may be temporarily allocated to those family members in need of land or bequeathed in accordance with the traditional rule. As was demonstrated in this study, individual land rights on these family-owned plots under the Akan matrilineal system are very weak. The individual rights of inherited land in non-Akan households are much stronger. Since non-Akans generally follow patrilineal inheritance, individualization was facilitated by the small number of family members, typically a father and his sons, involved in the inheritance decision. It is important to observe that the current share of allocated and inherited land is relatively low. Allocation and inheritance are giving way to gifts and acquisition of land via land markets, such as purchase and rental.

Although the proportion of women's land accounts for around 20 percent in Akan households in these areas of western Ghana, the inheritance system has been evolving in favor of women. Plots planted with trees, which confer strong individual rights, are

often transferred to wives and children as *inter vivos* gifts, with the permission of members of the extended family. The transfer to the wife and children represents a reward for their efforts in helping the husband or father to plant cocoa trees. Once land has been transferred to women as a gift, there are no significant differences in the probability of tree-planting between male and female farm managers. This finding is similar to those from studies on cocoa and coffee adoption in Côte d'Ivoire (Appleton et al. 1991). This is probably because the transfer of land to women is conditional on the previous planting of cocoa. The regression results suggested that women are as likely as men to plant cocoa and manage cocoa fields efficiently. That is, women parcel managers are equally efficient as men, which is consistent with the empirical evidence on male–female differences in agricultural productivity (Quisumbing 1996).

There is no strong statistical evidence to support popular arguments that customary land tenure in Ghana and Sumatra discourages commercial agroforestry. Indeed, commercial trees have been planted under the communal ownership system as widely and actively as under the private ownership system. This occurs because land rights have become highly individualized as a result of the investment in trees and the continuous cultivation of tree fields by farmers necessitated by high population pressure. Even where land rights are relatively weak, tree-planting is stimulated by the expectation of strengthened individual land rights.

Given the positive and significant effect of tree-planting on individual land rights, it is no wonder that sufficiently strong incentives to plant commercial trees exist under the communal ownership system. Once trees are planted, the land ownership system is converted to de facto private ownership within a community. Thus, the management efficiency of commercial tree fields under the communal system is generally comparable to other ownership systems in the study sites, according to the estimation results of profit or net revenue functions. In other words, the communal system is evolving toward an individualized system and does not impede the development of agroforestry.

Land Tenure, Gender, and Cropland Management

Land tenure rules affect expected future benefits accruing to those who invest in land improvement, including tree-planting. Therefore, land tenure affects long-term but not short-term management incentives. In support of this, land tenure institutions did not have any impact on the production efficiency of paddy fields in Sumatra, which do not require much investment. However, some differences in the management efficiency of annual crop production under different land tenure institutions can be observed in Ghana, where cropland owned and allocated by the extended family, with less secure land rights, is less frequently fallowed than land with more individualized rights. Land-use rights are fairly well established under extended family ownership so long as land is continuously used for cultivation. Once land is put into fallow, however, individual rights are substantially weakened. Thus, the less frequent fallow periods under extended family ownership can be explained by weaker tenure security, which forces farmers to continue to cultivate the land to secure use rights. Although customary land tenure institutions are not significantly inefficient for the management of tree fields, they are likely to be inefficient for the management of crop fields under shifting cultivation.

In neither Ghana nor Sumatra are there any significant managerial efficiency differences in cropped land depending on the gender of the parcel manager (in Ghana) or the gender composition of family labor (both Ghana and Sumatra).

Land Tenure and Gender Equity

A second type of equity concerns the distribution of assets by gender. One of the trends observed in Ghana—the erosion of traditional uterine matrilineal systems—indicates that

women's control over land resources has been strengthened under the transformation of communal tenure systems. If labor-intensive agriculture increases the demand for women's labor, as in the case of cocoa in Ghana (Okali 1983; Awusabo-Asare 1990), women's labor on their husbands' plots may represent a form of "sweat equity" that confers individualized land rights to them. The findings suggest that gift transactions, usually in return for labor on a husband's cocoa plot, are an increasingly important mode of land acquisition for women. The positive secular trend in gift transfers, particularly among the matrikin, is substantiated by the analysis of the intrahousehold distribution of land inheritance.

In contrast, men's land rights were strengthened in matrilineal communities of Sumatra, when demand for men's labor increased with the development of agroforestry. The increase in men's rights is specific to areas where agroforestry is intensive in male labor; where agroforestry uses male and female labor relatively equally, the inheritance system has evolved to benefit both daughters and sons. The inheritance system seems to be evolving from a strictly matrilineal system to a more egalitarian system in which sons and daughters inherit the type of land that is more intensive in their own work effort. In other words, the newly emerging customary land tenure institutions, by allowing for inheritance consistent with comparative advantage and work effort, seem to have built-in incentives for men and women.

We would like to emphasize that agroforestry systems, whether on private or on communally owned land, have a positive indirect effect on equity. This is because agroforestry is more favorable and profitable than food crops in marginal areas where there are relatively high levels of poverty, so that systems that encourage their development also make a contribution to reducing the welfare gap between the relatively wealthy and the poor rural population.

Policy Implications

This section highlights the key policy implications from the two country case studies for improving the efficiency of natural resource management while, at the same time, recognizing the importance of equity. Our study indicates that profit incentives are a strong economic force underlying institutional changes in land ownership systems, which, in turn, suggests that enhancing the profitability of agroforestry will facilitate its wider diffusion.

This section focuses first on property rights arrangements for both agricultural and nonagricultural land, second on the development and dissemination of agricultural and agroforestry technologies, and third on market development and other issues. All three areas must be addressed to improve the efficiency of natural resource management.

Property Rights Institutions and Policies

Property rights institutions are largely favorable to or moving in the right direction to provide proper incentives for efficient natural resource management. There are a few noteworthy exceptions and areas for improvement, however.

Though it seems reasonable that improved management will take place when there is a closer match between those who control and those who use resources, direct intervention in gender-based property rights policy has proved to be extremely difficult. It is important that any program that assigns rights to resources (whether titling laws, privatization of state or communal holdings, or allocation of land or water in settlement or irrigation schemes) be checked for overt or implicit barriers to women's obtaining rights. This applies in both the design and the implementation of programs. Legal systems need to be developed and adapted to assist women in obtaining and protecting their rights.

In addition, one should expect that the twin forces of commercialization and individualization of land rights will lead over time to a more widespread demand for titling by smallholder farmers. Although many titling programs have failed, largely owing to premature implementation, they have been

popular and sustainable in areas of high market and property rights development, such as central Kenya (Migot-Adholla, Place, and Oluoch-Kosura 1994). Land titling programs will become feasible once communal land tenure institutions have become sufficiently individualized. Yet such programs are costly and there is always the danger that the rich and the political elite will grab large areas of titled land. In fact, Hayami (1999) argues that the preemption of uncultivated land to the elite with legal title to land was the major source of inequality in land distribution and the development of large plantation sectors in Southeast Asia.

Implementation of land titling programs must pay special attention to the gender issue. If men are traditionally owners of land, as in western Ghana, land titling may strengthen their land rights at women's expense. To be fair, men and women should be equally qualified to acquire land titles, or titles could be awarded jointly to men and women. Judging from the experience of Ghana, the promulgation of the Intestate Succession Law, which stipulates how property should be bequeathed to the spouse, children, and other family members, may be a useful policy option, which would facilitate less gender-biased land inheritance systems in customary land areas. However, the effectiveness of efforts to strengthen women's land rights through legal reform depends on women's knowledge of the provisions of the law and their ability to enforce their claims in court. In all likelihood, improving women's education will help strengthen their land rights.

Development and Dissemination of Agroforestry Technologies

Since strong incentives exist to manage agroforestry plots on sloping lands under communal ownership, it makes sense to develop and disseminate profitable agroforestry systems, through such means as the development of improved species of commercial trees, improving techniques for selecting and propagating useful indigenous tree germplasm, improving the flow of information on these new technologies, and, finally, providing proper incentives for germplasm delivery systems to develop. It is important to involve both men and women in varietal selection, because men and women may have different preferences for tree species.

In addition, research on sustainable tree management needs to be carried out for the wide areas of barren land which used to be planted to coffee, cocoa, and other tree crops. Farmers in marginal areas are particularly poor, so the establishment of profitable and sustainable agroforestry systems will contribute significantly to the reduction of poverty by enhancing the efficiency of farming in marginal areas. It will also contribute to the prevention of soil erosion and the creation of tree biomass. Moreover, profitable agroforestry can help to strengthen individual land rights where they are weak. Thus, the development of agroforestry is expected to be conducive to both efficiency and equity from both private and social viewpoints. If so, the development of profitable agroforestry systems could be a superior substitute for land titling programs. Furthermore, with the introduction of profitable agroforestry systems, shifting cultivation areas, which tend to be managed inefficiently under communal tenure institutions, will further decline, reducing the need for land titling programs.

Note that we are not arguing that land titling is unimportant. It will become critically important, when the importance of credit increases as land use is intensified and the use of purchased inputs increases. Because land without clear titles cannot be used as collateral in formal credit markets, land titling programs will benefit cultivators who need credit, as in the case of Thailand (Feder et al. 1988). In our observation, however, our sites have not yet reached the stage at which purchased inputs and, hence, the availability of credit play significant roles.

In developing technology transfer programs, care must be taken to provide extension to women farmers, who have often been neglected by male-dominated extension

systems (Saito and Spurling 1992). Technologies to improve food crops intercropped with young trees may be especially useful to women, who are responsible for their families' food security.

Market Development and Other Policy Issues

Market development is critical to generate the degree of intensification required to enable rural people to uplift themselves from poverty without mining their surrounding resources. Increased expenditure for rural road construction will be a key component of such development. This point is well understood by policymakers. It must be also clearly understood that, although the development of roads may accelerate deforestation by enhancing the profitability of timber harvesting, it will also accelerate the development of agroforestry where primary forests have already been cleared.

The lower educational attainment of women in the study sites is cause for concern, even though there have been signs of improvement. Even if daughters continue to maintain control of land in their own right, lower levels of education would make them less likely to benefit from nonagricultural income-earning opportunities. If education is more important than land in the determination of income, as is found in the Philippines (Estudillo and Otsuka 1998), the inequality in income-earning capacity between men and women may have widened. Moreover, if population pressure continues to increase, it is unlikely that agriculture will be able to absorb the growing labor force, and this will create even more pressure on the existing stock of forest resources. Investing in the education of both sons and daughters would thus be part of a long-term solution to rural poverty and environmental sustainability in these areas. Increasing women's educational attainment will not only increase their opportunities in the nonfarm sector, but also, by increasing the opportunity cost of time, contribute to smaller family sizes and reduced population pressure on scarce forest resources.

References

Afonja, S. 1981. Changing modes of production and the sexual division of labor among the Yoruba. *Signs* 7 (2): 299–313.

Agarwal, B. 1994. *A field of one's own: Gender and land rights in South Asia.* Cambridge, U.K.: Cambridge University Press.

Alchian, A. A., and H. Demsetz. 1973. The property right paradigm. *Journal of Economic History* 16 (1): 16–27.

Anderson, T. L., and P. J. Hill. 1990. The race for property rights. *Journal of Law and Economics* 33 (1): 177–197.

Angelsen, A. 1994. From rice to rubber: The economics of shifting cultivation and deforestation in Kec. Seberida, Sumatra. Paper presented at the International Symposium on Management of Rainforests in Asia, 23–26 March, Jevnaker, Norway.

———. 1995. Shifting cultivation and deforestation: A study from Indonesia. *World Development* 23 (October): 1713–1729.

———. 1999. Agricultural expansion and deforestation: Modeling the impact of population, market forces, and property rights. *Journal of Development Economics* 58 (1): 185–218.

Appleton, S., D. L. Bevan, K. Burger, P. Collier, J. Willem Gunning, L. Haddad, and J. Hoddinott. 1991. *Public services and household allocation in Africa: Does gender matter?* Oxford, U.K.: Oxford University, Centre for African Studies.

Asenso-Okyere, W. K., S. Y. Atsu, and I. S. Obeng. 1993. Communal property resources in Ghana: Policies and prospects. Discussion paper No. 27, Institute of Statistical, Social and Economic Research, University of Ghana, Legon.

Aumeeruddy, Y. 1994. *Local representations and management of agroforests on the periphery of Kerinci National Park, Sumatra, Indonesia*. People and Plants Working Paper No. 3. Paris: Division of Ecological Sciences, United Nations Educational, Scientific, and Cultural Organization (UNESCO).

Awusabo-Asare, K. 1990. Matriliny and the new intestate succession law of Ghana. *Canadian Journal of African Studies* 24: 1–16.

Barlow, C., and S. K. Jayasuriya. 1984. Problems of investment for technological advance: The case of Indonesian rubber smallholders. *Journal of Agricultural Economics* 35: 85–95.

Barlow, C., and Muharminto. 1982. The rubber smallholder economy. *Bulletin of Indonesian Economic Studies* 18 (July): 86–119.

Bassett, T. J. 1993. Introduction: The land question and agricultural transformation in Sub-Saharan Africa. In *Land in African agrarian systems*, ed. T. J. Bassett and D. E. Crummey. Madison, Wisc., U.S.A.: University of Wisconsin Press.

Becker, G. S. 1974. A theory of social interactions. *Journal of Political Economy* 82 (6): 1063–1093.

Becker, G. S., and N. Tomes. 1986. Human capital and the rise and fall of families. *Journal of Labor Economics* 4: S1–39.

Behrman, J. R., R. A. Pollak, and P. Taubman. 1982. Parental preferences and provision for progeny. *Journal of Political Economy* 90: 52–73.

Benneh, G. 1987. Land tenure and agroforestry land use systems in Ghana. In *Land, trees, and tenure*, ed. J. B. Raintree. Nairobi, Kenya: International Centre for Research in Agroforestry, and Madison, Wisc., U.S.A.: Land Tenure Center.

———. 1989. The dynamics of customary land tenure and agrarian systems in Ghana. In *The dynamics of land tenure and agrarian systems in Africa, World Conference on Agrarian Reform and Rural Development: Ten years of follow-up.* Rome: Food and Agriculture Organization of the United Nations.

Berry, S. 1963. *No condition is perfect: The social dynamics of agrarian changes in Sub-Saharan Africa*. Madison, Wisc., U.S.A.: University of Wisconsin Press.

Besley, T. 1995. Property rights and investment incentives. *Journal of Political Economy* 103: 913–937.

Binswanger, H., and M. Rosenzweig. 1986. Behavioral and material determinants for production relations in agriculture. *Journal of Development Studies* 22 (3): 503–539.

Binswanger, H., K. Deininger, and G. Feder. 1995. Power, distortion, revolt, and reform in agricultural land relations. In *Handbook of development economics, volume 3B*, ed. J. Behrman and T. N. Srinivasan. Amsterdam: Elsevier.

Boadu, F. 1992. The efficiency of share contracts in Ghana's cocoa industry. *Journal of Development Studies* 29: 108–120.

Boserup, E. 1965. *The conditions of agricultural growth: The economics of agrarian change under population pressure*. London: Allen & Unwin.

———. 1970. *Woman's role in economic development*. New York: St. Martin's Press.

Bromley, D.W., ed. 1992. *Making the commons work: Theory, practice, and policy*. San Francisco: International Center for Self-Governance.

Bruce, J. W., and L. Fortmann. 1989. Agroforestry: Tenure and incentives. Land Tenure Center Paper 135. University of Wisconsin-Madison.

Bruce, J. W., and S. E. Migot-Adholla, eds. 1994. *Searching for land tenure security in Africa*. Dubuque, Ia., U.S.A.: Kendall/Hunt.

Brydon, L. 1987. Women in the family: Cultural change in Avatime, Ghana, 1900–80. *Development and Change* 18: 251–269.

Deere, C. D. 1985. Rural women and state policy: The Latin American agrarian reform experience. *World Development* 13 (9): 1037–1053.

Demsetz, H. 1967. Toward a theory of property rights. *American Economic Review* 57 (2): 347–359.

Dick, J. 1991. Forest land use, forest use zonation, and deforestation in Indonesia: A summary and interpretation of existing information. Background paper to United Nations Conference on Environment and Development for the State Ministry for Population and Environment (KLH) and the Environmental Impact Management Agency (BADEPAL).

Estudillo, J., and K. Otsuka. 1998. Green revolution, human capital, and off-farm employment: Changing sources of income among farm households in central Luzon, 1965–1995. *Economic Development and Cultural Change* 47 (3): 497–523.

Errington, F. K. 1984. *Manners and meaning in West Sumatra: The social context of consciousness*. New Haven, Conn., U.S.A.: Yale University Press.

FAO (Food and Agriculture Organization of the United Nations). 1990. *Situation and outlook of forestry sector in Indonesia, volume1: Issues, findings and opportunities*. Ministry of Forestry, Government of Indonesia, and FAO in Jakarta.

Feder, G., and D. Feeny. 1993. The theory of land tenure and property rights. In *The economics of rural organization: Theory, practice, and policy*, ed. Karla Hoff, Avishay Braverman, and J. E. Stiglitz. Oxford, U.K.: Oxford University Press.

Feder, G., and R. Noronha. 1987. Land rights systems and agricultural development in Sub-Saharan Africa. *World Bank Research Observer* 2 (2): 143–169.

Feder, G., T. Onchan, Y. Chalamwong, and C. Hongladarom. 1988. *Land policies and farm productivity in Thailand*. Baltimore, Md., U.S.A.: Johns Hopkins University Press.

Fortmann, L. 1981. The plight of the invisible farmer: The effect of national agricultural policy on women in Africa. In *Women and technological change in developing countries. AAAS Selected Symposium 53*, ed. Roslyn Dauber and Melinda Cain. Washington, D.C.: AAAS.

———. 1987. Tree tenure: An analytical framework for agroforestry projects. In *Land, trees and tenure. Proceedings of an International Workshop on tenure issues in agroforestry held in Nairobi, Kenya, 27–31 May 1985*, ed. J. B. Raintree. Nairobi, Kenya: ICRAF and Madison, Wisc., U.S.A.: Land Tenure Center.

———. 1988. The tree tenure factor in agroforestry with particular reference to Africa. In *Whose trees? Proprietary dimensions of forestry*, ed. Louise Fortmann and John W. Bruce. Boulder, Colo., U.S.A.: Westview.

Fraser, A. I. 1998. Social, economic and political aspects of forest clearance and land-use planning in Indonesia. In *Human activities and the tropical rainforest,* ed. B. K. Malonoey. Amsterdam: Kluwer Academic Publishers.

Gardner, R., E. Ostrom, and J. Walker. 1990. The nature of common-pool resource problems. *Rationality and Society* 2: 335–358.

Ghana Statistical Service. 1995. *Ghana living standard survey*. Accra, Ghana.

Gockowski, J., B. Nkamleu, and J. Wendt. 2000. Implications of resource use intensification for the environment and sustainable technology systems in the central African rainforest. In *Tradeoffs or synergies? Agricultural intensification, environment, and economics development*, ed. D. R. Lee and C. B. Barrett. Wallingford, U.K.: CAB International Publishing.

Gouyon, A., H. de Foresta, and P. Levang. 1993. Does jungle rubber deserve its name? An analysis of rubber agroforestry systems in Southeast Sumatra. *Agroforestry Systems* 22 (3): 181–206.

Haddad, L., J. Hoddinott, and H. Alderman. 1997. *Intrahousehold resource allocation in developing countries: Models, methods and policy*. Baltimore, Md., U.S.A.: Johns Hopkins University Press.

Hayami, Y. 1997. *Development economics: From the poverty to the wealth of nations*. Oxford, U.K.: Oxford University Press.

———. 1999. An ecological and historical perspective on rural sector development in Southeast Asia. World Bank, Washington, D.C. Mimeo.

Hayami, Y., and K. Otsuka. 1993. *The economics of contract choice: An agrarian perspective*. Oxford, U.K.: Clarendon Press.

Hayami, Y., and V. W. Ruttan. 1985. *Agricultural development: An international perspective*. Baltimore, Md., U.S.A.: Johns Hopkins University Press.

Heckman, J. J., and T. E. MaCurdy. 1980. A life cycle model of female labor supply. *Review of Economic Studies* 47 (1): 47–74.

Hill, P. 1963. *The migrant cocoa-farmers of southern Ghana: A study in rural capitalism*. Cambridge, U.K.: Cambridge University Press.

Honoré, B. 1992. Trimmed LAD and least squares estimation of truncated and censored regression models with fixed effects. *Econometrica* 60: 533–565.

Hsiao, C. 1986. *Analysis of panel data*. Econometric Society Monographs No. 11. Cambridge, U.K.: Cambridge University Press.

Institute of Statistical, Social, and Economic Research. 1995. *The state of Ghanaian economy*. Legon, Ghana.

Johnson, O. E. G. 1972. Economic analysis, the legal framework and land tenure systems. *Journal of Law and Economics* 15 (1): 259–276.

Kahn, J. S. 1980. *Minangkabau social formations: Indonesian peasants and the world economy*. Cambridge, U.K.: Cambridge University Press.

Kato, T. 1982. *Matriliny and migration: Evolving Minangkabau traditions in Indonesia*. Ithaca, N.Y., U.S.A.: Cornell University Press.

Lastarria-Cornhiel, S. 1997. Impact of privatization on gender and property rights in Africa. *World Development* 25 (August): 1317–1333.

López, R. 1997. Environmental externalities in traditional agriculture and the impact of trade liberalization: The case of Ghana. *Journal of Development Economics* 53: 17–39.

McElroy, M. B. 1990. The empirical content of Nash-bargained household behavior. *Journal of Human Resources* 25 (4): 559–583.

McElroy, M. B., and M. J. Horney. 1981. Nash-bargained household decisions. *International Economic Review* 22: 333–350.

McIntire, J., D. Bourzat, and P. Pingali. 1992. *Crop–livestock interaction in Sub-Saharan Africa*. Washington, D.C.: World Bank.

Marsden, W. 1811. *The history of Sumatra*. Reprint of third edition. Singapore.

Mendelsohn, R. 1994. Property rights and tropical deforestation. *Oxford Economic Papers* 46 (5): 750–756.

Michon, G., and H. de Foresta. 1995. The Indonesian agroforest model. Forest resource management and biodiversity conservation. In *Conserving biodiversity outside protected areas. The role of traditional agro-ecosystems*, ed. P. Halladay and D. A. Gilmour. Gland, Switzerland: World Conservation Union (IUCN).

Migot-Adholla, S. E., F. Place, and W. Oluoch-Kosura. 1994. Security of tenure and land productivity in Kenya. In *Searching for land tenure security in Africa*, ed. John W.Bruce and Shem E. Migot-Adholla. Dubuque, Ia., U.S.A.: Kendall/Hunt.

Migot-Adholla, S. E., G. Benneh, F. Place, and S. Atsu. 1994. Land, security of tenure and productivity in Ghana. In *Searching for land tenure security in Africa*, ed. John W. Bruce and Shem E. Migot-Adholla. Dubuque, Ia., U.S.A.: Kendall/Hunt.

North, D. C. 1991. Institutions. *Journal of Economic Perspectives* 5 (1): 97–112.

Okali, C. 1983. Kinship and cocoa farming in Ghana. In *Female and male in West Africa*, ed. C. Oppong. London: Allen & Unwin.

Ortsin, G. 1998. Natural resource utilization and community participation. Paper presented at the National Workshop on Land Use for Sustainable Land Management, Accra.

Ostrom, E. 1990. Governing the commons: The evolution of institutions for collective action. Cambridge, U.K.: Cambridge University Press.

Otsuka, K., and F. Place, eds. 2001. *Land tenure and natural resource management: A comparative study of agrarian communities in Asia and Africa*. Baltimore, Md., U.S.A.: Johns Hopkins University Press.

Otsuka, K., H. Chuma, and Y. Hayami. 1992. Land and labor contracts in agrarian economies: Theories and facts. *Journal of Economic Literature* 30: 1965–2018.

Otsuka, K., S. Suyanto, T. Sonobe, and T. Tomich. 2001. Evolution of customary land tenure and development of agroforestry: Evidence from Sumatra. *Agricultural Economics* 25 (1): 85–101.

Penot, E. 1997. From shifting agriculture to sustainable rubber complex agroforestry systems (jungle rubber) in Indonesia: A history of innovations, production and adoption process. Paper presented at ICRAF/Cornell University Workshop on Indigenous Strategy for Intensification of Shifting Cultivation in Southeast Asia, Bogor.

Pingali, P., Y. Bigot, and H. P. Binswanger. 1987. *Agricultural mechanization and the evolution of farming systems in sub-Saharan Africa*. Baltimore, Md., U.S.A.: Johns Hopkins University Press.

Pitt, M., M. R. Rosenzweig, and N. Hassan. 1990. Productivity, health and inequality in the intrahousehold distribution of food in low-income countries. *American Economic Review* 80 (5): 1139–1156.

Place, F., and P. Hazell. 1993. Productivity effects of indigenous land tenure in Sub-Saharan Africa. *American Journal of Agricultural Economics* 75 (1): 10–19.

Place, F., M. Roth, and P. Hazell. 1994. Land tenure security and agricultural performance in Africa: Overview of research methodology. In *Searching for land tenure security in Africa*, ed. J. W. Bruce and S. E. Migot-Adholla. Dubuque, Ia., U.S.A.: Kendall/Hunt.

Quisumbing, A. R. 1994. Intergenerational transfers in Philippine rice villages: Gender differences in traditional inheritance customs. *Journal of Development Economics* 43: 167–195.

———. 1996. Male–female differences in agricultural productivity: Methodological issues and empirical evidence. *World Development* 24 (10): 1579–1595.

Quisumbing, A. R., L. Haddad, and C. Peña. 1998. Gender and poverty: New evidence from 10 developing countries. International Food Policy Research Institute, Washington, D.C. Mimeo.

Quisumbing, A. R., E. Payongayong, J. B. Aidoo, and K. Otsuka. 2001a. Women's land rights in the transition to individualized ownership: Implications for tree resource management in Western Ghana. *Economic Development and Cultural Change*, October.

Quisumbing, A. R., J. B. Aidoo, E. Payongayong, and K. Otsuka. 2001b. Agroforestry management in Ghana. In *Land tenure and natural resource management: A comparative study of agrarian communities in Asia and Africa*, ed. K. Otsuka and F. Place. Baltimore, Md., U.S.A.: Johns Hopkins University Press.

Robertson, A. F. 1982. *Abusa*: The structural history of an economic contract. *Journal of Development Studies* 18: 447–478.

Rocheleau, D. E. 1988. Women, trees and tenure: implications for agroforestry. In *Whose trees? Proprietary dimensions of forestry*, ed. Louise Fortmann and John W. Bruce. Boulder, Colo., U.S.A.: Westview.

Rocheleau, D., and D. Edmunds. 1997. Women, men, and trees: Gender, power, and property in forest and agrarian landscapes. *World Development* 25 (8): 1351–1371.

Ruthenberg, H. 1980. *Farming systems of the tropics*. Oxford, U.K.: Clarendon Press.

Saito, K., and D. Spurling. 1992. *Developing agricultural extension for women farmers.* World Bank Discussion Paper 156. Washington, D.C.: World Bank.

Shepherd, G. 1991. The communal management of forests in the semi-arid and sub-humid regions of Africa. *Development Policy Review* 19: 151–176.

Suyanto, S., and K. Otsuka. 2001. From deforestation to development of agroforests in customary land tenure areas of Sumatra. *Asian Economic Journal* (in press).

Suyanto, S., T. P. Tomich, and K. Otsuka. 2001a. Land tenure and farm management efficiency: The case of smallholder rubber production in customary land areas of Sumatra. *Agroforestry Systems*, forthcoming.

———. 2001b. Land tenure and farm management efficiency: The case of paddy and cinnamon production in customary land areas of Sumatra. *Australian Journal of Agricultural and Resource Economics*, forthcoming.

———. 2001c. Agroforestry management in Sumatra. In *Land tenure and natural resource management: A comparative study of agrarian communities in Asia and Africa*, ed. K. Otsuka and F. Place. Baltimore, Md., U.S.A.: Johns Hopkins University Press.

Thomas, D. 1990. Intra-household resource allocation: An inferential approach. *Journal of Human Resources* 25: 635–664.

———. 1994. Like father, like son; like mother, like daughter: Parental education and child health. *Journal of Human Resources* 29 (4): 950–988.

Tomich, T. P., M. van Noordwijk, S. Budidarsono, A. Gillison, T. Kusumanto, D. Murdiyarso, F. Stolle, and A. M. Fagi. 2000. Agricultural intensification, deforestation, and the environment: Assessing trade-offs in Sumatra, Indonesia. In *Tradeoffs or synergies? Agricultural intensification, environment, and economics development*, ed. D. R. Lee and C. B. Barrett. Wallingford, U.K.: CAB International Publishing.

Warner, K. 1995. Patterns of tree growing by farmers in eastern Africa. In *Tree management in farmer strategies: Responses to agricultural intensification*, ed. J. E. M. Arnold and P. A. Dewees. Oxford, U.K.: Oxford University Press.

World Bank. 1990. *World development report*. Washington, D.C.

———. 1998. The World Development Indicators 1998 CD-ROM. WinSTARS Version 4.01. Washington, D.C.: World Bank.